

A sustainable clinical simulation framework for pre-specialisation clinical technology training in South Africa

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DECLARATION

I, Johannes Joseph Perkins, do declare that this research project submitted to the Central University of Technology for the degree Doctorate in Health Sciences Clinical Technology is my independent work that has not been submitted to any institution by myself or any other person in the fulfilment of the requirements for the attainment of any qualification.



Mr. JJ Perkins

2021-02-28

Date

DEDICATION

I dedicate this thesis to my mother, who has always encouraged me in my education. To my wife, Bernadette and daughter, Danielle, who has continuously supported me in my career and without their love and support, this research would never have been possible.

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LIST OF CONCEPT CLARIFICATIONS

Concept	Clarification
Adult learner	A student who is 24 years or older when he/she is enrolling at an institute of higher education as an undergraduate student (IGI Global, 2021).
Clinical simulation	An educational technique that replaces or amplifies real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner (Lopreiato, 2016).
Framework	A system of rules, ideas, or beliefs used to plan or decide something (Cambridge Dictionary, 2021).
High fidelity simulation	A very realistic simulation method uses computer-based manikins (Government of Western Australia, 2021).
Low fidelity simulation	An inexpensive scenario-based and/or role-playing simulation method used to train students in specific skills (Krishnan <i>et al.</i> , 2017).
Medium fidelity simulation	This type of simulation involves more realism than used in low fidelity simulation and may involve manikins and actors (Government of Western Australia, 2021).
Pre-specialisation	The training period a clinical technology student spends on campus before deciding which speciality they want to specialise in (Central University of Technology [CUT], 2020b).
Sustainable	Able to be upheld (Lexico, 2021).
Work-integrated learning (WIL) supervisor	A qualified healthcare professional supervising, lecturing and mentoring a clinical technology student (CUT, 2020b).

LIST OF ABBREVIATIONS

AAMC	Association of American Medical Colleges
ABG	Arterial Blood Gas
ACLS	Advanced Cardiac Life Support
ACT	Activated Clotting Time
ADDIE	Analysis, Design, Development, Implementation, and Evaluation
AED	Automated External Defibrillator
aEEG	Amplitude-Integrated Electroencephalography
AHPCSA	The Allied Health Professions Council of South Africa
AI	Artificial Intelligence
AIDS	Acquired Immunodeficiency Syndrome
AMEE	Association for Medical Education in Europe
BAP	Biomedical Apparatus and Procedures
BC	Before Christ
BLS	Basic Life Support
BMC	Biomed Central
BMJ	British Medical Journal
BP	Blood Pressure
BSc	Baccalaureus Scientia
CASE	Comprehensive Anaesthesia Simulation Environment
CAUTI	Catheter-Associated Urinary Tract Infections
CHAT	Cultural-Historical Activity Theory
CLT	Cognitive Load Theory
CNSH	Canadian Network for Simulation in Healthcare
Cont.	continue
COPD	Chronic obstructive pulmonary disease

COREQ	Consolidated Criteria for Reporting Qualitative Research
COVID	Corona Virus Disease
CPR	Cardiopulmonary resuscitation
CRRT	Continuous Renal Replacement Therapy
CT	Complexity Theory
CTI	Clinical Technology Instrumentation
CTP	Clinical Technology Practise
CUT	Central University of Technology
CVP	Central Venous Pressure
CVVHD	Continuous Veno-Venous Haemodialysis
DHET	Department of Higher Education and Training
DP	Deliberate Practice
Dr	Doctor
DUT	Durban University of Technology
e.g.	<i>exempli gratia</i> (for example)
ECG	Electrocardiogram
ECMO	Extracorporeal Membrane Oxygenation
EEG	Electroencephalogram
EL	Experiential Learning
ELT	Experiential Learning Theory
EMG	Electromyography
EP	Evoke potential
GMS	German Medical Science
HAP	Health Associate Professions
Hb	Haemoglobin
HLT	Humanistic Learning Theory

HPCSA	Health Professions Council of South Africa
HSREC	Health Sciences Research and Ethics Committee
ICD	Implantable Cardioverter-Defibrillator
ICU	Intensive Care Unit
INACSL	International Nursing Association for Clinical Simulation & Learning
IR	Industrial Revolution
IREC	The Institutional Research Ethics Committee
ISD	Instructional System Development
IT	Information Technology
LLC	Limited Liability Company
LNAI	Lecture Notes in Artificial Intelligence
LTEM	Long-term epilepsy monitoring
MB ChB	Bachelor of Medicine, Bachelor of Surgery
MEP	Maximum Expiratory Pressure
MIP	Maximum Inspiratory Pressure
ML	Mastery Learning
MSLT	Multiple Sleep Latency Test
n.d.	No Date
NCS	Nerve Conduction Studies
NGT	Nominal Group Technique
NHLBI	National Heart Lung and Blood Institute
NHS	National Health Service
OECD	Organisation for Economic Co-operation and Development
OPHTH	Ophthalmology
OSCE	Objective Structured Clinical Examination
PhD	Doctor of Philosophy

PPE	Personal Protective Equipment
Prof	Professor
REC	Research and Ethics Committee
RT	Respiratory Therapist
SA	South Africa
SACTA	South African Clinical Technology Association
SAGE	Scientific Advisory Group for Emergencies
SAQA	South African Qualifications Authority
SATS	Saturation
SCT	Social Cognitive Theory
SCUF	Slow Continuous Ultrafiltration
SDL	Self-Directed Learning
SL	Situated Learning
SLEDD	Sustained Low-Efficiency Daily Dialysis
SLT	Social Learning Theory
SP	Simulated Patient
SQA	Scottish Qualifications Authority
TCD	Transcranial Doppler
TUT	Tshwane University of Technology
UFS	University of the Free State
UK	United Kingdom
US	United States
USA	United States of America
WHO	World Health Organization
WIL	Work-Integrated Learning

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ABSTRACT

Introduction: As part of the healthcare fraternity, clinical technology has been lacking in using clinical simulation as part of the training of clinical technology students. However, as healthcare professionals, clinical technology students often face similar problems as other healthcare students when dealing with real patients for the first time or entering the healthcare environment. Simulation has proved its worth to prepare and train various healthcare students in the necessary technical and non-technical skills in a safe and controlled environment. Therefore, the purpose of this study was to investigate the development of a sustainable clinical simulation framework for pre-specialisation clinical technology students in South Africa.

Methods: An in-depth study based on the grounded theory approach was done using three known qualitative methods: a detailed literature review and data collected from focus group discussions and nominal group interviews. Due to the COVID-19 pandemic outbreak, both the focus groups discussions and nominal group interviews were conducted via an online meeting platform. Two focus groups discussions were conducted with work-integrated learning (WIL) supervisors responsible for the supervision and training of clinical technology students busy with WIL. Three online nominal group interviews were held with the personnel of tertiary institutions in South Africa responsible for offering the clinical technology qualification. The tertiary institutions included Central University of Technology (CUT), Durban University of Technology (DUT) and Tshwane University of Technology (TUT). Data and transcripts from the focus group discussions were analysed through a triple coding process, whereas nominal group interviews' data were analysed via known qualitative techniques.

Results: Two focus groups were conducted with various themes identified from the four focus group areas. The central theme from focus group area one was *"The importance of clinical simulation"*. Focus group area two, *"The preparation of the pre-specialisation clinical technology students."*, identified five major themes. Focus group area 3 viewed the role simulation may play in the training and assessment of clinical technology students. One major theme surfaced from this focus group area, namely *"The expectations of a clinical simulation programme"*. Focus group area 4, *"Important issues regarding practical and skills training"*, resulted in four major themes. In addition to the two focus group discussions, three nominal groups meetings were conducted with fifteen themes identified regarding the role simulation

may play in the training and assessment of pre-specialisation clinical technology students. Ten themes related to the important graduate attributes the nominal group participants ranked essential, clinical technology students should be trained in, were identified from the collected data.

Conclusion: The researcher was able to construct a clinical simulation framework that could be implemented into the current pre-specialisation clinical technology students' curriculum from the results. A clinical simulation framework and program will ensure that these students are adequately prepared on both a theoretical and practical level with the ability to apply the acquired knowledge in a real-life healthcare environment. The resultant effect will be a better prepared and knowledgeable student entering the WIL environment with confidence.

CHAPTER 1: ORIENTATION TO THE STUDY

1.1 INTRODUCTION

In this study, the researcher conducted comprehensive research to obtain the required information to develop a simulation training framework that can be used to train and prepare pre-specialisation clinical technology students before they continue with their specialised training in a real-life healthcare environment. Upon completing their first two years of study, these students are then accepted into work-integrated learning units (WIL) in various clinical technology specialities. As healthcare students, they are required to communicate with patients and colleagues effectively. In addition to the before-mentioned, they are also required to perform basic clinical procedures on patients.

To successfully negotiate the skills mentioned above, they need to be provided with the necessary knowledge and a stable learning platform to enhance their experience and build their expertise. Simulation has proved to be a successful supplementary training method for various healthcare programs to prepare students in a safe environment for their role as healthcare providers and engage with patients professionally within their scope of practice (Weller *et al.*, 2012).

Background to the research problem is provided in Chapter 1 to orientate the reader to the study.

1.2 BACKGROUND

The infamous “*Bristol Enquiry*” sparked the development of alternative training methods and assessments for healthcare workers that didn’t involve patients (Maran & Glavin, 2003). According to Dyer, the Bristol inquiry report published in 2001 described a bleak state of affairs in the Bristol Royal infirmary’s cardiac wing, where between 30-35 paediatric patients with a good prognosis passed away over five years. The report identified a variety of problems within the specific hospital. These problems included poor teamwork, the delegation of work, and lack of insight, especially when theatre lists needed to stop when the surgery started failing. Physical issues such as the distance between the operating theatre and intensive care units (ICU), ICU’s being on different floors, and the absence of dedicated theatre lifts further contributed to these patients’ poor outcomes (Dyer, 2001).

Research also indicated that preventable medical errors identified in the Bristol report are the third-highest cause of death in the United States (US) and is responsible for more than 400 000 deaths in this first-world country alone (Jones *et al.*, 2015). These alarming figures still haunt the medical education system, although Flexner's report in 1910 already indicated that new teaching strategies need to be developed and implemented (Jones *et al.*, 2015). It seems, however, that the students struggle to adapt to the tertiary environment. International research done on the difficulties students faces indicated that students have three distinct problems. The problems included time management, workload, and high expectations from other people (Brooker *et al.*, 2017). The before-mentioned is especially true for clinical technology students entering into WIL. They enter into WIL early and have to learn how to balance studying and working simultaneously in a short time. In clinical technology's current practical training program, students are not adequately exposed on a clinical and practical level to prepare them for WIL. In addition, students' stress levels are increased by the need to perform well and meet the unit supervisors' expectations. An additional and alternative training method may prove to be the solution to the current lack in practical and clinical training of the pre-specialisation clinical technology student.

The need for alternative training methods is further emphasised by the fact that patients need protection at all times (Krishnan *et al.*, 2017). The well-known Latin quote "*Primum non nocere*", or as it is better known "*do no harm*", emphasise the statement by Krihnan (Sokol, 2013). Therefore, healthcare educators cannot afford to use patients as a "*test ground*" to equip future medical professionals with the necessary skills to treat patients safely. Recent research indicated that medical errors were significantly reduced in students trained through a simulation-based curriculum (Kuo *et al.*, 2020). Medical simulation provides a sustainable alternative in training medical personnel, intending to allow the trainees to practice and learn how to cope with certain situations in a planned manner without harming actual patients (Krishnan *et al.*, 2017).

Simulation sets a learning environment that can be controlled by introducing different practices, manipulating external distractions, and providing feedback to each learner by a debriefing session at the end of each simulation (Beaubien & Baker, 2004). Therefore, the question is asked how training institutions for clinical technology students can use the benefits of simulation and implement a simulation programme as part of the clinical technologist pre-specialisation training programme?

1.3 PROBLEM STATEMENT

Medical simulation as a teaching, learning and assessment tool has greatly benefited the medical schools and training institutions responsible for training healthcare workers and their students (Vincent-Lambert & Bogossian, 2017). However, there is currently no structured medical or clinical simulation programme within the South African clinical technology curriculum, although various simulation equipment is available.

South African scholars entering the tertiary system, in addition to the difficulties mentioned earlier (Section 1.2), also face other barriers such as language and the quality of school education (Nkosi, 2016). Nkosi (2016) reported that the standard of education, especially in English and Mathematics, is questionable. The clinical technology program function under the Health and Environmental Sciences Faculty at CUT, teaching on campus and in the WIL units are only offered in English. Students applying for admission to the program require an admission point score of at least 30, with English, Mathematics, Physical Sciences and Life Sciences at least at Level 4 (50-59%) as per the National Senior Certificate criteria. Therefore, students without the proper base knowledge and understanding of the mentioned subjects may lack the required skills to progress through the course in the stipulated timeframe and possibly fail to complete the course entirely.

Work-integrated learning forms an integral part of the clinical technology student's training, and the tertiary institutions training these students are dependent on the WIL units to accommodate students specialising in a specific field of study. An increase in student numbers and a decrease in accredited WIL units makes it difficult to find placements for all the students. Students usually apply for WIL placement in their first choice of speciality but often must settle for their second or even third choice. Therefore, it is crucial to equip the student with the necessary basic procedural and clinical skills to better their chances of being accepted in their speciality of choice and empower them to achieve their goals and succeed.

Since the WIL units are all practising consultation rooms, clinics, and hospitals, the researcher believes that 3RD -year students are often overwhelmed. Students are suddenly exposed to real patients and medical cases. The before mentioned is confirmed by Jamshidi and her colleagues' research that students lacking specific skills often feel stressed and anxious when entering the clinical environment (Jamshidi *et al.*, 2016). It is essential to prepare the pre-specialisation

student properly to transition from “*university to the hospital*” successfully. Using a simulation programme, clinical technology students may be taught how to be professional, integrate successfully into their position as part of a multi-disciplinary team, provide them with the knowledge to cope emotionally with real-life patients, and promote clinical reasoning. However, most importantly, it is essential to provide them with the necessary procedural techniques, clinical skills and experience to contribute to the basic requirements needed within each of the seven specialities. Therefore, it is essential to inquire from the industry and tertiary institutions personnel what is required from a 3RD -year clinical technology student on a practical and emotional level to integrate into the healthcare environment and complete his/her WIL training successfully.

1.4 RESEARCH QUESTIONS

- How can clinical simulation be used to enhance the practical training programme of clinical technologists?
- How can clinical simulation be incorporated into the current pre-specialisation phase of the curriculum of clinical technology as sustainable teaching, learning, and assessment tool?
- What specific procedures, generic and specific, clinical skills and graduate attributes should be included in a practical training programme for clinical technologists during the first two years of study to ensure the delivery of competent and skilled students to WIL units?

1.5 RESEARCH AIM

The study aims to develop a sustainable clinical simulation framework for clinical technology students in the pre-specialisation phase. The purpose of such a framework would be to describe general and specific outcomes and to ensure clinical technology students are exposed to the biomedical apparatus they encounter during WIL and their future careers. Furthermore, to provide these students with the opportunity to gain experience in general and specialised clinical technological procedures using practical scenarios and simulation.

1.6 RESEARCH OBJECTIVES

The objectives of the research project are to:

- Develop a conceptual, clinical simulation framework to enhance the practical training programme of clinical technology. (This objective was achieved through the literature review, focus group discussions, and nominal group interviews).

- Provide guidelines on how clinical simulation can be incorporated into the current clinical technology curriculum's pre-specialisation phase. (This objective was achieved through the focus group discussions and nominal group interviews).
- Determine what specific procedures, both generic and specific, together with clinical skills (including graduate attributes) should be included as part of the practical simulation training programme for clinical technologists during the first two years of study to provide/deliver a competent and skilled student entering the WIL unit. (This objective was achieved through the focus group discussions and nominal group interviews).

1.7 SCOPE OF THE STUDY

The study focused on the development of a simulation framework for clinical technology students. Using the information gathered from interviewing WIL supervisors and personnel from clinical technology training institutions, a sustainable simulation framework was developed that could be used by the training institutions during the pre-specialisation period of the clinical technology students. The study was conducted online and included WIL trainers and clinical technology training personnel from Gauteng, Free State, Northern Cape and the Western Cape. The study commenced in August 2019 and concluded in January 2021.

1.8 VALUE AND SIGNIFICANCE OF THE STUDY

The subsequent clinical simulation framework developed from this study's results addresses the absence of structured clinical simulation in clinical technology students' training. The generic framework could be implemented in any pre-specialisation clinical technology curriculum and include simulation-based training in basic, specific, procedural skills and graduate attributes essential to the specialising and qualified clinical technologist.

1.9 RESEARCH METHODOLOGY

Based on the qualitative grounded theory, the study used a literature review and specific qualitative research methods that included nominal group interviews and focus group discussions in collecting the data. The literature review aimed to provide insight into clinical simulation as a training and assessment tool, thus confirming the development of a simulation framework specifically for clinical technology (Klopper, 2008).

Through discussion and observation, the focus groups provided insight into how important WIL supervisors perceived clinical simulation and the role clinical simulation may play in

training clinical technology students (Nagle & Williams, 2013). The role of clinical simulation included exposure of students to biomedical apparatus, basic and specific skills and procedures WIL supervisors proposed as part of a clinical simulation framework for clinical technology students.

The nominal group interviews with the three tertiary clinical technology training institutions' personnel complimented clinical simulation's role and importance in clinical technology. More importantly, the nominal groups provided balanced information regarding the graduate attributes the personnel agreed upon and considered necessary in these specific students' training (Horton, 2007). The research methodology is discussed in detail in Chapter 3.

1.10 OVERVIEW OF THE STUDY

Figure 1.1. below provides a brief overview and timeline of the study.

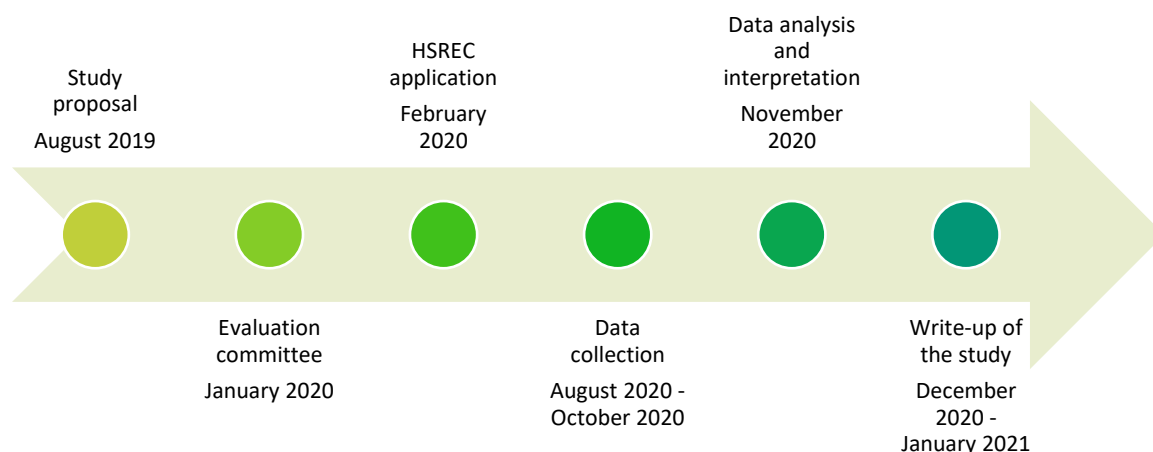


FIGURE 1.1 STUDY OVERVIEW AND TIMELINE

[COMPILED BY THE RESEARCHER, PERKINS 2020]

1.11 IMPLEMENTATION OF FINDINGS

The clinical simulation framework developed from the collected data could be implemented as part of the three tertiary institutions' pre-specialisation curriculum in South Africa responsible for training clinical technology students.

1.12 ARRANGEMENT OF THE STUDY

Reporting on the topic, the methods used, and the results of the study are arranged as follows:

In this chapter, Chapter 1: An orientation to the study, the background to the study together with the problem statement and research questions were provided. The overall aim and objectives were also stated. The scope of the study and the value and significance of the study were outlined. The research design and a short description of the study's methodology were described, with a full explanation in Chapter 3. The proposed implementation of the study findings was also discussed.

Chapter 2: Provides a detailed review of the literature related to clinical technology as a profession and its graduate attributes. The literature review further focuses on the learning theories describing how students learn and how different theories may incorporate simulation as a training tool. The literature also provided detailed information regarding clinical simulation, where it started and its current affiliation with clinical technology. The review concluded with the suggested process of developing a clinical simulation framework.

Chapter 3: Research Methodology, a detailed description of the research design and methodology, are provided.

Chapter 4: Findings and discussion of the focus group discussions, including presenting the focus group discussions' results.

Chapter 5: Findings and discussion of the nominal group interviews and presenting the nominal group interviews results.

Chapter 6: The development of a sustainable clinical simulation framework for pre-specialisation clinical technology students in South Africa's results are discussed.

Chapter 7: Conclusion, limitations together with recommendations, an overview and a summary of the study is provided.

1.13 CONCLUSION

Chapter 1 provided the introduction, overview and background to the research problem that was addressed. In the next chapter, Chapter 2: The literature related to clinical technology and clinical simulation as a means of training healthcare professionals, especially clinical technologists, are presented.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This study investigated the information and requirements necessary to develop a sustainable and practical simulation programme for pre-specialisation clinical technology students. Chapter 2 focuses on the literature related to simulation's current use as a training and assessment tool in healthcare education. The chapter provides a clear definition of clinical technology and a detailed description of the scope of practice for each profession's specialities. This chapter further reviews the history of simulation and its role in both non-medical and medical fields. The chapter also explores the advantages of using simulated based training. Lastly, the chapter reviews the literature on establishing and implementing a simulation programme into a current curriculum. Figure 2.1 provides a summary of the topics described in this literature review.



FIGURE 2.1 SUMMARY OF LITERATURE REVIEW

[COMPILED BY THE RESEARCHER, PERKINS, 2020]

2.2 DEFINING CLINICAL TECHNOLOGY

Clinical technologists are regulated under the Health Professions act 56 of 1974. Regulations defining the scope of the profession of clinical technology as published in the Government Gazette 43686 of 4 September 2020 by the Department of Health where a clinical technologist, in general, is defined as:

- (i) A healthcare provider that collaborates with a medical practitioner to perform clinical investigative procedures with the aid of appropriate apparatus and techniques.
- (ii) A healthcare provider that performs corrective and therapeutic procedures in collaboration with a medical practitioner.
- (iii) Operating clinical technology apparatus including but not limited to diagnostic testing, therapeutic procedures and organ support.
- (iv) Renting and supplying clinical technology apparatus directly to the public (Department of Health, 2020).

According to the South African Clinical Technology Association (SACTA), a clinical technologist is a qualified individual that forms an essential link between medical equipment and specific organ systems to ensure proper bodily function (South African Clinical Technology Association [SACTA], 2015).

The South African Qualifications Authority (SAQA) elaborates further and describes a clinical technologist as a healthcare provider registered with the Health Professions Council of South Africa (HPCSA). This person can perform medical and clinical procedures on various pathophysiological conditions to contribute to these conditions' diagnosis and treatment (South African Qualifications Authority [SAQA], 2015).

2.2.1 CURRENT OFFERING OF CLINICAL TECHNOLOGY

Currently, there are only three tertiary institutions authorised by the HPCSA to act as examining authorities for clinical technology in South Africa (SA); Durban University of Technology (DUT), Tshwane University of Technology (TUT), and Central University of Technology (CUT) (Health Professions Council of South Africa [HPCSA], 2018).

Clinical technology is offered as a four-year Bachelor of Science degree at CUT and DUT. In the first two years of the degree, the CUT students are trained on campus. At the end of the second year, the CUT students must decide which of the seven specialities they want to specialise in. Once they selected their speciality, the student will spend his/her 3RD and 4TH - years training in an HPCSA accredited WIL unit in that specific speciality. These WIL units are usually clinics, theatre complexes, and units situated in hospitals, doctors' rooms, or private practices. The purpose of the 1ST and 2ND years is to provide the student with the theoretical knowledge and necessary skills required as clinical technologists and equip them with important information about the medical environment they enter in their 3RD and 4TH years of study (CUT, 2019).

Students currently applying for entrance to the Clinical Technology program are mainly Centennials. Literature dictates that this particular generation born after 2000 prefers to learn through audio and technology. They see learning as a game and have a high level of creativity (Murad *et al.*, 2019). Hopkins *et al.* (2017) propose that to accommodate the generational gap between educators and learners, educators need to be accessible, honest and approachable. Research on the previous generation, the millennials, proved that simulation helped students to transfer essential knowledge. As is the case with centennials, millennials prefer to use technology and therefore, simulation may provide an interactive, hands-on method to learn about clinical experiences (Hopkins *et al.*, 2017).

The clinical technology program aims to accommodate approximately 30 first-year entry students and 10 students from the extended curriculum program. Currently of these 40 students, approximately 75% are female. In addition, 51% of these students are Black, 42% White, 4% Coloured and 2% Indian.

2.4 CLINICAL TECHNOLOGY SPECIALITIES AND SCOPE OF PRACTICE

A clinical technologist specialises in South Africa and is registered with the HPCSA as a clinical technologist supervised practice or clinical technologist independent practice in one of seven specialities. The scope of practice described below refers to the Clinical Technology scope of practice set out by the South Africa Qualifications Authority (SAQA). The updated Clinical technology scope of practice, as published by the HPCSA, are discussed in Chapter 6.

The following sections, 2.4.1 – 2.4.7, provide insight into the seven different specialities in clinical technology and the scope of practice for each speciality published by SAQA.

The clinical technology specialities include (SAQA, 2015):

- Cardiology
- Cardiovascular perfusion
- Critical care
- Nephrology
- Neurophysiology
- Pulmonology
- Reproductive biology.

2.4.1 CLINICAL TECHNOLOGY CARDIOLOGY

The Clinical Technology Association of South Africa (SACTA) describes the clinical technologist specialising in cardiology as a healthcare provider that assists physicians in diagnosing and treating heart, lung, and blood vessel disorders. The before mentioned is achieved by conducting invasive diagnostic tests of the cardiovascular and pulmonary systems. The cardiology clinical technologist is also responsible for maintaining equipment and recording test results (SACTA, 2015).

The scope of practice, according to SAQA (2015), with particular reference to the clinical technologist specialised in cardiology, is listed as known diagnostic and therapeutic procedures below (SAQA, 2015):

- Basic resting electrocardiogram.
- Basic and advanced cardiac life support and automated external defibrillator (AED).
- Spirometry measurement.
- Anthropometric measurement.
- Activating clotting time testing.
- Respiratory rate measurement.
- Non-invasive blood pressure measurement.
- Oral and axillary temperature measurement.
- Radial and femoral pulse measurement.
- Blood gas testing.
- Oximetry.

- Non-provocative nebulizers.
- Oxygen therapy (mask and nasal cannula).
- Setting up of pressure transducers, ventilators, infusion devices.
- Phlebotomy.
- 12-lead Electrocardiogram (ECG).
- Exercise stress test.
- 24hr/48hr ambulatory blood pressure monitor; 24hr/48hr Holter monitor.
- Cardiac catheterisation procedures.
- Electrophysiology studies.
- Temporary and permanent pacemakers.
- Cardioversion and defibrillation.
- Echocardiography; Testing/programming of permanent pacemakers - Dual, biventricular, implantable cardioverter-defibrillator (ICD), loop devices, trans - telephonic diagnostic checks.
- Permanent pacemaker selections.
- Intra-aortic balloon pump.
- Left ventricular assist therapy.
- Transoesophageal echocardiography.
- Advanced cardiopulmonary resuscitation.
- Drug administration and management of side effects.

2.4.2 CLINICAL TECHNOLOGY: CARDIOVASCULAR PERFUSION

SACTA describes the clinical technologist specialised in the speciality of cardiovascular perfusion as a perfusionist. The perfusionist is responsible for operating extracorporeal circulation equipment during any medical procedure where a patient requires artificial support or temporality replacement of his/her circulatory or respiratory function (SACTA, 2015).

The scope of practice of the perfusionist, according to SAQA, is listed below (SAQA, 2015) :

- Basic resting electrocardiogram.
- Basic and advanced cardiac life support and automated external defibrillator.
- Spirometry measurement.
- Anthropometric measurement.
- Activating clotting time testing.
- Respiratory rate measurement.

- Non-invasive blood pressure measurement.
- Oral and axillary temperature measurement.
- Radial and femoral pulse measurement.
- Blood gas testing and analysis.
- Oximetry.
- Non-provocative nebulizers.
- Oxygen therapy (mask and nasal cannula).
- Setting up of pressure transducers, ventilators, infusion devices.
- Phlebotomy.
- Aortic balloon pump.
- Autologous blood recovery.
- Cardiovascular monitoring.
- Activated clotting time.
- Cardiopulmonary resuscitation (CPR).
- Cardioversion.
- Defibrillation.
- Extracorporeal cardiovascular perfusion on paediatric and neonatal patients or [200 extracorporeal cardiovascular perfusion procedures on high-risk adult and paediatric /neonatal patients].
- Left ventricle assist therapy.
- Drug administration and management of side effects.

2.4.3 CLINICAL TECHNOLOGY: CRITICAL CARE

The clinical technologist specialised in critical care mainly works in intensive care, high care, and theatre units. According to SACTA, their primary focus would be monitoring, troubleshooting, and supporting equipment and technology needed to support organ function and maintain life-support of critically ill patients (SACTA, 2015).

The diagnostic and therapeutic procedures for clinical technologists in the field of critical care to achieve the description as mentioned above, as published by SAQA is listed below (SAQA, 2015):

- Basic resting electrocardiogram.
- Basic and advanced cardiac life support and automated external defibrillator.

- Spirometry measurement.
- Anthropometric measurement.
- Activating clotting time testing.
- Respiratory rate measurement.
- Non-invasive blood pressure measurement.
- Oral and axillary temperature measurement.
- Radial and femoral pulse measurement.
- Blood gas testing.
- Oximetry.
- Non-provocative nebulizers.
- Oxygen therapy (mask and nasal cannula).
- Setting up of pressure transducers, ventilators, infusion devices.
- Phlebotomy.
- Quality control of life support equipment.
- Statistical analysis and patient scoring.
- Blood gas sampling, measurement, and interpretation.
- Invasive hemodynamic monitoring procedures.
- Set up equipment for critically ill patients' intrahospital transportation, non-invasive hemodynamic monitoring, monitoring of an anaesthetised patient.
- Preparation of ICU drugs.
- Handling of infusion devices and drugs.
- Capnography.
- Assists with bronchoscopy and right heart catheterisation.
- Advanced cardiac life support (ACLS).
- CPR.
- Intubation, intravenous cannulation, emergency drug therapy.
- Monitor intra-aortic balloon pump.
- Ventilation therapy: monitoring and resuscitation.
- Assist with acute haemodialysis and continuous renal replacement therapy (CRRT).
- Determine blood flow (Doppler).
- Autologous blood recovery.
- Cell saving.

- Metabolic studies.
- Left ventricle assist therapy.
- Cardioversion.
- Defibrillation.
- Electrolyte determination.
- Coagulation studies.
- Endoscopy.
- Ultrasonography.
- General equipment management.
- Assist with ICU/trauma/theatre clinical procedures.
- Physiological data management.
- Advanced patient transport.
- Drug administration and management of side effects.

2.4.4 CLINICAL TECHNOLOGY: NEPHROLOGY

Clinical technologist specialised in nephrology is mainly responsible for the set-up and operation of equipment and procedures that would assist with treating patients with renal related issues, e.g. haemodialysis and peritoneal dialysis (SACTA, 2015).

The list of specialised procedures related to the scope of practice of the clinical technologist specialised in the field of nephrology is listed below (SAQA, 2015):

- Basic resting ECG.
- Basic and advanced cardiac life support and AED.
- Peak flow measurement.
- Anthropometric measurement.
- Activating clotting time testing.
- Respiratory rate measurement.
- Non-invasive blood pressure measurement.
- Oral and axillary temperature measurement.
- Radial and femoral pulse measurement.
- Blood gas testing.
- Non-invasive oximetry.

- Nonprovocative nebulisers.
- Oxygen therapy (mask and nasal cannula).
- Skin prick test.
- Intravenous cannulation and administration.
- Phlebotomy.
- Chronic and acute haemodialysis.
- Continuous venovenous haemodialysis (CVVHD).
- Peritoneal dialysis.
- Administer blood transfusion.
- Exchange transfusions.
- Paediatric haemodialysis.
- Apheresis.
- Plasma filtration.
- Haemoperfusion.
- Haemofiltration and haemodiafiltration.
- Plasmapheresis.
- Slow continuous ultrafiltration (SCUF).
- Cell saving.
- Stem cell harvesting.
- Reuse of dialysers (automated and manual).
- Water analysis and quality control.
- Drug administration and management of side effects.
- Slow, low-efficiency daily dialysis (SLEDD).

2.4.5 CLINICAL TECHNOLOGY: NEUROPHYSIOLOGY

The clinical technologist specialising in neurophysiology, known as a neurophysiologist, is described by SACTA as a person who studies the nervous system. The neurophysiologist uses specialised equipment and procedures to diagnose problems of the central and peripheral nervous systems. Typical patients seen by a neurophysiologist include patients with cerebral palsy, head injuries, psychiatric disorders, and various other neurological conditions (SACTA, 2015).

The scope of practice of the neurophysiologist is listed below (SAQA, 2015):

- Basic resting electrocardiogram.
- Basic and advanced cardiac life support and AED.
- Spirometry measurement.
- Anthropometric measurement.
- Activating clotting time testing.
- Respiratory rate measurement.
- Non-invasive blood pressure measurement.
- Oral and axillary temperature measurement.
- Radial and femoral pulse measurement.
- Blood gas testing.
- Non-invasive oximetry.
- Non-provocative nebulizers.
- Oxygen therapy (mask and nasal cannula).
- Setting up of pressure transducers, ventilators, infusion devices.
- Phlebotomy.
- Electroencephalography (EEG).
- Multiple sleep latency tests (MSLT).
- Polysomnography.
- Nerve conduction studies (NCS).
- Assist in electromyography (EMG).
- Transcranial dopplers (TCD).
- Evoke potentials (EP).
- Long-term epilepsy monitoring video studies (LTEM).
- Brain mapping.
- Subdural monitoring.
- Memory testing and Wada testing.
- Drug administration and management of side effects.

2.4.6 CLINICAL TECHNOLOGY: PULMONOLOGY

Clinical technologists are responsible for the study of the respiratory system and lung function of patients, specialised in the field of pulmonology. Pulmonology technologists perform tests mainly to assist physicians with diagnosing lung diseases using electronic equipment and

specialised diagnostic procedures. Technologists specialised, specifically in pulmonology, are involved but are not limited to patients with conditions such as asthma, emphysema, or possible post-operative pulmonary complications (SACTA, 2015).

The scope of practice as published by SAQA (date) related to the work of the pulmonology clinical technologist is listed below (SAQA, 2015):

- Basic resting electrocardiogram.
- Basic and advanced cardiac life support and AED.
- Spirometry measurement.
- Anthropometric measurement.
- Activating clotting time testing.
- Respiratory rate measurement.
- Non-invasive blood pressure measurement.
- Oral and axillary temperature measurement.
- Radial and femoral pulse measurement.
- Blood gas testing and analysis.
- Oximetry (Pulse-oximetry).
- Non-provocative nebulisers.
- Oxygen therapy (mask and nasal cannula).
- Setting up of pressure transducers, ventilators, infusion devices.
- Phlebotomy.
- Maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) testing.
- Vital signs monitoring.
- Assist with bronchoscopy procedures.
- Plethysmography.
- Diffusion measurement.
- Provocation testing.
- Polysomnography (neurological and respiratory).
- Lung compliance, exercise, shunt, and endurance studies.
- Drug administration and management of side effects.

Finally, the last but not the least speciality in clinical technology is reproductive biology. Technologists specialised in this field of study are infertility specialists. Infertility specialists offer a service to infertile couples by assisting in diagnosing possible infertility problems and highly specialised procedures and treatments to help couples fall pregnant (SACTA, 2015).

The scope of practice of the clinical technologists specialised in reproductive biology that depicts the specialised diagnostic procedures and treatments are listed below (SAQA, 2015):

- Basic resting ECG.
- Basic and advanced cardiac life support and AED.
- Spirometry measurement.
- Anthropometric measurement.
- Activating clotting time testing.
- Respiratory rate measurement.
- Non-invasive blood pressure measurement.
- Oral and axillary temperature measurement.
- Radial and femoral pulse measurement.
- Blood gas testing.
- Non-invasive oximetry.
- Non-provocative nebulizers.
- Oxygen therapy (mask and nasal cannula).
- Setting up of pressure transducers, ventilators, infusion devices.
- Phlebotomy.
- Collection of semen/sperm samples from and through various sources and methods.
- Performance of standard and advanced semen analyses.
- Cervical mucus collection and examination.
- Spermatozoa (Semen) -cervical mucus interaction tests.
- Immunological (male/female sperm antibody) tests - basic and advanced.
- Advanced semen/spermatozoa preparation/separation methods.
- Preparation of media (including blood).
- Identification and evaluation of ova/embryos.
- Insemination and transfer of ova/embryos in the laboratory.
- Embryo transfers in patients.

- Cryopreservation/vitrification of semen, ova, and embryos.
- Artificial insemination (sperm preparation and transfer).
- Experimental animal work.
- Advanced micromanipulation procedures/cell biopsies/assisted hatching.
- Drug administration and management of side effects.

The previous sections described the scope of practice for each of the seven specialities found in clinical technology. Clinical technologists are more than just people working in a healthcare environment; they are healthcare professionals. Therefore, they are expected to act and react in a specific manner. The following section discusses the graduate attributes and the clinical technology's profession association with these graduate attributes.

2.5 CLINICAL TECHNOLOGIST AND GRADUATE ATTRIBUTES

Bowden *et al.* (2000) (cited in Bitzer & Withering 2020) provide the following definition to describe the term graduate attribute: *“Graduate attributes are the qualities, skills and understandings a university community agrees its students should develop during their time with the institution. These attributes include, but go beyond, the disciplinary expertise or technical knowledge that has traditionally formed the core of most university courses. They are qualities that also prepare graduates as agents of social good in an unknown future.”* (Bitzer & Withering, 2020). Adhering to the before-mentioned definition, most universities across the world compile their own set of graduate attributes. These graduate attributes may include both generic and institution-specific attributes. The graduate attributes considered necessary for all CUT graduates are listed below (CUT, 2020):

- Sustainable development – This attribute refers to a person's ability to act unselfishly, make sure that the decisions, projects and work are done considering others and that the before-mentioned are done to benefit the country and the environment.
- Community engagement – Graduates should understand their communities' needs and be socially active in their respective communities.
- Entrepreneurship – Unemployment is a global issue, and graduates should be able to identify possible opportunities that may be converted into successful businesses and practices.

- Innovation and problem solving – Innovation goes hand in hand with entrepreneurship; however, identifying specific problems and addressing these problems through innovative ideas and applying theoretical knowledge is important.
- Technologically literate – The modern age is known for using technology to conduct work and for communication. It is vital that graduates can use technology to conduct their work and communicate effectively.
- Numerate – Numeracy in itself is essential, and for the person interested in starting a new business or practice, it is important to set up a budget and successfully manage the business financially.
- Communication – As mentioned regarding technological literacy, effective communication is an important skill, not only in its written format but orally as well.
- Technical and conceptual competence – Graduates should demonstrate specific knowledge and understanding of their field of speciality with the ability to apply the knowledge to solve problems.
- Teamwork – Being able to work and function within a team is an important skill.
- Citizenship and global leadership – Social responsibility and contributing to society by being an ethical and visionary leader are essential for the CUT graduate.

Clinical technologists register with the HPCSA and form part of a professional community of healthcare providers that deliver health care to South African patients. Therefore, it is not strange that a professional governing body such as the HPCSA also prescribed a comprehensive list of graduate attributes to healthcare providers and their clients. The attributes prescribed by the HPCSA include (HPCSA, 2014):

- Professional - Healthcare professionals should be committed to individuals and communities' health and well-being through ethical practice, profession-led self-regulation, and high personal standards of behaviour.
- Communicator - Healthcare professionals should effectively facilitate good communication between the carer-patient/carers-client to ensure a professional relationship during and after interventions.
- Collaborator - Healthcare professionals should be able to work effectively within a team to optimise patient/client care.

- Leader and manager - Healthcare practitioners are integral participants in healthcare organisations, organising sustainable practices, making decisions about allocating resources and contributing to the healthcare system's effectiveness.
- Health advocate - Healthcare professionals responsibly should be able to use their expertise and influence to advance the health and well-being of individuals, communities and populations
- Scholar - Healthcare professionals must demonstrate a lifelong commitment to reflective learning and the creation, dissemination, application and translation of knowledge.

From the graduate attributes listed above, a clinical technologist is more than just a former student but a professional responsible for the physician-assisted diagnosis and treatment of patients within the South African healthcare system. Even more so for the CUT clinical technology students since they integrate into the professional community at the beginning of their 3RD year of study. Therefore, students would be required to be exposed and taught these attributes at a 1ST and 2ND -year level.

2.6 LEARNING THEORIES

2.6.1 LEARNING THEORY DEFINED

Albert Einstein said: *“Any fool can know. The point is to understand”* (Lagacé, 2004). It is, therefore, crucial for teachers to understand exactly how students learn. Learning, especially concerning humans, makes it difficult to define the expression. An assortment of scholars has been trying over the last century to grasp the essence of learning. Resulting in a wide variety of definitions for learning being accepted as correct. However, defining learning as a change in behaviour due to experience has been recognised by many publications and textbooks as a general definition for the term (de Houwer *et al.*, 2013).

On the other hand, learning theories can simply be defined as a method to provide structure in understanding how people learn and how people acquire and retain knowledge (Luis & Cunha, 2015). Many different learning theories have been developed over recent years, and three primary theories have been identified: Behaviourism, cognitivism, and constructivism (Table 2.1) (Stevens-Fullbrook, 2019).

Kalhil and Elkhider (2016) simplified the understanding of the three primary theories by describing the theories under the following headings:

- Learner's role
- Implication
- Teaching method
- Assessment

TABLE 2.1 DESCRIPTION OF THE THREE PRIMARY THEORIES OF LEARNING

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (KHALIL & ELKHIDER, 2016)]

Theories of Learning	Behaviourism	Cognitivism	Constructivism
Learner's role in the learning process	Passive participation	Active participation	Active participation
Implication	Objective-based instruction Competency-based education Skill development and training	Concept maps Reflective thinking	An authentic case-based learning environment Reflective practice Collaborative construction of knowledge
Teaching method	Lecture Simulation Demonstration Programmed instruction	Problem-solving Concept mapping Advanced organiser	Diaries/reflection Role modelling Problem-based learning Collaborative learning
Assessment	Multiple-choice questions Recall items	Essays Written reports Projects	Elimination of grades Standardised testing Peer review

2.6.2 BEHAVIOURISM

An American psychologist named John B. Waston (1878-1958) proposed an alternative to structuralism and functionalism, namely behaviourism (Moore, 2011). Behaviourism's definition can be explained by three significant facts as pointed out by Danley *et al.* (2012):

- Behaviourism associates learning with behaviours that can be observed and measured.
- Reinforcement is key to the successful transfer of information through behaviouristic learning.
- Strong emphasis on the stimulus, the response, and the relationship between them (Danley *et al.*, 2012).

Braungart *et al.* (2016) define the behaviourist learning theory as follows: “*Learning is the result of connections made between the stimulus conditions in the environment and the individual’s responses that follow.*” (Braungart *et al.*, 2016).

The question, however, remains how does the learning theory of behaviourism fit into medical education? Rostami proposes that behaviourist learning may effectively condition learners to do things in a specific way and provide these learners with an orientation guide to the profession they are pursuing (Rostami, 2010). The typical methods used to apply behaviourism into medical simulation include (Erlam *et al.*, 2017):

- Memorisation
- Repetition of skills
- Pre-briefing
- Modular learning

The answer to the question posted above lies in the fact that behaviourist philosophy can be successfully used through conditioning and a student's correct response to stimuli, such as training clinical technology students to manage a patient that collapsed in the clinic (Erlam *et al.*, 2017).

2.6.2.1 DELIBERATE PRACTICE

Deliberate practice (DP) as an educational theory is based on how a learner can become an expert in a specific field? The answer to the question is simple: experts usually set specific goals to improve their performance. Goals are achieved by repetitive practising of tasks allowing for the refinement of skills and knowledge. These experts are generally supported by trainers or coaches who assist them by designing structured practice activities and providing constructive feedback. Eventually, they learn to control, monitor, and evaluate their performance (van de Wiel *et al.*, 2011).

Van Schaik states that DP is relevant in medical education, especially when students need to develop practical skills and medical expertise. Students need to: “*See a lot, practice a lot, reflect a lot, and practice more.*” and is especially relevant in medical simulation. Van Schaik mentions activities where learners can conduct history taking on a standardised patient, repeated peripheral-line placement on a task trainer, or multiple cardiopulmonary resuscitation efforts on a Resusci Annie™ manikin. The opportunity for students to review themselves afterwards using video recording allows the student to reflect on what they did right and what

they did wrong, which in turn facilitates feedback from the trainer and guides these students on a path to becoming experts in their own right (Van Schaik, 2019).

2.6.2.2 MASTERY LEARNING

Mastery learning (ML) levelled the education playing field by providing all students with the same primary education, ensuring that differences between them are acknowledged to prevent these differences from haltering students' achievement of specific learning outcomes (Sajadi *et al.*, 2015).

To achieve the above-mentioned, ML focus on a student's performance without being time-restricted. Students are assessed regularly until they reach the desired outcome or mastery level (Shamsi & Dorri, 2019).

ML's success is based on certain key elements, and these key elements are listed below:

- Diagnostic pre-assessment with pre-teaching – Students are pre-tested before instruction begins to establish their current level of knowledge or skills.
- High-quality group based initial instruction - It is imperative to the success of mastery level that all students are exposed to high-quality, developmentally appropriate research-based instruction.
- Progress monitoring through regular formative assessments – Students should be exposed to regular formative assessments to monitor their progress and provide feedback.
- High-quality corrective instruction – If it was found from the formative assessments that students are not at the required level, teachers should then engage students with corrective instructions to accommodate differences in students with particular reference to learning styles/modalities and intelligence types.
- Second parallel formative assessments – Once corrective instruction has taken place, students need to be re-assessed to establish if the remedial instruction was successful.
- Enrichment or extension activities – It is essential to acknowledge and accommodate students who acquired mastery level without corrective instruction. These students may be accommodated by providing them with the opportunity to explore the range and depth of their knowledge and skills through challenging and rewarding learning experiences (Guskey, 2010).

ML is a learning performance-orientated model that takes students characteristics into consideration but still enables clinical teachers to improve their students level of knowledge and self-efficacy (Shamsi & Dorri, 2019).

2.6.3 COGNITIVIST THEORY

The cognitivist theory is explained by Arab and his fellow researchers in the concept that learning takes place in a person's cognitive structures and that the process of learning, therefore, happens within the person's internal environment. Procession of new information does not take place as a singularity but rather by accessing multiple routes such as insight, data processing, understanding, and memorising (Arab *et al.*, 2015). By shifting the learning process from external stimulants to internal stimulants, educators can use attention, perception, memory, forgetting, and retrieval as learning tools (Akdeniz *et al.*, 2016).

2.6.3.1 COGNITIVE LOAD THEORY

Cognitive load theory (CLT) can be a valuable and successful instructional theory to teach healthcare students. The theory functions that a learners' working memory has a limited capacity, especially when introduced to new information. As soon as the students are pushed to the limit due to massive amounts of new information, learning is impaired (Fraser *et al.*, 2015). However, experts realised that working memory capacity could be unlimited when the students are exposed to information retrieved from long term memory. The key to exploiting this total working memory capacity is to ensure the information has been previously organised and stored in long-term memory (Fraser *et al.*, 2015).

Three different cognitive load types have been identified: intrinsic cognitive load, extraneous cognitive load, and germane load (Leppink, 2017). The three cognitive load types are defined by Klepsch and Seufert (2020) as follows:

- “*Intrinsic cognitive load refers to the number of interacting elements as the primary determinant of the amount of perceived intrinsic cognitive load.*”
- “*Extraneous cognitive load refers to the design of learning material. Anything that distracts the learner and hampers the learning process should be avoided in the design of learning material.*”
- “*Germane cognitive load is the load imposed on working memory that can have a positive impact on learning.*” (Klepsch & Seufert, 2020).

CLT may be used to integrate required skills into a current curriculum by starting a simple task in a low fidelity environment moving towards more difficult skills in a high fidelity environment (Leppink, 2017).

2.6.3.2 SOCIAL COGNITIVE THEORY

In the 1960s, Albert Bandura, a Psychology professor, developed the Social Learning Theory, which later in the mid 80's evolved into the Social Cognitive Theory (SCT). Bandura believed that learning occurs in a social context with dynamic interactions between the person, environment, and behaviour (LaMorte, 2019).

In 2013, Kaufman and Mann clarified the social cognitive theory as a combination of two known learning theories: behaviourism, where the environment plays a vital role in a students' actions, and the cognitive theory, where cognition drives the learning of a student. Therefore, the researchers mentioned above can be quoted: *"A students actions, learning, and functioning are the results of a continuous, dynamic, reciprocal interaction among three sets of determinants: personal, environmental and behavioural."* The authors provide excellent examples for each of the three factors to explain SCT's relevance in medical education. Regarding environmental factors, it is believed that students will prevail even if the environmental conditions are not favourable, meaning that the students would do what is required of them to complete their tasks. Concerning behaviour, the feedback students receive after learning and practising a new skill will significantly impact them. A student's values and goals may influence the student's preference in what he/she would like to learn, e.g. learning a new skill vs the execution of good patient communication (Kaufman & Mann, 2013).

2.6.4 CONSTRUCTIVISM LEARNING THEORY

The infamous proverb: *"You can lead a horse to water but can't make him drink."* does have some reference when defining the constructivism learning theory. In Dr Steve Olusegun's article titled *"Constructivism Learning Theory: A Paradigm for Teaching and Learning"*, he claims that one of the essential education restrictions is that students still need to process and organise the knowledge in their way and minds. Students even need to compare the new knowledge against what is already known and familiar to them. Olusegun describes students through the constructivist view as *"active agents"* in the process of learning. In his opinion, constructivism is an approach to teaching and learning build on a foundation that learning is the results of a student constructing knowledge in his/her mind (Olusegun, 2015).

To create a constructivist learning experience for students, a lecturer can incorporate the following strategies:

- Provide expertise with knowledge, e.g. making use of experiments.
- Multiple perspectives and the appreciation of different viewpoints, e.g. group work.
- Social and emotional learning, self-awareness, managing feelings, motivation, empathy, and social skills.
- Using different modes in presenting information - e.g. videos and teaching aids.

A wide variety of learning methods lend themselves to the constructivist learning environment, and some of these strategies have been used successfully in medical simulation, e.g. case studies, role-playing, teaching aids, and group activities (Dagar & Yadav, 2016).

2.6.4.1 EXPERIENTIAL LEARNING THEORY

Cognitive learning theories mainly focus on cognition rather than on affect, whereas experiential learning (EL) uses the experience as one of its main pillars. However, an essential concept of EL is that experience is not a singular process within the theory but that it is instead a combination of experience, perception, cognition, and behaviour (McCarthy, 2010). An alternative description of EL would be that knowledge is built when a raw experience is grasped, interpreted, and transformed (Clarke, 2017).

EL can effectively be used within the realm of medical simulation. During the simulation, a learner is usually actively involved as a participant and observer while being part of a realistic, dynamic, and complex scenario. Therefore, the learner is actively engaged in the experience of learning; this corresponds with Dewey's learning theory (1938), on which Kolb, the father of experiential learning's approach, was based. Furthermore, both participant and observer's active involvement in learning is amplified when reflecting on what happened during and after an activity. The resultant effect is that learners' critical thinking capabilities are initiated and enhanced (Abelsson, 2017).

As referred to by Abelsson above, active participation is also known as concrete experience and is mentioned by Kolb's experiential learning cycle, a crucial factor to ensure effective learning (Abelsson, 2017). For the learner to alter behaviour regarding future experiences, the learner's past experiences must be considered. This way, the student can connect the different

experiences. Debriefing the student is a useful tool for the student to make these connections and is enhanced by goal-directed learning relevant and helpful to the individual (Zigmont *et al.*, 2011a).

Zigmont *et al.* (2011a) propose using a 3D model of debriefing to address each important aspect that might influence whether the learning will be successful. Elements such as the individual, the experience, micro and macro environments are all addressed in this 3D model. The 3D model is suggestive of three key concepts, namely defusing, discovering, and deepening. It is vital to provide the students with ground rules regarding the debriefing in a pre-briefing session. Pre-briefing is essential because it will ensure that learning takes place in the micro-environment. During the defusing session, the learners can express their “*experience*” individually, in other words, “*What happened?*” and to blow off some steam, ensuring a successful reflection session. During the discovery session, learners will be allowed to reflect on their own experience, what they have learned from their experience, and develop new ideas that can be applied and tested in their environment. In the deepening session, the learner connects with what they have learned to encourage possible practice changes. Debriefing is concluded by summarising the key objectives and the lessons learned (Zigmont *et al.*, 2011a).

2.6.4.2 GIBB’S REFLECTIVE CYCLE

The Gibbs reflective cycle was developed in the late ‘80s as a reflection model where students are prompted to think systematically about the different phases of a task. This cyclic process, driven by six stages or preferably six questions, allow students to learn by building on previous knowledge or repeated experiences to improve their skills (Wain, 2017).

The six stages of the Gibbs reflective cycle (Chiplin & Stavric, 2017):

- Description – What happened?
- Feelings – What were you feeling?
- Evaluation – What was “*good*”, and what was “*bad*” about the experience?
- Analysis – What sense can you make of the situation?
- Conclusion – What else could you have done?
- Action plan – If it arose again, what would you do?

The University of Edinburg developed a handy reflection toolkit with specific reference to Gibb's reflective cycle (The University of Edinburgh, 2019). The toolkit provides sample questions students can ask themselves to negotiate the reflective process better. The Gibbs reflective cycle proved to be especially valuable in training certain clinical specialities, such as midwives (Wain, 2017). Herewith, some of the sample questions the University of Edinburg suggests in Table 2.2:

TABLE 2.2 GIBBS REFLECTIVE CYCLE SAMPLE QUESTIONS

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (THE UNIVERSITY OF EDINBURG, 2019)]

Stage	Possible helpful questions
Description	What, when, and where did it happen? Who was present? What did you and the other people do? What was the outcome of the situation? Why were you there? What did you want to happen?
Feelings	What was your feeling during the situation? What were you feeling before the situation? What do you think other people feel about the situation now? What were you thinking during the situation? What do you think about the situation now?
Evaluation	What was good and bad about the experience? What went well? What didn't go so well? What did you and other people contribute to the situation (positively or negatively)?
Analysis	Why did things go well? Why didn't it go well? What sense can I make of the situation? What knowledge – my own or others (for example, academic literature) can help me understand the situation?
Conclusion	What did I learn from this situation? How could this have been a more favourable situation for everyone involved? What skills do I need to develop for me to handle a situation like this better? What else could I have done?
Action Plan	If I had to do the same thing again, what would I do differently? How will I develop the required skills I need? How can I make sure that I can act differently next time?

2.6.4.3 TRANSFORMATIVE LEARNING

Transformative learning is widely accepted to be the brainchild of Jack Mezirow, who developed the theory in the '70s. The idea is a learning process where the learner is challenged to question his/her assumptions, beliefs, and values and logically consider various other possible points of view. The theory is based on the understanding that learners make sense or the meaning of their experiences (Rahman & Hoque, 2017).

Mezirow identified ten stages of transformative learning (Deveci, 2014):

- Facing a disorientating dilemma.
- Self-examining one's feelings, e.g. fear, anger, and shame.
- Assessing beliefs and feelings about assumptions.
- Recognition of being discontent and noticing that others also experience the transformation process.
- Exploring alternative options for new actions, roles, and relationships.
- Planning a course of action to carry out plans.
- Gaining the necessary knowledge and skills to implement plans.
- Trying out new roles and new actions.
- Practising roles and actions to build competence.
- Reintegrating into a new life with new perspectives.

Briese from the University of North Dakota suggested in 2018 the following application (Table 2.3) of Mezirow's transformative learning theory in simulation-based learning.

TABLE 2.3 MEZIRROW'S TRANSFORMATIVE LEARNING THEORY

[COMPILED BY THE RESEARCHER PERKINS 2020 WITH DATA FROM (BRIESE, 2018)]

Phase	Stages	Simulation-Based Learning
1.	Facing a disorientating dilemma.	Pre-briefing/Simulation
2.	Self-examining of one's feelings, e.g. fear, anger, and shame.	Pre-briefing/Simulation
3.	Assessing beliefs and feelings about assumptions.	Pre-briefing/Simulation
4.	Recognition of being discontent and noticing that others also experience the transformation process.	Pre-briefing/Simulation
5.	Exploring alternative options for new actions, roles, and relationships.	Debriefing
6.	Planning a course of action to carry out plans.	Debriefing
7.	Gaining the necessary knowledge and skills to implement plans.	Simulation/Debriefing
8.	Trying out new roles and new actions.	Repeat Simulation
9.	Practising roles and actions to build competence.	Repeat Simulation
10.	Reintegrating into a new life with new perspectives.	Repeat Simulation

2.6.4.4 THRESHOLD CONCEPTS

Maid and D'Angelo describe threshold concepts as: “A *transformed way of viewing or understanding something*.” in other words, understanding or viewing things in a different or new way will allow the learner to progress (Maid & D'Angelo, 2016). Alpi and Hogan extend the threshold concepts description by citing Meyer, referring to threshold concepts being transformative, irreversible, integrative, and troublesome (Alpi & Hoggan, 2016).

The following explanations to the characteristics mentioned above are outlined (Randall *et al.*, 2018):

- Transformative – The threshold concept can cause a significant shift in the learner's perception of a subject or how he/she view him or herself as a professional.
- Irreversible - Once a threshold concept is acquired, it would be difficult to forget or unlearn, and it becomes an integral part of the learner's professional identity.
- Integrative – Threshold concepts can change the entire concept of a subject and allow the student to grasp complicated theories.
- Troublesome – Threshold concepts, in this instance, refer to a learner's fear or angst when they approach a new role.

To appreciate the influence of threshold concepts, Randall *et al.* (2018) provide a clear understanding of the term. Their qualitative research reviewed 135 paediatric clerks and asked

specific questions about their experience as interns. Seven specific threshold concepts were identified from the study, and most of the threshold concepts would be identified in other healthcare students as well. However, it was the overarching theme of these threshold concepts that immediately grasps the attention: *“There is a disconnect between what I thought medicine was going to be and the reality”*. Should a similar study be conducted amongst third-year clinical technology students, these students’ resultant response would most probably be identical to what was found in the Randall study as clinical technology students have indicated in focus groups conducted in their 3RD year that the WIL was not what they expected (Randall *et al.*, 2018).

2.6.4.5 COMPLEXITY THEORY

Alvira defines the term complex as: *“Those which identity or meaning emerges from the interaction between two or more parts”*. The term complexity refers to the quality or degree to which something is deemed as complex and proposes the following definition for this term: *“The quality of those objects whose identity or meaning emerges from the interaction between two or more parts that make up a unit or entity without losing their individuality”* (Alvira, 2014).

The complexity theory (CT) dated back to the 1940s and developed from research on general systems theory and cybernetics (Snyder, 2013). Various educational scholars have tried their hand to define CT and found it rather difficult. Ramiah (2014) describes CT as a theory of change, consisting of a collection of ideas about the dynamics of change in a system. Ramiah explains the theory by citing Prigogine and Stengers’s (1985) example of an organisms’ ability to use self-organisation to adapt to a changing environment. Therefore, the statement was made that schools and classrooms are also *“organisms”* with the ability to adjust (Ramiah, 2014).

Healthcare professionals are faced with *“complexity”* daily. Some of these challenges include the personal safety of the healthcare professionals, staff shortages and an increased workload (Healthcare Business Today, 2021). It is, therefore, important to teach healthcare students how to manage complexity effectively. CT can be used through simulation to demonstrate and expose students to the characteristics of complexity. The exposure will help the students develop and incorporate strategies to manage complexity (Gormley & Fenwick, 2016).

2.6.5 SOCIAL LEARNING THEORY

Scientific research is not necessary to state that human children are incredibly skilled at imitating adults, especially their parents and older siblings. Not only imitate children's behaviour, sounds, body posture, and interactions with objects immediately after they have been exposed to it, but they also demonstrate the ability to imitate these actions from memory which suggests learning (Meltzoff & Marshall, 2018). Therefore, it is not strange that a learning theory, namely social learning theory (SLT), was developed. Humans learn from their interactions with other people, especially when people observe other people's behaviour and demonstrate the ability to reproduce the observed motor activities, as Bandura noticed in 1977 (Nabavi, 2012).

An important aspect to keep in mind with SLT is that not all learned behaviours through observation are positive. Research indicated that people are more likely to assimilate behaviour when the reward outweighs the consequences of the behaviour, which, unfortunately, in some cases, might result in negative behaviour (Hillman, 2016).

Keeping the above-mentioned in mind, three essential concepts have been identified by Nabavi (2012) regarding SLT:

- People learn through observation.
- The mental state of the learner may influence the learning process.
- The results of the learning do not always lead to a change in behaviour.

For people to learn through observation, a lecturer may use one of three models or methods identified by Bandura, a live demonstration, verbal explanation, or a role model, either fictional or real (Nabavi, 2012).

To ensure observational learning success, students must pay attention when certain behaviours are demonstrated with as little as possible distractions. It is also crucial that the students demonstrate the ability to retain the information they observed. Good retention leads to the sound reproduction of the behaviour, which may be enhanced by motivation, primarily through positive rewards (Cherry, 2019).

2.6.5.1 SITUATED LEARNING THEORY

Situated learning (SL) can be described as a theory that stipulates if learners actively participate in their learning instead of just listening in a classroom, learning would be more successful (Gawande & Al-Senaidi, 2015). Specifically, if the students' participation takes place in a contextual environment, in other words, students learn in an environment where the knowledge they are introduced to is demonstrated and applied practically. Therefore, it is not strange that certain areas require and essentially benefit from SL, especially the healthcare sciences, where students may acquire practical experience in a real-life setup. Resulting in the assimilation of essential knowledge and experience with the end-goal to work independently (Gawande & Al-senaidi, 2015).

Researchers from Brunei Darussalam agrees with the understanding of the theory, as mentioned above. When students interact with the tools, technology, language, and the community of a particular profession, they gain knowledge and learn, e.g. students are exposed to practical tasks that would take place in a real-life environment (Pengiran, 2018).

2.6.5.2 CULTURAL-HISTORICAL-ACTIVITY THEORY

The cultural-historical-activity theory (CHAT) can, in some sense, be defined as a modified version of social action theory and the theory views how the nature of actions is influenced socially, culturally, historically, and educationally (van der Walt & Wolhuter, 2018).

Iskander describes CHAT as follows: *“A theory that is rooted in the concept, the interplay, and relationship between the subjective experience and external world”*. Iskander further argues that CHAT's application in a medical simulation would benefit a group or team rather than an individual and proposed that medical teams working together should also train together (Iskander, 2019).

Eppich and Cheng (2015) identified four ways of how CHAT may assist in teaching through medical simulation:

- Reformulation of observations and interpretation of social interactions within team simulations.
- Identification and prioritisation of topics for debriefing.
- Exploration of contextual factors that may promote or impede safe and patient care.

- Facilitation of discussion beyond lessons from concrete simulation events to generalise learning for future clinical practice (Eppich & Cheng, 2015).

2.6.6 HUMANIST LEARNING THEORY

The humanistic learning theory (HLT) positions the learner at the centre of the learning process and places the authority regarding his/her learning in the student's hands. HLT provides the learner with the opportunity to “*self-select*” on various levels, with the teachers acting as a facilitator or coach during the entire process (Hare, 2019).

The HLT gave birth to the term “*self-actualisation*”, which refers to self-fulfilment. The USA's Army recruiting slogan “*Be All You Can Be*” captures Maslow's definition of the term referring to a student achieving his/her full potential (McLeod, 2018).

2.6.6.1 SELF-DIRECTED LEARNING

Self-directed learning (SDL), as defined by Knowles (1975), where the learner not only establishes their individual learning needs and goals and identifies the required resources, implements learning strategies, and evaluates learning outcomes to achieve those individualised goals, falls well within the description of the humanist theory (Morris, 2019).

Kerr *et al.* (2017) state that the purpose of using SDL in students through simulation is the following:

- Development of skills to improve performance in a clinical setting.
- Prepare and ready students for clinical placements.
- Ensuring the students understand the reason why each skill is practised.
- Pushing students to recognise the possible gaps in their knowledge and identify the necessary resource to fill those gaps (Kerr *et al.*, 2017).

It is important to understand that training within the medical healthcare realm often involves adult learners and that the training occurs in a professional setting. This type of training tends to become one dimensional, focusing only on the individual and not creating a supportive learning environment. The individual forms a crucial part of the entire learning process to ensure effective practice-based learning occurs specifically in adult learners. One of the characteristics of adult learners is that they are self-directed and self-regulated. Adult learners

prefer to control their learning, providing them with the required motivation to negotiate the training successfully. Simulation-based learning is exceptionally well-positioned in training adults for the simple fact that it allows the hands-on practice of skills in a social setting promoting community. The resultant effect is increased competency and autonomy, leading to motivated adult learners (Zigmont *et al.*, 2011b). Persons applying for clinical technology at CUT are mainly scholars exiting high school with a few individuals ($\pm 4\%$) who already obtained degrees, such as a Bachelor of Science degree.

2.6.7 LEARNING THEORIES CONCLUDED

As described above, it is clear that learning theories are not simplistic but rather complex and interlaced. However, a proper understanding of learning theories can assist the educator in the correct and effective application of clinical simulation training. Specific theories lend themselves more towards simulation than others, especially the cognitive, behavioural, constructivist, and cognitive load theories. Special consideration should be given to these theories when simulation scenarios are developed (Felix & Simon, 2019). The different learning theories and their educational principles are summarised in Table 2.4.

Table 2.4 Learning Theories and Principles ¹

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (FELIX & SIMON, 2019)]

Learning theory	Educational principles
Behaviourism	Deliberate practice Mastery learning
Cognitivist	Cognitive load theory Social cognitive
Constructivism	Experiential learning Gibb's reflective cycle Transformative learning Threshold concepts Complexity theory
Social learning theory	Situated learning Cultural-historical activity theory
Humanist	Self-directed learning

The question needs to be asked what the outcomes of simulation-based medical education are or ought to be, and will these outcomes be any different from the traditionally accepted

¹ Learning theories and educational principles associated with simulation are highlighted in "Bold".

apprenticeship model? Both models come with their unique challenges. Simulation-based education, primarily when referring to high fidelity simulation, can be quite costly. The apprenticeship model presents issues such as decreased clinical placements, increased student numbers, and increased alertness regarding patient safety. The definitive answer to this question might even differ slightly from medical profession to medical profession. However, ultimately most healthcare professions have one common denominator, the patient. Therefore, a generic answer to the question regarding the ultimate goal when using simulation-based education would be first and foremost improved patient safety through a change in practice (Zigmont *et al.*, 2011b).

When using simulation-based training, trainers should not fall into the trap of the activity just being an experience. Students need to “*take something home*” after a session in the simulation laboratory. Zigmont *et al.* (2011b) propose that three crucial components are considered when simulation exercises are developed: individual, key experiences, and the learning environment. All three of these concepts are interlinked, and it is on this common ground that effective-based learning occurs (Zigmont *et al.*, 2011b).

2.7 CLINICAL SIMULATION

2.7.1 SIMULATION DEFINED

The Collins dictionary defines the word simulation as an act or an instance of simulating, assuming a false appearance or a representation of a problem or situation (Collins, 2018). The Simulation dictionary, on the other hand, incorporated Gaba’s definition of the term and provided a more educational description: “*An educational technique that replaces or amplifies real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner*” (Lopreiato, 2016).

Gaba described simulation further as a technique rather than a technology. Simulation is used either to replace or amplify real experiences with controlled and guided experiences that imitate certain important aspects of the actual real-life experience (Gaba, 2004). Durham defines the term as a pedagogy using one or more typologies to promote, improve, or validate a participant’s progression from novice to expert (Durham, 2013).

Gavin Perkins (2007) elaborated on Gaba’s definition of simulation when he also defined simulation in the context of medical education as an education technique that allows

interactive, and at time immersive, activity by recreating all or part of a clinical experience without exposing patients to the associated risks (Perkins, 2007).

Al-Elq's clinical simulation interpretation describes simulation as a generic term that refers to an artificial representation of real-life scenarios to assist learners with confidence and provide them with the required skill level through experimental learning (Al-Elq, 2010).

2.7.2 HISTORY OF SIMULATION

Simulation is not something new and has been used in various applications over the course of history. The use of war games as a form of simulation, primarily as a means to assist with tactical decision-making, can be found as far back as 500BC by the Greeks in the form of a board game named "*petteia*". Even the silent game of chess evolved from a military game that had its origins in India around the sixth century (Rehder *et al.*, 2016).

The first successful use of simulation in a non-medical field as a means of a training method can be dated back to 1929 when Edwin Albert Link developed a ground-instruction device to train future aeroplane pilots. The Link trainer or "*Blue Box*" (Figure 2.2) as it became better known turned out to be so popular with regards to training pilots that it was incorporated into the Army Air Corps formal training programme by 1934 (Jeon, 2015). The use of simulation as a training method in the medical field, however, can be traced back as early as the 1700s with evidence of a French midwife that made use of a life-sized birthing pelvis and baby manikin to provide experience and training to midwives in the possible complications of childbirth (Krishnan *et al.*, 2017). The first commercially or production simulator was known as the Chase Hospital Doll, nicknamed "*Josephine*", and was introduced in 1911 to assist with nurses' training (Weir, 2012).



FIGURE 2.2 LINK TRAINER OR “BLUE BOX”

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (MCFADDEN, 2018)]

One of the reasons why the Link pilot trainer was so successful and popular with trainers and training institutions was because the simulator created a controlled and safe environment in which trainees could be exposed to high-risk situations or scenarios. These scenarios were reproducible, which meant that each new student was provided with a similar opportunity to experience the same simulation as the previous student. The replication of exercises led to standardised training for all pilots (Jones *et al.*, 2015).

It was only a few years later, in 1960, when the use of simulation in medical training also became more prominent with the development of the Resusci Annie™ manikin (Figure 2.3) by Ausmund Laerdal. Laerdal was intrigued by Peter Safar’s work and his promotion of the efficacy and use of mouth-to-mouth resuscitation (Jones *et al.*, 2015). To create a realistic and sympathetic simulated patient, Laerdal replicated the face of Resusci Annie™ from the death mask of an unidentified young French woman who drowned in the River Seine in the 1880s. Initially, Resusci Annie™ was mainly used to train and demonstrate mouth-to-mouth breathing

techniques, but later, a mechanical spring was added to the manikin thoracic compartment to simulate chest compressions (Rosen, 2008).



FIGURE 2.3 RESUSCI ANNE™ MANIKIN

[COMPILED BY THE RESEARCHER, PERKINS 2020]

In the mid-1960s, a more sophisticated and computer-controlled manikin was introduced to medical education, namely Sim One (Cooper & Taqueti, 2004). This incredibly realistic and lifelike simulator was the brainchild of an engineer, Dr Abrahamson, and medical physician, Dr Denson, both affiliated to the University of Southern California. In comparison to Resusci Annie™, Sim One was way more advanced. The before-mentioned was especially true due to Sim One's accurate anatomical features and because it incorporated many high fidelity features such as chest movement, blinking eyes, and pupils capable of dilation constriction (Cooper & Taqueti, 2004).

A few years after the introduction of Resusci Annie™ in 1968, Dr Gordon, one of the researchers at the University of Miami, developed a cardiology patient simulator known as the Harvey® simulator (Okuda & Quinones, 2008). The simulator was named after Dr WP Harvey, a renowned expert in education and teaching. The Harvey® simulator specifically focused on cardiology and cardiac-related pathology and reproduced and simulating more than 20 cardiac conditions. Research investigating the use of the Harvey® simulator as a training tool versus

conventional bedside teaching methods, specifically in cardiology, indicated a significant improvement in clinical knowledge and patient skills in the students exposed to the simulator (Okuda & Quinones, 2008). Over the years, the Harvey® simulator evolved to incorporate a wider variety of cardiac conditions and training goals and sparked the development of other cardiac patient simulators such as Simulator K (Cooper & Taqueti, 2004). The influence of Resusci Annie™ and the Harvey® simulator in medical education and other simulators' development is so well recognised that both these simulators are considered the cornerstones of modern medical simulation. Advances in technology over the next 20 years, specifically computer-related progress, led to the development of more advanced simulators such as SimMan™ Essential (Figure 2.4) with the capability of providing students with physiological responses and feedback (Jones *et al.*, 2015).



FIGURE 2.4 SIMMAN™ ESSENTIAL

[COMPILED BY THE RESEARCHER, PERKINS 2020]

One of these computer-based simulators was developed by Dr David Gaba in 1987 and was known as the comprehensive anaesthesia simulation environment or CASE. The uniqueness of CASE was emphasised by the fact that a trainee was exposed to a “*patient*” whose vital signs could be altered by the trainer. The trainer could create critical scenarios specifically for anaesthesia. Dr Gaba added realism to scenarios by placing the CASE system in a real theatre with authentic equipment typically found in an operating and surgical environment (Cooper & Taqueti, 2004).

However, it is without a doubt that the Edward Albert Link invention paved the way in how medical simulation is currently implemented as a training tool. Healthcare providers of various specialities are trained in general and specific skills in a safe and controlled but realistic and

interactive manner. Therefore, it is not strange that most institutions training healthcare providers have integrated simulation as a standard training method in their curricula (Rehder *et al.*, 2016).

2.7.3 CLASSIFICATION OF MEDICAL SIMULATION

The rapid advancement and development in simulation within the medical field made it necessary to classify and categorise the different types of medical simulation to ensure a better understanding and the correct application of each type. If a generalised approach is used to classify simulation, Joseph Barjis model classifies and defines simulation into the following four main groups:

- 1) Clinical simulation: This simulation type is mainly used to train students in specific clinical areas, disease behaviours, and biological processes.
- 2) Operational simulation: This simulation class mainly focuses on training students in specific healthcare operations, service delivery, business processes, and patient flow.
- 3) Managerial simulation: Are used to train people in healthcare management with specific reference to decision making, implementation of policies, and strategic planning.
- 4) Educational simulation: This simulation category is directed solely towards students' training and educational purposes by creating realistic virtual scenarios or environments (Barjis, 2011).

Shoukri prefers to use a twin model to simplify simulations into two main groups: computer and educational (Shoukri, 2016). Shoukri claims that computer simulations have gained much ground as a training method in various fields, including physics, chemistry, and biology. The desired outcome can be obtained by altering the parameters of a simulation-specific programme; this is especially valuable in a medical scenario where clinical data can be modified to change a treatment plan. Educational simulation, according to Shoukri, can be further categorised into three subdivisions:

- Live simulations where real circumstances and environments are used.
- Virtual simulations where an artificial environment is created.
- Constructive simulations where the focus is concentrated on a specific task.

All three subcategories allow the student to gain new information and knowledge through a simulated experience (Shoukri, 2016).

Barjis recognises that not one single model would describe all the different applications within a healthcare simulation environment. With continued advancements and progress in this field of education, classifications models are likely to be adapted and changed accordingly (Barjis, 2011).

The development of a wide variety of different medical simulators made it necessary to organise and classify the simulators. Datta *et al.* (2012) classify medical simulators according to type and fidelity. According to the author mentioned above, two main types of simulators are identified, compiler-driven and event-driven simulators displayed in Table 2.5. Event-driven simulators can be classified into three different types, namely standardised patient's/care actors, hybrid simulation, and computer-based simulators. Simulators can also be classified according to fidelity, specifically referring to medical simulation. Beaubien and Baker (2004) define fidelity as the degree to which the simulator replicates reality.

TABLE 2.5 TYPES OF SIMULATORS

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (DATTA *ET AL.*, 2012)]

Type		Specifications	Examples
1.	Compiler Driven	Specific part-task trainers are replicating a part of the anatomy.	Intravenous-insertion arms, urinary catheter trainers and airway manager trainers.
2.	Event-Driven		
2.1	Standardized patient's/care actors	Trained actors for reliable patient history taking, physicals and testing the communication skills of the trainee.	Simulated clinical situations and mock scenarios.
2.2	Hybrid simulation	Combination of simulation modalities in the same simulation activity.	SP and part-task trainer.
2.3	Computer-based simulators	Keyboard and mouse interfaced.	Pharmaco-physiological models -categorized by fidelity.

The main categories of fidelity in context to medical simulation are low-fidelity simulators and medium/high fidelity simulators (Table 2.6). Low-fidelity simulators can be either screen-based text simulators or static manikins, whereas medium/high fidelity simulators mainly

consist of screen-based graphical simulators (Datta *et al.*, 2012). Fidelity as a recognized concept within simulation is not one dimensional but multidimensional since the degree of fidelity may vary due to equipment used, the environment in which the simulation takes place, and the realism of the simulated scenario (Beaubien & Baker, 2004).

TABLE 2.6 SIMULATOR PER FIDELITY TYPE

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (KRISHNAN *ET AL.*, 2017)]

Fidelity	Description
Low fidelity screen-based text simulators	This inexpensive scenario-based simulation method is used for the training of students in specific skills.
Static manikin	The manikins are a lot less expensive than high-fidelity simulators and can be used for basic life support training. A good example of a static manikin is the Resusci Anne™ manikins.
Medium fidelity screen-based graphical simulators	These simulators are especially useful in the training of physiological and pharmacological patient responses rather than specific skills.
Manikins with mechanical movement	The manikins are usually used in collaboration with computer software and maybe be used to test student's skills in effective resuscitation.
High fidelity simulators	These simulators are usually expensive but very useful in clinical immersive simulations and creating realist scenarios.

The classifications applicable to this thesis would include both clinical and educational simulations. The clinical simulation described above by Barjis focuses on students' training in specific clinical areas and disease behaviours (Barjis, 2011).

Students in clinical technology, especially the pre-specialised students, are novices in the field of clinical experience. The hypothesis is that exposing these students to various clinical areas and diseases in a simulated environment would prepare them for WIL and help them decide which speciality they would like to pursue.

Educational simulation is more directed towards a student's training using realistic scenarios (Barjis, 2011). The belief is that exposing clinical technology students to scenarios and situations they may experience during WIL will prepare them to integrate better into the

healthcare environment and prepare them for what might be expected of them as students and as qualified professionals.

2.7.4 CLINICAL SIMULATION AS TEACHING AND LEARNING TOOL

Before one can understand the role simulation plays within teaching and learning, it is important to understand the factors that promote simulation-based education. Research conducted in Australia identified three fundamental but significant factors responsible for driving simulation-based education (Weller *et al.*, 2012):

- Clinical placements
- Patient safety
- Educational imperatives

The clinical placement of medical students seems to be a global problem. Regarding the specific research in Australia in 2012, it would be unwise not to assume that similar factors such as increasing student numbers and shortage of suitable training institutions will not also result in the lack of available access for healthcare students in South Africa to obtain the required experience. The before-mentioned has been confirmed in local research and the problem enhanced with the worldwide pandemic of COVID-19 having an impact on the placement of 155 medical graduates not receiving medical placement to undergo their training (Maliba & Tshabalala, 2021). Simulation-based training might be able to address this issue.

The assurance of patient safety seems like an obvious responsibility within any healthcare system. However, adverse events resulting in patient harm are a daily occurrence in many hospitals (Weller *et al.*, 2012). Using simulation as a teaching and learning tool could contribute to eliminating these adverse events.

Providing students access and opportunity to real live patients will always form an integral part of any healthcare curriculum. However, simulation-based training may offer students the opportunity to grasp theoretical concepts quicker, help develop specific or specialized skills, and better understand certain disease profiles (Weller *et al.*, 2012).

Lateef confirms the above-mentioned when she states that even though students need to be exposed to real patients, it is important to keep patient safety and optimal treatment in mind.

This can be accomplished by applying simulation-based training to enhance real patients' experiences by replicating the “*real thing*” in an interactive manner. By achieving the before-mentioned, students can extend their knowledge, develop their skills, and shape their attitudes with little to no risk to real live patients (Lateef, 2010).

Krishnan and his fellow researchers elaborate on the possible factors that may lead to the incorporation of simulation in medical education by compiling their list of justifiable reasons:

- Patient safety – patients need to be protected at all times.
- Ethical sensitivity towards patients includes the patients' initial willingness to participate only to refuse participation later, the payment of patients and confidentiality concerns.
- Depleted resources may include the shortage of equipment or disposable items and the lack of willing patients to participate in a teaching programme.
- Medicolegal concerns go hand in hand with patient safety.
- Reduced teaching due to the current rapid accumulation of knowledge in the medical field and reduced availability of physicians to teach (Krishnan *et al.*, 2017).

Al-Elq states that simulation training programs must ensure that students are provided with learning opportunities and be inclusive of appropriate assessments to evaluate student competency and skills. These skills, especially at an undergraduate level, should include communication, history taking, professionalism, healthcare ethics, physical examinations, procedural and diagnostic skills, teamwork, and resuscitation skills (Al-Elq, 2010).

A simulation programme should not stand alone and is more likely to succeed when it is part of a standard curriculum. By assessing and identifying the curriculum components that would mostly benefit from simulation, the simulation programme can be developed around these components, resulting in a sustainable goal-directed programme (Motola *et al.*, 2013).

In 2004, Gaba already stated that simulation should be explicitly utilised for activities for which it is best suited, e.g. hazardous, uncommon, or rare activities. Furthermore, he also noted that simulation applies to all healthcare disciplines (Gaba, 2004). Wayne *et al.* (2006) support Gaba's statement of 2004 when he states that medical education at all healthcare levels relies on simulation as an educational tool.

Al-Elq (2010) summarized various papers describing an assortment of advantages simulation brings to medical education. These advantages are listed below:

- Practising hands-on and invasive procedures.
- Continuing and repeated practice.
- The ability to allow errors to continue to their natural conclusion.
- Risks to patients and learners are avoided.
- Undesirable interference is reduced.
- The opportunity for the same scenario to be accessed by multiple students providing similar learning opportunities.
- Planning clinical cases based on student needs rather than patient availability.
- Exposure to rare and complex clinical situations.
- Immediate feedback during debriefing sessions.
- The use of real medical equipment.
- The transfer of training from the classroom to the real situation is enhanced.
- Retention and accuracy are increased.
- Standards against which to evaluate student's performance and diagnose educational needs are enhanced.

One of the main benefits or advantage of clinical simulation is directed towards the patient. Harder states the following: *“Rather than to ask, what the value of simulation is, the question should be rephrased to what the cost would be if we did not simulate?”* The “cost” Harder refer to is not of monetary value but about patient safety. Current education methods should benefit the patient (Harder, 2018).

The World Health Organisation's (WHO) also recognised the benefits of clinical simulation and listed the benefits of simulation as the following (World Health Organization, 2018):

- The expansion and consolidation of a student's knowledge.
- Acquisition of technical skills in a controlled and safe environment.
- The development and sensitisation of students regarding ethics and ethical behaviour.
- Motivation and initiation of self-learning.

- Improvement of confidence with the resultant positive effect on clinical skills and sensitivity to the patient's needs.
- Students become more reflective and with enhanced critical thinking skills.
- Patient safety.
- Development of leadership skills.
- Improvement of patient care through the development of clinical judgment, decision making and teamwork.

In 2012, Weller amplified the benefits of simulation as a teaching and learning tool by stating that through simulated based training, clinical skills can be deconstructed into smaller components. The deconstruction will allow the students to engage in tasks and scenarios appropriate to their level of training. Using a well-structured framework, specific skills can be practised and rehearsed to the extent where the student would feel comfortable and confident in performing a particular task. Providing constructive feedback to the student after each session would allow the student to become more self-aware and enable them to monitor their own progress (Weller *et al.*, 2012).

Simulation-based training does not come without risks, and Shoukri emphasizes five important aspects/factors that can negatively influence the student's experience in the simulated environment (Shoukri, 2016):

- Not providing feedback to the student results in inefficient teaching and a possible lack of improvement.
- Insufficient numbers of simulated equipment and time to accommodate all the students.
- Lack of realism widens the gap between simulation and real live patients.
- Students' inability to work with simulators forces them to focus on the simulator and not the specific training.
- Inappropriate or incorrect utilization of simulators as a means of assessment, especially in practical exams that carry a heavyweight in contributing to the student passing or failing the module.

Therefore, it is important to ensure that possible pitfalls in medical simulation as a teaching and learning tool are clearly understood to provide the student with the best possible experience

and outcome. Krishnan and co-workers published examples of these pitfalls in 2017 are listed below (Krishnan *et al.*, 2017):

- Incomplete mimicking of human systems – due to the complexity of the human body, it is not always possible to incorporate all the potential information a healthcare worker would gain by engaging a real live patient into a simulator.
- Defective learning – simulation should be properly researched, designed, and set-up and teachers should take care to address problems such as the inability to take consent or students not adhering to standard safety protocols as it would have been with a real patient.
- The learner's attitude – students always find it challenging to approach a simulator in the same manner they would approach a real live patient. This may lead to the student being extremely cautious because they expect something to happen or be too complacent because they know they are not working with a real patient.
- Cost factor – due to the inclusion of highly advanced technology in simulators, these simulators are quite costly and need to be maintained to ensure optimal performance.
- Time factor – health education curriculums, irrespective of the profession or field of speciality, usually incorporates much work, and it might be challenging to find and allocate time towards simulation.
- Infrastructure – refers to an appropriate space to conduct and execute simulated teaching successfully and relates to personnel. Current research advocates an instructor to learner ratio of 1:4, which is seldom achieved due to the increasing number of students.
- Technical difficulties – irrespective of the technological advancements in simulators, cannot all human attributes be simulated effectively.
- Programming difficulties – it is important to include qualified facilitators and simulation engineers in the personnel corps of a simulation unit to ensure that simulators respond in the desired manner in reference to the specific scenario.
- Learner-specific teaching not always possible – not all students are on the same level of experience, and teachers might find it difficult to ensure that simulations are set-up according to each student's level of knowledge and experience.

Irrespective of the cons mentioned above and using careful planning and a structured framework, as Weller (2012) suggested, simulation can successfully be used as an additional

means of training healthcare students. Resulting in complementing the current apprenticeship model of “*see one, do one, teach one*” and provide students with enough experience in specific tasks and procedures to confidently and safely approach real live patients (Lateef, 2010).

It is important to ensure that once a problem within a training method has been identified, the problem is not replicated in the new method or even made worse. Just after the Harvey® cardiac simulator was released, the National Heart Lung and Blood Institute (NHLBI) in the United States of America (USA) did a comparative study between students exposed to simulation versus students only being trained via the traditional patient dependant curriculum. The study showed that the students exposed to simulation during their training acquired more cognitive information and were better skilled than those not exposed to simulation. A significant point of this study was that both groups of students were assessed on real live patients with real cardiac problems (Aggarwal *et al.*, 2010).

Simulation not only addresses the educational part of training but the ethical part as well. Using recently deceased or sedated patients as models for students to train and practice invasive procedures is common in certain training centres. Simulation offers a much more acceptable alternative for students to ethically and without risk to themselves and the patients practice specific procedures (Jones *et al.*, 2015).

2.7.5 CLINICAL SIMULATION - ASSESSMENT TOOL

The SQA Academy defines assessment as the process of gathering, recording, and using information about a learner’s response or performance to a task (SQA Academy, 2018). Vincent-Lambert and Bogossian (2017) confirm that assessment is a systematic collection of information and data regarding a student’s knowledge and skills, which can be used to determine if the student has achieved specific learner outcomes.

Various forms of assessment are available to a teacher. Two of the well-known assessment tools are formative, typically used for learning purposes, and summative, where the student will either end up with a pass or fail grade. Labadidi and Munshi (2015) advise that before a decision on any assessment format is made, specifically in simulation-based education, the following important aspects should be taken into consideration (Lababidi & Munshi, 2015):

- Purpose of the assessment (summative or formative).
- Matching the assessment with the intended objectives and goals of the simulation.

- Psychometrics of the assessment tool (reliability and validity).
- Standard-setting.

With specific reference to medical training and education literature, the most commonly used format is a summative format that includes multiple-choice questions, extended matching questions, essay questions, objective structured clinical examination (OSCE), and oral assessments (O'Shaughnessy & Joyce, 2015). However, Sando *et al.* (2013) state that both formative and summative methods as a means of assessments can be used in simulation-based training with great success. In fact, simulation-based medical education has been used over the last few years quite successfully on a formative level, with a vast amount of literature to support this claim (Soffler *et al.*, 2018). However, in contrast to the formative format, research on the summative format seems to be lagging. The statement is even being made that simulation-based assessment is an underused modality for evaluation (Soffler *et al.*, 2018). Therefore, it is important to ensure that if the simulation-based assessment is to be used in a summative role, for example, to assess clinical performance or critical thinking, previously validated assessment tools should be used (Soffler *et al.*, 2018).

The design and set-up of a simulated based assessment do not happen automatically, and scholars recommend that the assessor must keep the following key aspects in mind (Boulet, 2008):

- The intended purpose of the assessment.
- The knowledge and skills evaluated.

In an ideal setting, the assessment should be set up according to the student's ability level (Boulet, 2008). It is important to ensure that any assessment results are valid and reliable, and it is important to determine the type of assessment before the simulation-based experience commenced. Sando *et al.* (2013) describe a set of guidelines that may assist an assessor in deciding what method of assessment would yield the best results for a specific outcome as described below and demonstrated in Figure 2.5:

Criterion 1: Formative assessment

Guideline: This form of assessment should provide continuous feedback to students to assist with the improvement of their performance and behaviours, explicitly referring to their knowledge, attitude, and skills.

Criterion 2: Summative evaluation

Guideline: This assessment must format focuses on measuring whether students have achieved the specific outcomes and objectives set out for the specific simulation module. The assessment usually occurs at the end of a predetermined period using a valid evaluation tool that can be shared with the student before the assessment.

Criterion 3: High-Stakes evaluation

Guideline: This assessment should preferably be conducted by an independent assessor or observer who uses a standardised and validated evaluation/scoring tool, focusing on specific skills (Sando *et al.*, 2013).

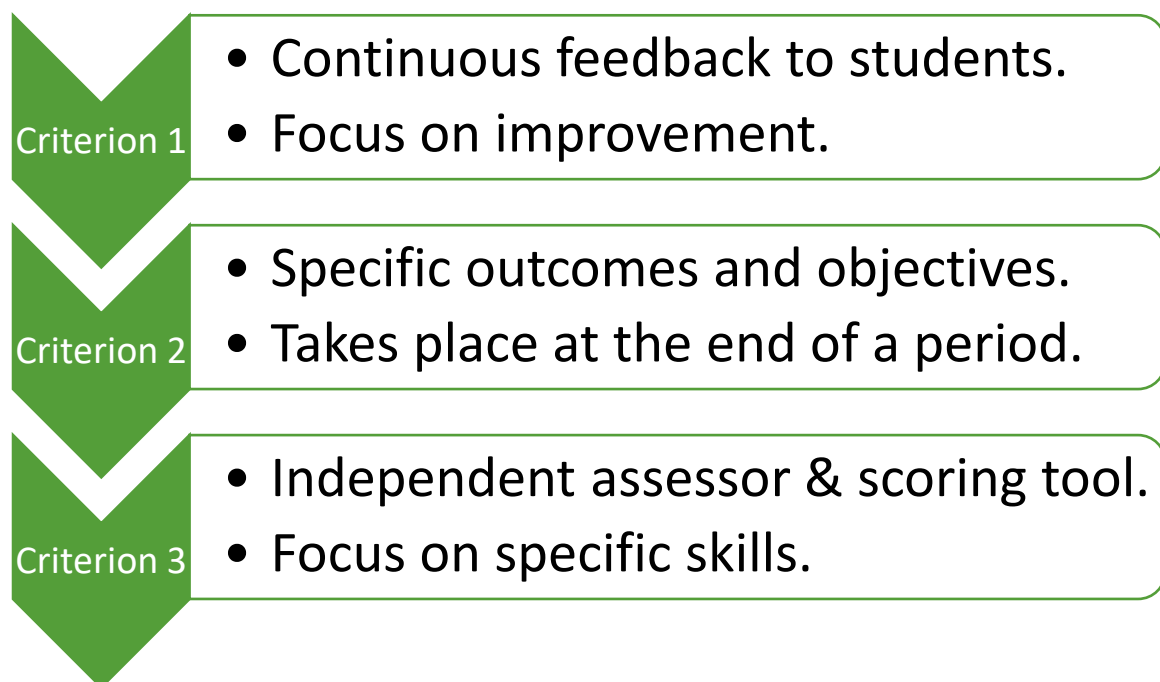


FIGURE 2.5 ASSESSMENT CRITERIA GUIDE

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (SANDO *ET AL.*, 2013)]

Vincent-Lambert & Bogossian (2017) highlight various benefits of using simulation as an assessment tool. One of the major benefits is that the educators can allow the student to continue regardless of possible mistakes the student might have made. The before-mentioned fact overcomes the ethical dilemma, where a student would previously have been stopped if

the assessment was performed on a real patient. The ability to standardize the simulation and expose all the students to the same simulated patient and scenario enhance the assessment's validity and reliability. Using a real patient is not always advisable, especially if a large group of students needed to be assessed. Simulation also allows educators to target specific skills or areas that can be manipulated to ensure that the student's responses are recorded accordingly (Vincent-Lambert & Bogosian, 2017).

Simulation as a tool of assessment is almost as old as the concept of simulation itself. Simulation provides a safe environment for a healthcare provider to practice clinical skills and allows the educator to increase the clinical skills' difficulty level progressively. Therefore, it is not strange that healthcare educators adopted simulation-based assessment as a sustainable means of evaluation (Ryall *et al.*, 2016).

2.8 SIMULATION – CLINICAL TECHNOLOGY

2.8.1 SIMULATION – INTERNATIONALLY

The results of a survey performed by the Association of American Medical Colleges (AAMC) indicated that more than 80% of the teaching hospitals confirmed that other healthcare professionals who included but was not limited to respiratory therapists, occupational therapist and dieticians also participated in simulation activities (Passiment *et al.*, 2011). The activities were divided within the survey into various content areas that included preclinical content and subspecialty content. Participants were asked to indicate all the areas where simulation was used regarding preclinical content, 60% of simulations were spent on physical diagnosis, especially in medical schools. Concerning subspecialty content, the results indicated 50% of the respondents used simulations in Critical Care, >30% in Pulmonology, 30% in Cardiology, and about 5% in Infertility (Passiment *et al.*, 2011).

Rozansky reported in 2012 that respiratory therapists (RT) using simulation as a part of their training protocol resulted in various positive outcomes. These positive outcomes included increased self-confidence and the ability to practice skills in a controlled non-threatening environment without the fear of making a mistake on a live patient (Rozansky, 2012).

2.8.2 SIMULATION – HEALTH ASSOCIATE PROFESSIONALS SOUTH AFRICA

This study does not refer to allied healthcare professionals but instead to Health Associate Profession (HAP) to avoid confusion. The aforementioned is related to the fact that allied health professionals in South Africa are registered with the Allied Health Professions Council of South Africa (AHPCSA). It refers to allied health professions such as Aromatherapy, Ayurveda, Chinese Medicine and Acupuncture, Chiropractic, Homeopathy, Naturopathy, Osteopathy, Phytotherapy, Reflexology, Therapeutic Aromatherapy, Therapeutic Massage Therapy, Therapeutic Reflexology and Unani-Tibb (The Allied Health Professions Council of South Africa, 2018).

It seems that most of the HAPs in South Africa find themselves in similar waters. In an integrated literature review of undergraduate peer-assisted learning in “*Allied Health Professions*”, Van Vuuren (2017) concluded that insufficient clinical placements and undergraduate students’ supervision in most of the HAPs are of concern. The need for innovative methods to teach professional and communication skills, leadership development, and clinical reasoning should be prioritised (Van Vuuren, 2017).

A patient’s primary caregiver usually consults most HAPs to assist with the diagnosis or therapeutic process. Good inter-professional relationships between the different role players benefit the patient. A study conducted on inter-professional education between medical and nursing students indicated the value of shared learning. The study’s results demonstrated that interprofessional education could be very beneficial to all students, especially if integrated into a formal curriculum. The study further indicated that interprofessional education expands the student’s understanding of the roles different professionals play and provides them with the opportunity to gain the required skills to ensure effective teamwork in treating a patient (Treadwell, 2014).

In South Africa, clinical technology students are currently not part of any inter-professional simulated-based education. The lack of exposure to this type of training, especially in the pre-specialised clinical technology student, might cause unnecessary stress and confusion when these students initially enter the healthcare environment to start their WIL cycle.

At the CUT pre-specialization, clinical technology students are exposed to practical sessions within a simulated environment. The focus is mainly on the 2ND year students through the subject Clinical Technology Practice (CTP206). The subject’s curriculum starts students with

basic clinical skills, e.g., measuring a patient's pulse rate and non-invasive blood pressure measurement. The students are then taught basic clinical technology procedures, e.g., performing spirometry or a 12-lead ECG. The students are also required to complete Level 1 and 2 First Aid courses, which expose them to Adult and Child cardio-pulmonary resuscitation (CPR). An external facilitator currently offers this course and not by the University's staff. However, students must demonstrate their CPR knowledge at the end of the 2ND year in a practical assessment (CUT, 2019).

A formal simulation programme for clinical technology students in South Africa has not yet been clarified or established.

2.9 DEVELOPMENT OF A SIMULATION PROGRAMME

Would it be fair to say: “*to be human is to make mistakes*”? At some time in their working careers, most humans made some mistake or error, irrespective of the type of career they found themselves in. The healthcare system is not excluded from human error, and the report “*To Err is Human*” endorses this statement from 1999 that more patients died because of human error than due to Acquired Immune Deficiency Syndrome (AIDS) and breast cancer combined (Kohn *et al.*, 2000). Therefore, it is not strange that simulation as an educational tool was incorporated in most healthcare curriculums (Kohn *et al.*, 2000). Some of the medical fields do not have a formal simulation programme, and the question therefore arises, where does one start to establish such a programme?

Any medical training programme must focus on providing the learners with the opportunity to learn the appropriate competencies for them to become professional and skilled healthcare providers in their specific field of study. However, it does seem that the method of “*See one, do one, teach one*” falls short of providing the learner with the necessary training. Other factors, such as shorter patient stay and the availability of cases, place the medical schools under more pressure to provide the required minimum training to their students (Al-Elq, 2010). Motola *et al.* (2013) suggested that the simulation programme should include general basic procedures and one or two core skills within each of the specialities.

A formal theory of instructional design for simulation in healthcare in its totality seems to be lacking in the available literature. Theoretical frameworks do exist; however, these frameworks

only address individual aspects within healthcare simulation and are therefore one of the main reasons why the Canadian Network for Simulation in Healthcare (CNSH) advocate the use of a conceptual framework for the instructional design in healthcare simulation as an educational activity (Chiniara *et al.*, 2013).

To understand the function of an “*instruction system design*” (ISD), defining the term is essential. Lababidi and Munshi (2015) define the term as follows: “*Instructional system design is a term used to describe the systematic process used for planning the delivery of training to the learner.*” The process includes assessing learning needs and the development of learning materials” (Lababidi & Munshi, 2015).

If an instructional design model is not used when educators develop or design a new course or curriculum, they risk a very high possibility of encountering serious pitfalls. These pitfalls include informal or unstructured instruction by inexperienced supervisors regarding specific procedures requiring experienced supervisors. These supervisors then demonstrate instructional methods not supported by current literature with the likely possibility of learners attempting procedures they are unfamiliar with, resulting in these procedures being performed incorrectly. Cheung (2016) describes the use of Gagne’s theory of instructional design as a workable model when developing specific components for a healthcare curriculum.

Gagne has been identified and recognized as a pioneer concerning curriculum design (Ngussa, 2014). According to Ngussa’s (2014), Gagne proposed that instruction must consider two learning conditions: External factors that might interact with the second condition, namely, internal factors. Examples of external factors include the environment, resources, and management of learning activities. Internal factors include the state of mind, previously learned capabilities, and personal goals of the learner. Other instructional designers have overlooked these internal factors; however, Gagne deemed these factors significant and influential in learners’ academic performance (Ngussa, 2014).

Gagne identified five major categories of learning, and different internal and external conditions are necessary for each learning type. The learning types are listed as follows:

- Verbal information – This refers to the ability to state previously learned information such as facts, concepts, principles, and procedures.

- Intellectual skills – The ability to distinguish between objects, features, or symbols, the ability to identify classes of concrete concepts, the ability to classify concepts by their definition, the ability to apply rules to solve a problem, and combining rules to solve more complex problems.
- Cognitive strategies – Where personal methods are employed to guide learning, thinking, acting, and feeling.
- Attitudes – The ability to choose personal action based on internal states of understanding and feeling.
- Motor skills – The ability to execute performances involving the use of muscles (McGovern & Bray, 2007).

Gagne’s comprehensive understanding of student learning led to the development of the “*Nine Events of Instruction*” and can be grouped into three groups, as shown in Table 2.7.

TABLE 2.7 NINE EVENTS OF INSTRUCTION

[COMPILED BY THE RESEARCHER PERKINS 2020 WITH DATA FROM (NGUSSA, 2014)]

Group 1	Group 2	Group 3
Preparation	Instruction and Practise	Assessment and Transfer
1) Gaining attention	4) Presenting the stimulus	8) Assessing performance
2) Informing learners of the objective	5) Providing learner guidance	9) Enhancing retention and transfer
3) Stimulating recall of prior learning	6) Eliciting performance	
	7) Giving feedback	

Cheung (2016) elaborates on Gagne’s nine events of instruction as follows:

- Gain attention – The lecturers should obtain the student’s attention before the learning content is presented.
- Informing learners of the objective – Inform the students of the learning outcomes for them to understand what they are about to learn.
- Stimulating recall of prior learning – Make use of students’ previous knowledge to assist with integrating new information.
- Presenting the stimulus or content – Show and explain the new material to the learners.
- Providing learner guidance – Assist the student in learning or approaching the new information through demonstration, guided activities, or examples.

- Eliciting performance – Allow the students to practice and demonstrate the newly acquired information or skill.
- Giving feedback – Provide immediate feedback on the students’ performance.
- Assessing performance – Test the students to evaluate if the required outcomes have been achieved.
- Enhancing retention and transfer – The student must be able to repeat the newly acquired information or skill and adapt these skills or apply the knowledge to different situations.

Using Gagne’s theory of instructional design, educators would be able to design courses and teach specific procedures and skills, particularly in healthcare modules (Cheung, 2016).

Lazzara *et al.* (2014) described eight critical factors with suggestions for incorporating these factors to ensure successful creation and implementation of simulation. The factors and the tips to ensure successful incorporation is demonstrated and summarized in Table 2.8.

TABLE 2.8 EIGHT CRITICAL FACTORS FOR THE DEVELOPMENT OF A SUCCESSFUL SIMULATION PROGRAMME
[COMPILED BY THE RESEARCHER PERKINS 2020 WITH DATA FROM (LAZZARA *ET AL.*, 2014)]

Factor	Tips for Incorporation
Science	• Using a multidisciplinary team of collaborating clinicians and training designers. • Apply the use of checklists to ensure that all facets of training have been accounted for. • Use an in situ conveniently located training location to improve attendance. • Create a bulletin board to announce desired behaviours and outcomes publicly. • Provide impromptu drills to offer trainees more opportunities to practice.
Staff	• Recruit champions to promote the use of simulation for training. • Demonstrate simulation in all departments to encourage interest and active participation. • Capitalize on unique resources, such as college or high school volunteers, local theatrical students, and military medical personnel.
Supplies	• Procure supplies from surplus or expired equipment available in other units. • Look to outside funding when obtaining supplies from local facilities is not feasible.
Space	• Connect with the committee responsible for allocating facility space. • Suggest temporary locations like a “<i>timeshare</i>” for the simulation laboratory when a permanent location is not possible. • Seek off-site locations and consider community resources.
Support	• Offer simulation briefings and demonstrations to senior leadership to generate their interest and support. • Focus on the positives of simulation-based training and show its value.

	Consider publishing a facility employee newsletter with articles on simulation training to keep interest and awareness alive.
Systems	- Match the fidelity of the training system with the desired training objectives. - Ensure that the network infrastructure/capabilities are sufficient. - Consider upfront costs and recurring maintenance that is needed for simulation equipment
Success	- Share success stories verbally and in newsletters or posters. - Encourage sharing success stories.
Sustainability	- Hold contests for naming the manikins. - Create simulation committees. - Build a cadre of staff with new simulation champions and instructors.

Another instructional system development (ISD) model to consider when developing a curriculum for simulation in healthcare is the Analysis, Design, Development, Implementation, and Evaluation design, more commonly known as the ADDIE model. The ADDIE model has been criticized for being quite time-consuming and costly, and the before-mentioned might be since the ADDIE model uses a linear process (Lababidi & Munshi, 2015). However, one of the benefits of the ADDIE model is that it can be used via an online platform or a traditional face-to-face setting (Aldoobie, 2015).

To use the ADDIE model, the curriculum developer would start with the first step, namely, “*Analyse*”. During the analysis phase, the designer ideally would like to gain a clear understanding of the instructional programme in its totality, e.g. why is the subject/module offered, to which students will the subject be taught, what is the current knowledge of the students on the subject and what is the desired outcomes of the specific module?

The next phase in the ADDIE model is the design phase, and during this phase, specific learning objectives for each task, assessment instruments, exercises, and materials (e.g. study guides, lab equipment) are decided on and documented. The designer has to decide how the information are provided to the students, e.g. using lectures, demonstrations, or group work. The development phase is used to create the actual learning material used for the specific subject, such as study guides, rubrics, and presentations. After the development phase, the implementation phase is set in motion. In the implementation phase, the developed learning material is delivered and distributed to each of the learners. Actual instruction or lecturing of the students happens during the implementation phase.

The “*final*” step in the ADDIE model is the evaluation phase, where the lectures evaluate the effectiveness of the learning material and instruction provided to the students. Various methods exist to conduct the evaluation; a simple example would be to have the students provide feedback either at the end of a class or halfway through a semester. However, it is vital that evaluation occurs throughout the instructional design process and not just at the end of the process (Kruse, 2002).

2.10 CONCLUSION

This chapter presented the literature associated with clinical technology as professional healthcare professional. The chapter also provided an in-depth view of the learning theories and their association with clinical simulation as a learning and assessment tool. Furthermore, an extensive review of simulation in general and its current function within healthcare professionals’ training was provided. The chapter concluded with a discussion on the development of a simulation programme. Therefore, the literature provided detailed information on the possible use of simulation in clinical technology training. The literature above also provided guidelines for developing a sustainable clinical simulation framework integrated into a current curriculum. In the subsequent chapter, the focus is on the research methodology used in this study.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

In this chapter, the research design and methodology are discussed. The methods used in this study consisted of an in-depth literature review and data collected from the focus group and nominal group interviews. Information on data sampling, collection and analysis, ethical considerations, and how validity and reliability for this study were ensured are included in this chapter's discussion.

3.2 THEORETICAL PERSPECTIVES ON THE RESEARCH DESIGN

The research paradigm's significance relates to the methodology used in this research study (Kivunja & Kuyini, 2017). The next section reports on the research paradigm and how the researcher approached the research and essentially decided on a specific methodology.

3.2.1 RESEARCH PARADIGM

The researcher, a qualified clinical technologist, interviewed other clinical technologists and people involved in clinical technology students' training. The study, therefore, tended towards a constructivist paradigm research design. As illustrated in Figure 3.1, this research paradigm used participants' experiences, specifically clinical technologists and personnel training clinical technologists, to accommodate and assimilate the required data (Adom *et al.*, 2016).

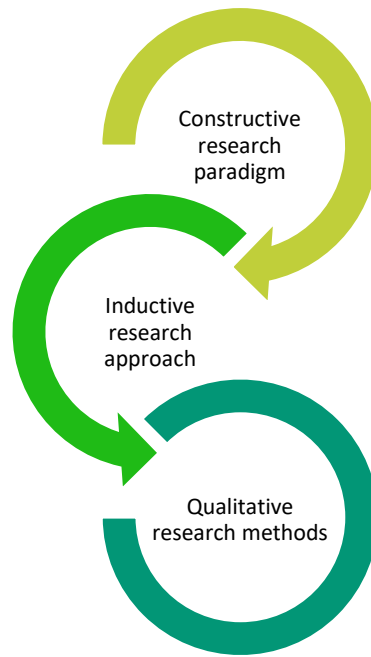


FIGURE 3.1 RESEARCH PARADIGM AND APPROACH

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM, (ADOM *ET AL.*, 2016)]

Rehman and Alharthi (2016) state in simple terms that a research paradigm is a belief system and a philosophical framework consisting of ontology, epistemology, methodology and axiology. Therefore, according to the authors mentioned above, a research paradigm refers to researchers understanding the world's reality and learning about it. Quoting Kuhn, an American philosopher, believed that the word paradigm refers to a person's philosophical way of thinking (Kivunja & Kuyini, 2017).

To incorporate philosophical thinking in science, each research paradigm is characterized by specific procedures that consist of several different stages. Therefore, scientists working within the same paradigm are guided by the same rules and scientific practices relevant to that particular paradigm (Žukauskas *et al.*, 2018).

As humans, we are quite diverse, especially in the way we view the world, and it is therefore not strange that quite a few different paradigms have been identified over time, primarily due to the progression of human thinking. Paradigms can be divided into two main theories: positivism and interpretivism, with subsequent subcategories for each of the two main philosophies (Adom *et al.*, 2016).

The constructivism paradigm, one of the subcategories of interpretivism philosophy, is defined and based on how people construct and build their knowledge through what they experienced in the past. This is achieved in two ways, firstly through accommodation and secondly via assimilation. Accommodation as a knowledge construction process refers to framing a person's mental representation of the external world to fit new experiences. In contrast, assimilation refers to how the person integrates new experiences into an already existing background of previous experiences (Adom *et al.*, 2016).

Describing the paradigm framework, especially in perspective with constructivism, is simplified in Table 3.1.

TABLE 3.1 CONSTRUCTIVISM PARADIGM FRAMEWORK

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (BIEDENBACH & JACOBSSON, 2016; GUARINO *ET AL.*, 2009; SIANGCHOKYOO & SOUSA-POZA, 2012; SOINI & KRONQVIST, 2012; Mertens, 2015)]

Philosophy	Constructivism
Axiology Definition: axiology addresses questions related to what is valued and considered to be desirable or “good” or “What is the nature of ethics?” (Biedenbach & Jacobson, 2016).	- Adhering to the basic principles of “<i>The Belmont Report</i>”. - Using a morally neutral objective observer. “<i>The Belmont Report</i>” principles were incorporated in this study and are further discussed in Section 3.3.3.6.
Ontology Definition: The branch of philosophy deals with the nature and structure of “reality” (Guarino <i>et al.</i> , 2009).	- Reality is socially constructed. - Rejecting the notion that there is an objective reality that can be known and taking the stance that the goal is to understand the multiple social constructions of meaning and knowledge. - For this study, it was important to obtain and understand the current reality related to students in WIL, what influences that reality and the current relationship between the students and the training preparing them for WIL. Through the interpretation of knowledge, the current reality is explained.
Methodology Definition: The science of methods/theory of methods: How the knower can obtain the desired knowledge and understandings (Siangchokyyoo & Sousa-Poza, 2012).	- Typical qualitative methods such as interviews, observations and document reviews. - A thorough literature review, focus group discussions, and nominal groups meetings were used as data collection methods for this study.
Epistemology Definition: Refers to how we know and the relationship between the knower and the known (Soini & Kronqvist, 2012).	- Interlinking the researcher and the participants in an interactive process where one can influence the other. - Using a personal interactive mode of data collection, data can be tracked to the source, and the logic used to assemble interpretations can be made explicit in the narrative.

3.2.2 RESEARCH DESIGN

The researcher reviewed literature and used nominal group interviews and focus group discussions, therefore adhering to the scientific principles of data collection and analysis for a study based on the grounded theory design as illustrated in Figure 3.2. From analysing the data, various themes and categories were identified. By further following the recommended and specific qualitative data analysis processes for nominal group interviews and focus group

discussions, connections between the different themes were established, allowing for a comprehensive report (Willig, 2013).

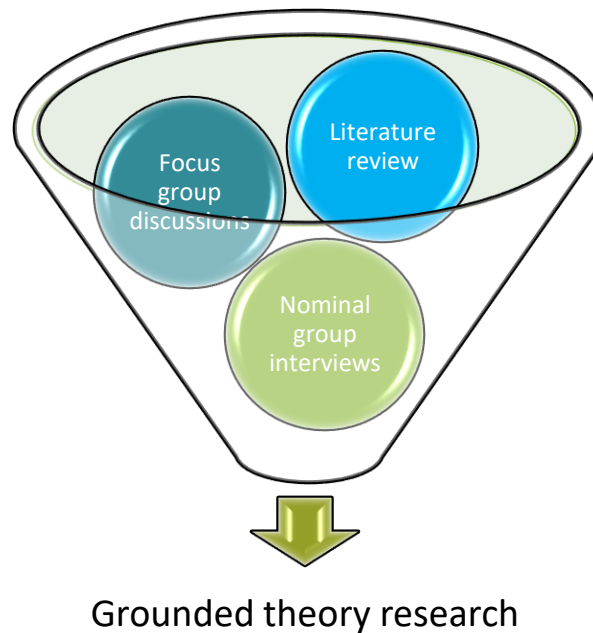


FIGURE 3.2 RESEARCH METHODS AND RESEARCH DESIGN

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Foley and Timonen, 2015 provide a general description of grounded theory as a systematic set of techniques and procedures that help the researcher build a theory from qualitative data. The same authors' data collection method includes qualitative interviews with individual participants, specifically semi-structured interviews and the inclusion of multiple data in the form of archival material and written sources (Foley & Timonen, 2015). Chong & Yeo (2015) agrees with Foley and Timonen (2015) regarding data collection and recommends that the grounded theory research design lends itself to collecting data through different forms of interviews, observations, focus group discussions and documents.

Six specific characteristics describe the grounded theory research design (Chong & Yeo, 2015):

Characteristic 1: Process approach where the research is identified as a series of interactions and outcomes among people with particular reference to the specific research topic.

Characteristic 2: Theoretical sampling refers to an ongoing coding process, comparing and grouping data to construct categories and sub-categories. This way, the most important data may be identified.

Characteristic 3: Constant comparison occurs to identify a possible emerging pattern or theory by finding out the commonalities and variations in the collected data.

Characteristic 4: Core category that portrays the central theme of the research.

Characteristic 5: Theory generation, where the research outcome leads to constructing a theory that addresses the research topic.

Characteristic 6: Theoretical memos, where the researcher creates notes about the collected data to record emergent concepts or ideas throughout the research process.

3.3 DESCRIPTION AND METHODS

3.3.1 PHASE 1: LITERATURE REVIEW

The grounded theory research design recommends a thorough review of the literature to support the proposed theory, develop a sustainable training model, and emphasize the importance of a clinical simulation programme (Klopper, 2008). The literature review, therefore, contributed significantly to this study. Using the “*Seven-step*” literature review model as proposed by Onwuegbuzie and Frels (2016), the researcher was able to compile a comprehensive report on the use of clinical simulation as a training tool in undergraduate clinical students.

The “*seven-step*” model is grouped into three phases:

- Exploration phase.
- Interpretation phase.
- Communication phase.

The exploration phase includes five of the seven steps used with this particular literature review model. The first phase mainly focused on the exploration and investigation of past and current concepts regarding clinical simulation. An important step within this phase included selecting and deselection of relevant and irrelevant literature on the specific research topic (Onwuegbuzie & Frels, 2016). The before-mentioned process was challenging for this research topic due to the lack of current literature on clinical simulation and clinical technology as a joint concept. The second and third phase of the “*seven-step*” model included the analysis and the reporting of information gathered from the relevant literature (Onwuegbuzie & Frels,

2016). The inclusion of literature mainly revolved around clinical technology, simulation as an education and training tool, and assessment tool for primary healthcare providers and HAPs.

3.3.2 PHASE 2: FOCUS GROUPS

The focus group discussions provided insight into the clinical technologists' opinions and attitudes involved in the training and supervision of 3RD and 4TH-year clinical technology students towards clinical simulation. Further providing a better understanding of what WIL trainers expected on a theoretical and practical level from a 2ND-year student entering WIL and how clinical simulation may be implemented in the pre-specialisation clinical technology student's curriculum to achieve the required skill levels. The decision to include focus groups as one of the qualitative research methods provided answers to all the research questions. Focus groups provided the opportunity for participants to interact with each other and communicate with each other regarding clinical simulation and the use thereof in clinical technology students' training. This interaction helped participants connect certain concepts that might not have been the case should they be interviewed individually. The focus groups also provided the researcher with the ability to capture data through observation of the communication, e.g. responses from participants and conversations between participating members (Nagle & Williams, 2013).

3.3.2.1 FOCUS GROUP - TARGET POPULATION

Twelve WIL units currently accommodating CUT students for work-integrated learning were targeted for possible inclusion into the study as part of the focus groups. All possible participants, 21 clinical technologists working within the WIL units were contacted and requested to participate in the study through a "Letter of Invitation" (Appendix B1). The focus groups consisted of qualified clinical technologists from the seven different specialities of WIL clinical technology training. Communication with prospective participants was done via e-mail requesting and confirming participation in the focus group interviews. Clinical technologists from Bloemfontein, Pretoria, Kimberley and Cape Town were approached to attend one of two focus group discussions directed by an experienced facilitator. Clinical technologists from Cape Town were asked to participate in focus group discussions 1, named "*Western Cape Focus Group*", and clinical technologists from Bloemfontein, Kimberley and Pretoria were asked to attend focus group discussions 2, named "*Free State/Gauteng Focus Group*". All seven different specialities within clinical technology were represented between the two focus groups.

3.3.2.2 FOCUS GROUP – DESCRIPTION OF POPULATION

Participants that participated in the focus group discussions were required to be qualified clinical technologists registered with the HPCSA representing one of the seven different specialisation categories. These clinical technologists standing in the profession known as WIL lecturers or unit supervisors are responsible for overseeing and managing the practical training of clinical technology students in their 3RD and 4TH years of study. Participants were not excluded from the focus group discussions based on work experience, and the information gathered from the demographic questionnaire with special reference to work experience is discussed in Chapter 4 (Section 4.3.2). Participants were required to have at least one of the following qualifications, a Diploma in Clinical Technology, Baccalaureus Technologiae degree in Clinical Technology, Magister Technologiae or Masters in Health Sciences in Clinical Technology or Doctorate Technologiae degree in Clinical Technology. Participants were not required to be experienced in medical simulation. However, the participants demonstrated a diverse knowledge of simulation, with one of the participants well versed in simulation due to prior international experience. Some of the other participants were/are currently involved with simulation and working in simulation training within their respective specialities, and others were less knowledgeable on the subject. Participants from the Free State/Gauteng focus group were previously introduced to clinical simulation through advisory board meetings held at CUT. The before-mentioned resulted in an unbiased study population. All participants had to be fluent in English with good stable internet access. Participation was voluntary and only participants who have signed and returned the informed consent document were allowed to participate in the focus group meetings. All the participants adhered to the before-mentioned requirements.

3.3.2.3 FOCUS GROUP – SAMPLE SIZE

The aim to hold at least two focus groups was achieved with one focus group attended by clinical technologists from the Western Cape and the second focus group attended by clinical technologists from the Free State, Northern Cape and Gauteng regions. Initially, the researcher and independent facilitator would have travelled to the Western Cape to conduct the focus group discussions in Cape Town. The focus group discussions for the Free State and Northern Cape would have been held in Bloemfontein with no representation from Gauteng. All the focus group meetings were arranged before the outbreak of the COVID-19 pandemic. The protocol was amended with the outbreak of the COVID-19 pandemic, and the focus group

discussions were conducted online. Facilitating the focus group discussions online allowed for participants from Gauteng to be included in the focus group. The relevant ethical committees approved the amended protocol. Some researchers dictate that a focus group should consist of between 7 – 12 participants (Nagle & Williams, 2013). Dilshad and Latif (2013) advocate a focus group size of between 6 – 9 participants. Both focus group 1 (Western Cape focus group) and focus group 2 (Free State/Gauteng focus group) consisted of nine participants achieving the initial aim of including between 5 – 12 participants per focus group from the various clinical technology specialities.

3.3.2.4 FOCUS GROUP - DATA COLLECTION

The focus group discussions were moved to an online platform due to the worldwide outbreak of the COVID-19 pandemic. Online focus group discussions are not a new concept and have been used since 1997 (Morgan & Lobe, 2011). Online focus groups are not different from traditional focus groups and are mainly applied within an online environment (Nyumba *et al.*, 2018). Each focus group discussion was conducted synchronously to benefit participants from interacting and conversing with each other on a real-time basis via live video chat (Oringderff, 2004). A variety of online platforms lends itself towards the hosting of online focus group discussions, e.g. “Zoom”, “GoToMeeting”, and “Webex”. However, Microsoft Teams® was chosen as the online platform of choice (Myers, 2020). The reason for the before-mentioned was that most of the participants were familiar with the Microsoft Teams® software, and the download of any additional application software was not required since participants were able to access the meetings via a weblink without a Microsoft account (Microsoft, 2020).

Before data collection commenced, an “informed consent document” (Appendix B2) was sent electronically to all possible participants. The participants signed and returned the document to the researcher electronically. The facilitator ensured that the researcher received all the informed consent documents before the focus group meetings was conducted.

The study supervisors identified and selected the facilitator based on previous facilitator experience. The facilitator used an interview guide (Appendix C2). This interview guide was adapted from guidelines for conducting a focus group (Eliot & Associates, 2005) and consisted of investigative questions that were put forward to each of the focus groups. The focus group questions were formulated in such a manner to provide possible answers to the study’s research questions. In addition, because the focus group discussions were held online, the question was

shared with the participants using the “*whiteboard technique*” screen sharing so that participants could read the questions themselves (UXalliance, 2020).

The questions that the facilitator put forward to each one of the focus groups are described below:

- What is your personal opinion on using a clinical simulation programme as part of the preparation and training of pre-specialisation clinical technology students?
 - What are the basic practical and or clinical skills that you consider essential/important for a student clinical technologist to be trained in before he/she starts their WIL? E.g. taking a patient’s vital signs, use of a blood gas machine?
 - What specialised biomedical apparatus would you recommend pre-specialisation clinical technology students should be exposed to?
 - Which specialised procedures would you recommend pre-specialisation clinical technology students should be exposed or trained in, e.g. draw of blood gasses, set-up of an intravenous infusion.
 - Is exposure to practical scenarios important to the pre-specialisation clinical technology student? Motivate your answer.
 - What are the best modes of delivery to training students in the mentioned skills?
- In your opinion, what role can simulation play in the training and assessment of pre-specialisation clinical technology students?

Both the focus group discussions were digitally recorded, and the researcher who attended the focus group meetings as an observer recorded and then transcribed the contributions of the focus groups. The facilitator verified the recordings and transcriptions. Copies of the complete transcriptions for each of the two focus group discussions were sent electronically via e-mail to each of the contributing participants to confirm their satisfaction that their respective comments were captured accurately and in the correct context (Labuschagne *et al.*, 2014). Participants from both focus groups indicated their satisfaction with the accuracy of the transcriptions.

3.3.2.5 FOCUS GROUP – DATA ANALYSIS

The interview guide and research questions were tested in an exploratory interview with two qualifying participants to test the process and evaluate if the questions' content was understandable. No changes to the process or the content of questions were required. The data from the exploratory interviews were not included in the data for this study. The purpose of the exploratory interview was to refine the guide and the interview process.

Data were analysed according to the grounded theory approach and included the process of open, axial and selective coding described below. The researcher read through the transcriptions several times, and specific themes and similarities were identified through coding processes (Labuschagne *et al.*, 2014). The “constant comparison analysis” method was used because more than one focus group was conducted. This method allowed for the data from the two focus groups to be analysed. This method helped the researcher assess data saturation in general and determine if data saturation was achieved between the two respective focus groups (Onwuegbuzie *et al.*, 2009).

The constant comparison analysis method consists of three stages:

- Stage one: This stage is also known as the open coding phase. Data were broken down into smaller, more manageable units using descriptors and codes.
- Stage two: The axial coding phase consisted of the researcher's identified codes grouped into similar categories.
- Stage three: In the final or selective coding stage, themes were identified by the researcher that reflected the focus groups' contributions in a reportable and scientific manner (Onwuegbuzie *et al.*, 2009).

Focus group discussions were transcribed and analysed through open, axial and selective coding (Labuschagne, 2012). Rauf emphasized the importance of identifying common themes from the data collected (Rauf *et al.*, 2014). In this study, the researcher identified the common themes and verified the themes by submitting the transcriptions and a draft report to the study's supervisors experienced in qualitative research analysis and methods. The research team discussed the draft report before the final document was compiled.

3.3.2.6 FOCUS GROUP – RELIABILITY, VALIDITY AND TRUSTWORTHINESS

The reliability of the data collected from the focus groups was ensured by using a focus group guide (Appendix B3) which ensured replicability (Chioncel *et al.*, 2003). Reliability was

further confirmed by using the same experienced facilitator for both the focus group discussions (Flom, 2017). Validity was ensured by using specific research questions to induce key points of discussion, which helped the facilitator guide the conversations during the focus group discussions (Chioncel *et al.*, 2003).

To further ensure validity, the researcher used a selected target population, namely qualified clinical technologists, to answer the specific research questions. To ensure reliability within the target population, clinical technologists from all seven different specialities were included from the WIL units in Cape Town and Bloemfontein, where most of the CUT students are based (Chioncel *et al.*, 2003). In addition to the Western Cape and Free State units, WIL units from Gauteng and Northern Cape were also included.

Trustworthiness related to qualitative research should take place on three planes, data collection, analysis and reporting. To ensure trustworthiness regarding data collection, the researcher used a well-described population and method that ensured the availability of rich and well-saturated data. Furthermore, by preparing and using an interview guide with the meetings conducted by an experienced facilitator, trustworthiness was further established. Data analysis were done on a tri-level, which included the researcher, facilitator and supervisors. Finally, data reporting was done systematically and logically (Elo *et al.*, 2014).

The researcher and facilitators notes and observations ensured theoretical validity and, by using digital audio recordings from the sessions, confirmed descriptive and interpretive validity (Chioncel *et al.*, 2003).

3.3.3 NOMINAL GROUPS

The nominal group technique can be described as a variation of small group discussions to reach a consensus among participants on a specific topic (Centers for Disease Control and Prevention, 2018). The same facilitator used to facilitate the focus group discussions were identified and appointed to pose questions to the individuals participating in the nominal group interviews. The reason for using the same facilitator is that the facilitator is both experienced with the nominal group technique and unbiased because she is not in any way related to the clinical technology profession. The nominal group participants were requested to prioritise and rank the ideas generated during the nominal group discussions. The advantage of using the nominal group technique is that various balanced ideas are usually generated (Horton, 2007).

The data collected from the nominal group interviews confirmed those mentioned above, and the findings from the nominal group interviews are discussed in Chapter 5.

3.3.3.1 NOMINAL GROUPS – TARGET POPULATION

The nominal group technique was used for interviewing the personnel from three tertiary institutions responsible for training clinical technology students. This population consisted of 17 qualified persons actively functioning as lecturers in clinical technology students' training. Communication with prospective participants was done via e-mail to the Head of the Department to request and confirm the participation of the particular institution in the nominal group interview. All three institutions approved the researcher's request to approach their personnel and request study participation.

3.3.3.2 NOMINAL GROUP – DESCRIPTION OF POPULATION

Personnel responsible for lecturing and teaching 1ST and 2ND-year clinical technology students were approached for possible inclusion in the study. Participants did not specifically have to be qualified clinical technologists and may be qualified in other areas, e.g. Anatomy and Chemistry. These lecturers are responsible for mainly teaching theoretical subjects to the pre-specialisation clinical technology students. The participants were required to be actively involved in the training and lecturing of clinical technology students. Therefore, lecturers, part-time lecturers, lecturer's assistants and WIL coordinators from CUT, DUT and TUT were targeted to participate in the nominal groups. Participants in the nominal groups were familiar with simulation as a training method but not experts in its use in the clinical technology environment. Participants from DUT were exposed to clinical simulation through participation in an HPCSA audit conducted at CUT.

3.3.3.3 NOMINAL GROUP – SAMPLE SIZE

The aim was to conduct at least three nominal groups with between 5 – 9 participants per nominal group (University of Wisconsin-Madison, 2019). This goal was achieved, and three online nominal group interviews were conducted with one nominal group per tertiary institution. The participants included personnel from CUT Bloemfontein, the second group included participants from DUT Durban, and the third nominal group included participants from TUT Pretoria.

Eight possible participants were identified from CUT, and this nominal group consisted of eight participants, with none of the participants declining to participate in the meeting. Five possible participants were identified for participation in the DUT nominal group, and the final nominal group consisted of four participants with one participant that did not reply to the “*letter of invitation*”. Finally, five possible participants were identified from TUT, with all five of these participants accepting the invitation and participating in the nominal group interview. E-mail contact details for the participants were provided to the researcher by the different Heads of each institution's departments.

3.3.3.4 NOMINAL GROUP – DATA COLLECTION

All three nominal groups were conducted online due to the COVID-19 pandemic, which prevented face-to-face meetings and group gatherings. Nominal group interviews via online platforms have not been widely used. However, literature dictates that the nominal group technique may be used successfully via internet-based communication (Kulczycki & Shewchuk, 2008). As with the focus group discussions, the digital platform of choice was Microsoft Teams®.

The nominal group interviews were conducted under an experienced facilitator’s supervision with the researcher as an observer in the online meeting (Breedt & Labuschagne, 2019). The following questions were presented to the three nominal groups by the independent facilitator (Appendix A3):

- 1) *“In your opinion, what role can simulation play in the training and assessment of pre-specialisation clinical technology students?”*
- 2) *Which graduate attributes should a student clinical technologist develop during his/her pre-specialisation training?*

The nominal group technique consisted of the following steps:

Step 1: Preparation and logistics

All the participants who completed and returned the informed consent documents were sent a weblink to access the online meeting. The facilitator ensured to open the digital meeting at least ten minutes before each meeting’s scheduled starting time. An electronic index card document and an explanatory video on how to complete the electronic index cards were sent to each

participant (Appendix A4). Participants were also asked to have a pen and paper at hand during the meeting.

The facilitator welcomed the participants and asked each participant to introduce themselves to the rest of the group members. To avoid participants talking over each other during the meeting, the facilitator requested each participant to mute their microphones. The facilitator invited participants to speak individually by calling their names. However, participants were also encouraged to use the “*raised hand*” function on the Microsoft Teams® application if they wanted to comment on a specific topic (Microsoft, 2020).

Step 2: Silent idea generation

The facilitator presented the two questions (one question at a time) to the group participants utilizing the screen sharing function on the Microsoft Teams® application (Microsoft, 2020). The facilitator then read each question to the group and instructed each participant to silently write his/her ideas as short statements on a piece of paper (Horton, 2007). Each question was discussed separately. Once step 3 to step 7 was completed for question 1, the facilitator presented the group with the second question and repeated steps 3-7 for this question.

Step 3: Round-robin recording of ideas

During this step, the facilitator asked each participant to share one idea at a time from his/her list. Then, each participant was asked by name in a round-robin fashion to share their ideas until all the ideas were tabled (Wright *et al.*, 2012).

Step 4: Serial discussion of ideas

This step involved discussing and clarifying each idea individually before the initial voting took place. Ideas with a similar topic or trend were identified, and with the approval of the group members, consolidated into a single idea (Wright *et al.*, 2012). The ideas were electronically recorded and presented to the entire group via the screen sharing function (Microsoft, 2020).

Step 5: Preliminary voting and ranking

Participants were then requested to list five of their most important items and rank these items from “*most important*” to “*least important*” on the electronic index card document (Wright *et al.*, 2012). An idea ranked as “*most important*” received the highest score, with the idea ranked “*least imported*” allocated the lowest score (Breedt & Labuschagne, 2019).

The electronic index document included five index cards. The electronic index document was set-up in such a manner for participants to complete the cards electronically. On top of the electronic index document, the participants were required to fill in the specific question number. Two questions were posed to the nominal group member, and therefore each participant had to complete two electronic card documents, one for Question 1 and one for Question 2.

Once participants identified their top five ideas from the group’s ideas, each participant was requested to capture their top five ideas on each one of the five index cards. This was achieved by allowing the participants to capture the specific ideas’ “*Identifying Number*” and a short description of the idea in the “*Idea Description*” block. By following this procedure, the researcher ensured that the identifying number corresponded with the idea description.

Once the top five ideas were captured on the five index cards, participants were required to rank their ideas by allocating a ranking number ranging from a “*five*” to a “*one*” in the ranking block located in the lower right-hand corner of each index card. Participants were instructed to choose the idea they deemed as most important from the top five ideas on the electronic index card document and allocate a ranking of “5” to that idea. The participants were then asked to identify the idea they thought to be the least important idea from the top five ideas and allocate a ranking of “1” in the ranking block for that specific idea. The same process was repeated for the remaining three ideas with the difference that the most important idea from the remaining three ideas was to be allocated a ranking number of “4” and the least important idea from the remaining three ideas a ranking number of “2”. The last remaining idea automatically received a ranking number of “3”, and the participants were asked to complete the process as mentioned above for both of the two nominal group questions.

The facilitator asked the participant to email their completed electronic index cards to the designated e-mail address displayed at the bottom of the electronic index card document after

each one of the two questions were discussed. The researcher confirmed the receipt of the electronic index cards from all the participating members, and the meeting was not allowed to continue until all the electronic index card documents were received and verified for correctness by the researcher.

Step 6: Discussion of voting

This step was used to ensure accurate voting; during this step, any items indicating an inconsistent voting pattern were discussed (University of Wisconsin-Madison, 2019). Participants were required to email their electronic index card documents back to the researcher for each one of the two nominal group questions. The researcher verified each electronic index card document's legitimacy and correctness, and any discrepancies were resolved before the meeting continued.

Step 7: Once all the electronic index cards were verified, the votes were counted, and the results were e-mailed to each participant, and the meeting concluded. No further discussions with the participants were needed, and there were no breaks during the nominal group interviews.

3.3.3.5 NOMINAL GROUP – DATA ANALYSIS

Data collection and analysis did overlap because, through the consolidation of statements and voting for ideas by the participants, important themes already emerged before the final data analysis was completed. However, none of the nominal group interviews' questions changed, and no questions were added or removed. The researcher identified ideas and theories as a result of the questions posed to each nominal group participant. Participants were asked to rank and vote for statements generated from the group.

Digital recordings were made for each of the three nominal group interviews, and these recordings were evaluated and verified by the researcher, facilitator and supervisors. The researcher reviewed and interpreted the collected qualitative data to identify similarities, categories and themes. The identified categories from the nominal group interviews were then used to determine the importance of exposing pre-specialisation clinical technology students to the following:

- Basic practical and clinical skills.

- Evaluation of learned skills.
- Important gratitude attributes.

3.3.3.6 NOMINAL GROUP - RELIABILITY, VALIDITY AND TRUSTWORTHINESS

The nominal group technique is viewed as a form of an interview, even though it takes place in a group format and not individually. Interview as a method of collecting data has proven strengths, e.g., allowing for good interpretative validity. Because a nominal group interview guide was also used in this study, a high measurement of validity and repeatability was further ensured (Varga-Atkins *et al.*, 2011).

For this study, external reliability was ensured using a specific target population, namely tertiary institution personnel, involved in pre-specialisation clinical technologists' training. In addition, internal reliability was confirmed by recording all the nominal group interviews digitally (Zohrabi, 2013).

The data's trustworthiness was ensured due to the study explicitly using the nominal group technique to review ideas on specific research questions where the weight of each participating member's opinion is equal. The use of a trained independent facilitator ensured that members participating in the nominal groups were not influenced or interfered with (Peña *et al.*, 2012).

An exploratory interview was done to ensure that the questions are understandable for collecting the study's data. The questions were presented to two qualifying participants. No adjustments to the questions were made, and the before-mentioned participants indicated their satisfaction with the quality and understandability of the nominal group questions. Therefore, the results of the preliminary interviews were not included in the study.

By considering the framework, as mentioned earlier, the following breakdown relevant to the constructivist paradigm and related to the research study was made:

2.Axiology – Adhering to the three basic principles of “*The Belmont Report*”.

- i) Respect for persons: Participants from the nominal group interviews were under no obligation to participate in this research study. The researcher obtained institutional consent to approach the three tertiary institutions' personnel before the informed consent document was sent to the willing nominal group participants. Basic, but

critical ethical considerations, especially regarding confidentiality and the withdrawal of individual data without the loss of benefits, were communicated via the informed consent document to the nominal group members.

- ii) **Beneficence:** The outcome of this research lends itself to be beneficial towards future clinical technology students, the industry, technologists involved in the training and mentoring of clinical technology students, and the personnel responsible for the training of pre-specialised clinical technology students.
- iii) **Justice:** Person's responsible for the lecturing clinical technology students in the different WIL units were targeted to participate in the focus groups. No discrimination or preference was given regarding age, sex, ethnicity or class for inclusion or exclusion of participants in the nominal groups (Mick, 2019).

All the nominal meetings were facilitated and conducted by the same independent, experienced facilitator.

Epistemology – It must be mentioned that participants from the nominal group interviews were known to the researcher either from previously working together as clinical colleagues or through the education and training of clinical technology students. The use of an independent facilitator limited the researcher's influence on the participants and *vice versa*, especially during the data collection process of the nominal group interviews. The nominal group interviews were digitally recorded and stored.

3.4 ETHICAL CONSIDERATIONS

3.4.1 ETHICAL APPROVAL

Permission to conduct the study was obtained from the Health Sciences Research Ethics Committee (HSREC) of the Faculty of Health Sciences at the University of the Free State on 26 March 2020 (UFS-HSD2020/0165/2104). Due to the COVID-19 outbreak, the protocol had to be amended to accommodate the proposed change from a face-to-face format to an online format with specific reference to the focus and nominal group interviews. The protocol was amended accordingly, and a second application was submitted to HSREC to obtain approval

for the amended protocol. HSREC approved the amended protocol on 19 June 2020. Both approval letters from HSREC are attached as Appendices D1 and D2.

Approval to approach and include the personnel of TUT was obtained via the Research Ethics Committee (REC) of Tshwane University of Technology on 16 September 2020 (REC2020/08/003). REC provided consent for the study, and the approval letter is attached as Appendix D3.

The Institutional Research Ethics Committee (IREC) of the Durban University of Technology was also approached to inquire regarding approval from the institution to include DUT personnel. However, IREC indicated that since an ethics committee already approved the study, their institution did not require any additional ethical approval.

3.4.2 VOLUNTARY PARTICIPATION

Participation in this study was voluntary, and no person was under any obligation to consent to participation. Participants were also free to withdraw from the study at any time. Participants who indicated that they wished to withdraw could withdraw without providing a reason without losing any benefits. The before-mentioned was communicated to possible participants through the informed consent documents. (Appendix A2 and B2). No participant indicated that they would like to withdraw their data from the study.

Persons who decided to participate in the study were provided with an electronic version of the informed consent document with the requirement to complete, sign and return the document to the researcher via e-mail at their earliest convenience and before the focus group or nominal group interviews took place.

Completed and signed informed documents are stored electronically on a memory stick in a locked cabinet in the researcher's office for a minimum of five years.

3.4.3 RIGHT TO PRIVACY

All information and data collected from interviews will be kept strictly confidential. No participants' names or personal information were made known. Reporting on the focus group discussions and transcripts was done by allocating two distinct alphabetical letters to each focus group. The focus group participants' confidentiality was maintained by replacing the

participant's name with a specific number in the transcripts. In addition, nominal group participants were allocated a specific participant number to ensure confidentiality when reporting the results.

3.4.4 AVOIDANCE OF HARM

The researcher undertook to ensure as far it is reasonably possible that no physiological, physical, legal or social harm was caused to any person that participated in this study.

3.4.5 DECEPTION OF RESEARCH PARTICIPANTS

Due to the nature of the study, no deception of participants took place. All participants were provided with detailed information on the nature and reasons for this specific study through letters of invitation (Appendices A1 and B1).

3.4.6 FUTURE PUBLICATION

Study results and outcomes will be used to publish articles in accredited scientific and peer-reviewed educational journals. All the data and information collected during this research study will be stored for five years on a password-protected computer.

3.5 CONCLUSION

This chapter described the research paradigm and how it influenced the researcher's decision to use a specific research design and methodology associated with such a design. The chapter further discussed and explained the researcher's specific methodology to identify, collect, and analyse data ethically as obtained from the various qualitative methods. The next chapter, Chapter 4, discusses the results and findings from the focus group discussions.

CHAPTER 4: RESULTS OF THE FOCUS GROUP INTERVIEWS: ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

This chapter presents the findings from the focus group interviews conducted for this research study. The focus groups allowed the researcher to explore the participants' opinions and attitudes to better understand their specific view on the possible use of clinical simulation as part of the curriculum in the training of clinical technology students, especially pre-specialisation students. Two online focus group discussions were held, and data were captured using digital recordings, transcriptions and observations for both the meetings (Nagle & Williams, 2013).

The two focus groups consisted of qualified clinical technologists involved in WIL of CUT students. All seven different specialities within clinical technology were presented in the two focus groups. The two groups were divided geographically, with focus group 1 consisting of WIL lecturers from the Western Cape, whereas focus group 2 consisted of WIL lectures from Gauteng, Free State and the Northern Cape.

The focus groups' reliability was guaranteed using a focus group guide that ensured replicability (Chioncel *et al.*, 2003.). Reliability was further established by using an experienced facilitator that presented the group with specific research questions (Flom, 2017). The data's validity was promoted by ensuring that the focus groups consisted of a selected target population, namely qualified clinical technologists specifically involved in CUT students' supervision and academic training (Chioncel *et al.*, 2003).

The researcher was responsible for compiling the transcriptions from the digital audio recordings recorded for each of the two focus group discussions. These transcriptions were sent electronically to all the participants, facilitator, and observer to verify accuracy and assurance of reliability.

To provide an all-inclusive report on the two focus group discussions, the consolidated criteria for reporting qualitative research (COREQ) or, as it is also known, the 32-item COREQ checklist for reporting on focus group findings were used. The 32-item COREQ checklist is

divided into three domains, and the domains are listed below and summarized in Figure 4.1 (Tong *et al.*, 2007):

- Domain 1: Research team and reflexivity.
- Domain 2: Study design.
- Domain 3: Analysis and findings.

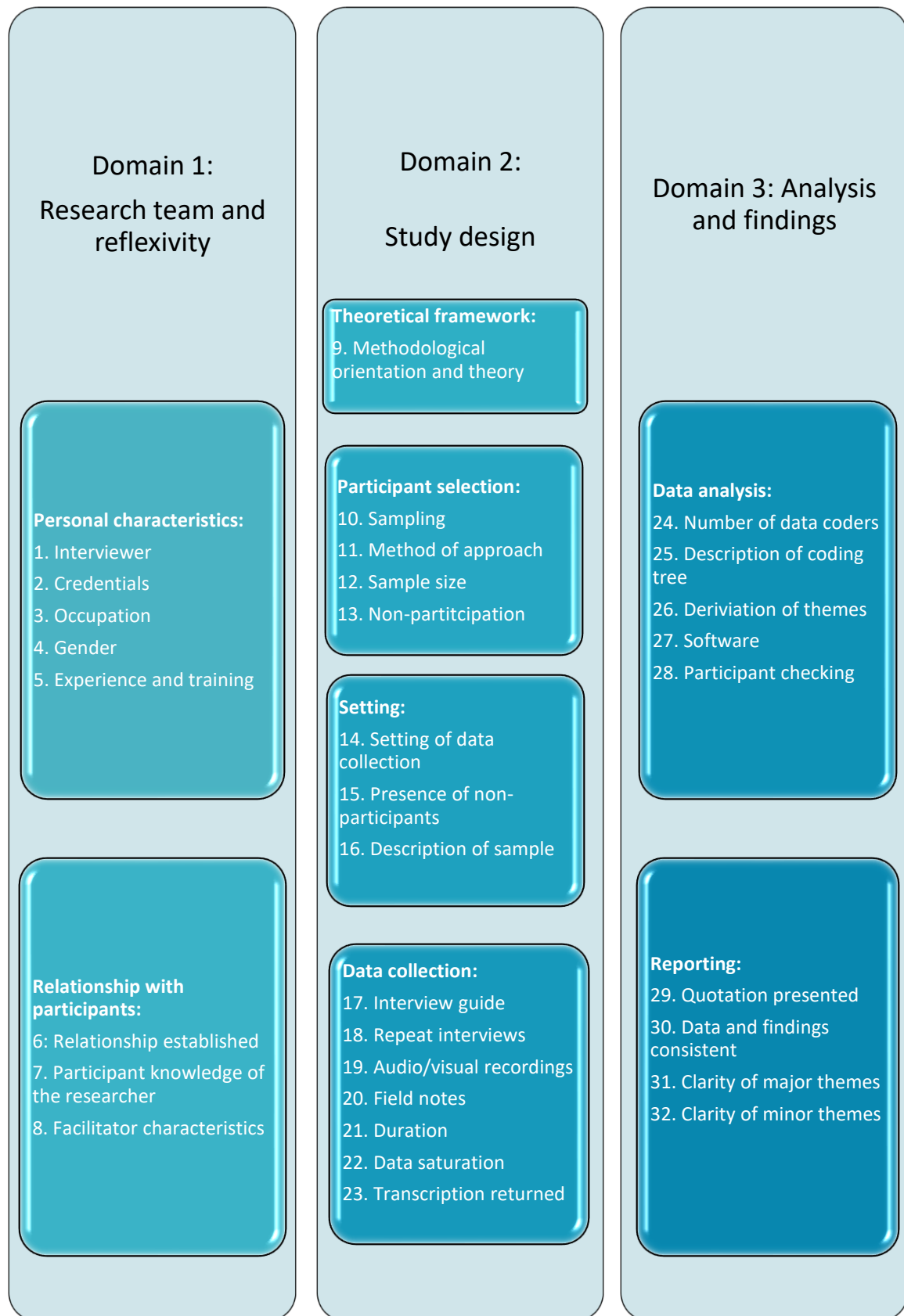


FIGURE 4.1 32-ITEM CHECKLIST FOR REPORTING ON A FOCUS GROUP INTERVIEW

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (TONG *ET AL.*, 2007)]

4.2 DOMAIN 1: RESEARCH TEAM AND REFLEXIVITY

4.2.1 PERSONAL CHARACTERISTICS

Both focus groups were facilitated by the same independent facilitator identified and appointed by the supervisors for this study. The facilitator, an academic staff member and senior lecturer at CUT, is registered at the HPCSA as an environmental health scientist (HI0067911). She holds a Doctorate Technologiae degree in Environmental Sciences and is involved in undergraduate and postgraduate students' training. The facilitator experienced in the facilitation of focus groups demonstrated the required skills as suggested by Nyumba *et al.* (2018) and include the following (Nyumba *et al.*, 2018):

- Rapport building.
- Active listening skills.
- Good observations, skills.
- Excellent communication skills.
- Flexibility.
- Unbiased.
- Ability to encourage discussion.

The researcher is an academic staff member employed by CUT, registered as a clinical technologist specialised in critical care at the HPCSA (KTG 0003425). As a lecturer, the researcher is actively involved in the training of pre-specialisation clinical technology students, specifically in the subject area of biomedical apparatus and clinical procedures related to the profession of clinical technology. The primary investigator holds a Master's degree in Health Sciences Clinical Technology and is very familiar with the curriculum of pre-specialisation clinical technology students.

4.2.2 RELATIONSHIP WITH THE PARTICIPANTS

The independent facilitator was not familiar with the focus groups' participants, whereas the researcher and observer were well acquainted with most of the focus groups' participants. The before-mentioned were either due to previous work-related and current academic relations. All the focus groups' participants were presented with a letter of invitation to participate in the research study and a signed informed consent document. Therefore, the participants understood that the data generated from the focus group interviews would be used as part of an academic research study to complete and obtain a Doctorate in Health Sciences, Clinical Technology.

4.3 DOMAIN 2: STUDY DESIGN

4.3.1 THEORETICAL FRAMEWORK

The research was based on the grounded theory design, and focus group interviews were selected as one of the methods to collect data (Chong & Yeo, 2015). Focus group interviews are defined as one of the qualitative techniques in the form of a discussion between a small group of people (6 – 9 participants) to collect data on a specific topic (Dilshad & Latif, 2013). The focus group interview is also described as a semi-structured interview with open-ended questions and a guide. Focus group members were allowed to respond and comment on the ideas and suggestions voiced by the other focus group participants (Foley & Timonen, 2015).

4.3.2 PARTICIPANT SELECTION

Participants were selected using “*purposive sampling*”, and the group demonstrated the traits of a homogenous sample, specifically concerning the participant’s profession (Etikan, 2016). The researcher only included qualified clinical technologists involved in CUT students’ WIL training for both focus groups. Focus group 1 consisted of WIL lecturers from the Western Cape and included the following clinical technology specialities: Pulmonology, Cardiology, Perfusion, Critical Care and Reproductive Biology, as illustrated in Figure 4.2 below. Focus group 2 mainly consisted of WIL lecturers from Gauteng, Free State and Northern Cape. Clinical technology specialities represented in these focus groups included: Cardiology, Critical Care, Perfusion, Neurophysiology and Nephrology, as illustrated in Figure 4.3.



FIGURE 4.2 CLINICAL TECHNOLOGY SPECIALITIES REPRESENTED IN FOCUS GROUP 1 ²
[COMPILED BY THE RESEARCHER, PERKINS 2020]



FIGURE 4.3 CLINICAL TECHNOLOGY SPECIALITIES REPRESENTED IN FOCUS GROUP 2
[COMPILED BY THE RESEARCHER, PERKINS 2020]

² Two of the focus group participants are registered in both Pulmonology and Critical Care.

All the participants were invited to participate in the meeting using an invitation letter accompanied by an informed consent document send via e-mail. Focus group 1 consisted of nine participants, two females and seven males. The average age for participants in this focus group was 41-years. Approximately 50% of this focus group participants indicated that they had more than 10-years' experience as a healthcare professional, and 89% of the participants reported that they trained more than six students in their units over the last 5-years.

Focus group 2 consisted of nine participants, seven females and two males that participated in the online focus group discussions. The average age for participants in focus group 2 was 39-years, with five participants (55.5%) who indicated they had more than 10-years' experience as healthcare professionals. 78% of the participants in focus group 2 indicated that more than six students were trained in their respective units in the last 5-years.

None of the focus group participants refused to participate in the meeting or later requested to withdraw their data. However, one participant did try to join the focus group 1 meeting but could not participate in the discussions due to internet connectivity problems. The before-mentioned participant didn't contribute to any of the data and was excluded from focus group 1.

4.3.3 SETTING

Both focus groups were conducted online via the Microsoft® Teams application platform. Participants were either joining the meetings from their offices or homes via an internet connection. In addition to the researcher, facilitator and participants that joined the meeting, the internal supervisor also joined both focus group discussions as an observer.

4.3.4 DATA COLLECTION

The data collection method was discussed in Chapter 3. The reliability, validity and trustworthiness, together with the ethical considerations, were also discussed in Chapter 3. The facilitator used a focus group interview guide (Appendix B3) and two main questions, and one concluding question posed to the participants.

Question 1:

- *“What is your personal opinion regarding the use of a clinical simulation programme as part of the preparation and training of pre-specialisation clinical technology students?”*

Question 1 was augmented by five additional guiding questions that the facilitator used to encourage discussion among the participants.

- *“What are the basic practical and or clinical skills that you consider as essential/important for a student clinical technologist to be trained in before he/she starts their WIL? E.g. taking a patient’s vital signs, use of a blood gas machine.”*
- *“What specialised biomedical apparatus would you recommend pre-specialisation clinical technology students should be exposed to?”*
- *“Which specialised procedures would you recommend pre-specialisation clinical technology students should be exposed or trained in? E.g. collection of blood gas, set-up of an intravenous infusion.”*
- *“Is exposure to practical scenarios to the pre-specialisation clinical technology student important? Motivate your answer.”*
- *“What are the best modes of delivery training students in the mentioned skills?”*

Question 2:

- *“In your opinion, what role can simulation play in the training and assessment of pre-specialisation clinical technology students?”*

Concluding question:

- *“Of all the things we’ve discussed today, what would you say are the most important issues you would like to express about the practical and skills training of pre-specialisation clinical technologists?”*

No, follow up meetings were necessary, and both focus group discussions’ audio tracks were digitally recorded. The researcher made field notes during both focus group discussions. Focus group, one’s meeting, lasted for approximately one hour and forty-six minutes and focus group 2’s meeting concluded after one hour and thirty-seven minutes. Transcripts for both focus group discussions were returned to the participants via e-mail for verification of accuracy. None of the participants indicated that their comments were captured or transcribed incorrectly.

4.4 DOMAIN 3: DATA ANALYSIS AND FINDINGS

In this section, the data analysis, together with the reporting of the findings, are discussed. The detailed analysis process is described in Chapter 3.

4.4.1 DATA ANALYSIS

The data collection method and the reliability, validity, and trustworthiness were discussed in Chapter 3. Ethical considerations were also discussed in Chapter 3.

In summary, a *constant comparison analysis* as developed by Glaser and Strauss (1978) was used to analyse data generated from the two focus groups (Onwuegbuzie *et al.*, 2009). A “*deductive analysis*”, where participants answers to specific research questions were evaluated, and an “*inductive analysis*” process where possible unexpected issues and common topics are identified, were used for analysing the focus group data (Harrell & Bradley, 2009). Coding was conducted manually by the researcher, and no coding software was used. The coding process included open, axial, and selective coding (Wagner & Fernández, 2015).

4.4.2 REPORTING

Reporting on the focus group discussions and transcripts was done by allocating two distinct alphabetical letters to each focus group. Comments from focus group 1, consisting of WIL supervisors and trainers from the Western Cape’s transcripts, were allocated the letter “W”. Comments from focus group 2, consisting of WIL supervisors and trainers from the Free State and Gauteng’s transcripts, were allocated the letter “F”. Each paragraph in the respective transcript was numbered according to its corresponding letter, and paragraph number, e.g. paragraph 1 from the focus group 1 transcript were numbered [W1].

The allocated numbers were used to refer to specific comments from the corresponding focus groups. All direct comments copied from the transcripts (Appendices C1 and C2) were displayed in *Italics* font between inverted commas.

4.4.2.1 FOCUS GROUP AREA 1: PERSONAL OPINION

This focus group area investigated the focus group participant’s personal opinions regarding using a clinical simulation training programme to prepare and train pre-specialised clinical technology students. One central theme emerged from the discussions, namely the importance

of clinical simulation as part of the practical preparation and training for clinical technology students and are illustrated in Figure. 4.4 below.

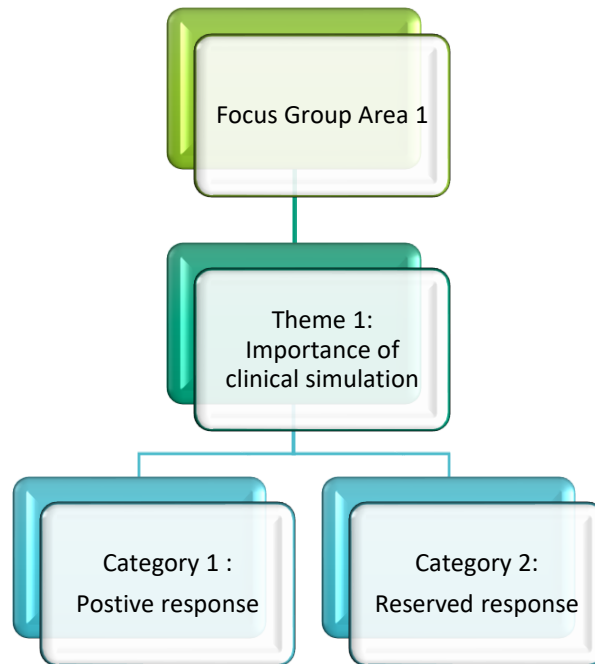


FIGURE 4.4 THEMES AND CATEGORIES IDENTIFIED IN FOCUS GROUP AREA 1

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Theme 1: Importance of clinical simulation

Category: Positive response

Most of the participants from both focus groups expressed that they feel the use of a clinical simulation programme is essential.

- *“I would say for basic practical and clinical skills. It is very important, I think, for students, because in the first and second years there is nothing that they know about working with patients as such.” [F1].*
- *“Definitely, a clinical skill, practical side if we expose the student a bit earlier....” [F2].*
- *“So I think that will be very helpful.....I think it will be beneficial.” [F3].*
- *“Um, I think simulation, helps and exposure is very important....” [F31].*
- *“Okay, so I do feel that this simulation is very, very important.” [F34].*
- *“I think it’s very important....” [W1].*
- *“I think it’s quite vital that we actually have this as a background in training for the students...” [W2].*

- *“What I said is I think it’s, I’m all for this type of simulation before they specialized..... I think it’s a very good idea For me, to me, I’m for it. I’m a hundred per cent for a simulation programme.....” [W5].*
- *“I think the simulation is actually a very good idea....” [W7].*
- *“It will benefit the students quite a lot if we had simulation.” [W9].*

Category: Reserved response

A couple of participants voiced reserved opinions and responses towards the importance and use of clinical simulation in clinical technology students’ training. However, these responses were either associated with being unfamiliar with clinical simulation, concerned with the cost related to simulation, especially the equipment, the practicality and use of simulation in a specific clinical technology speciality, and the current ineffective practical training of clinical technology students CUT.

Sub-category: Unfamiliarity with simulation

- *“Okay. Um, neurophysiology, unfortunately, is kind of on its own. There’s not much I can tell you regarding simulation....” [F6].*
- *“And with the simulation, as much as they say, it is expensive. It’s something that’s very difficult to do.” [W17].*

Sub-category: Cost related to simulation

- *“Simulation is a good idea the question being, and this is where one of the later questions is apparatus and that type of thing because we are all different categories, one has to look at, you can’t supply all the equipment, even for basic tests and that it costs a lot of money and expenses are going to be exorbitantly high.” [W6].*
- *“.... you know the cost is going to be quite high... I mean, this is going to cost millions of Rand....” [W11].*
- *“To put out millions of Rand is not going to be possible for equipment....” [W12].*

Sub-category: Simulation in specific specialities

- *“Yes, um, unfortunately, in the reproductive field. Um, our job is a very hands-on job there is nothing that we really do, our procedures are so specialized that the students will unfortunately only be able to learn it in the unit itself. I mean,*

out there in a simulation room you can't really teach a student how to do a semen analysis, for instance, that's only one part of our specialized procedures and everything.... And that's the sad part of the reproductive field. You can't even really teach them how to communicate with patients because the type of patients that come here they are already so stressed, they so sensitive about the whole reproductive issue that you can only learn with experience how to communicate with these type of patients." [W26].

- *"Sorry, regarding simulation it's a bit difficult, regarding neurology and neurophysiology in that regard."* [F33].
- *"Unfortunately, I don't think simulation. For the first and second-year students is going to work for the, for the reproductive field, because the procedures that we do are too specialized."* [W56].
- *"Um, to be honest, I'm not entirely sure how much help simulation would be for neurophysiology department?"* [F51].

Sub-category: Current practical training of clinical technology students at CUT.

- *"I know there is a simulation lab for how long now, and I can't see that it really makes a difference."* [F36].
- *"I think, from my side I made it clear that the simulation didn't help too much in the past, I know if I look at yes, there may have been some advantages, but taking into account all the things that I experienced year after year I cannot see that it makes that big difference."* [F45].
- *"Yes, with regards to simulation I have to agree with number 9 and number 1 that, in retrospect over the last few years, we haven't seen much results of the students, you know, coming through the programme, but I also have to add, I think it's only recently that the researcher is taking up the simulation and skills lab, and I think his aim is definitely to develop a proper skills lab to equip the students..."* [F53].

Some participants indicated that they have a reserved opinion on the use of clinical simulation.

Reasons for the before-mentioned are listed below:

- Unfamiliarity with clinical simulation as a teaching method.
- Cost of simulation and simulation equipment.

- Speciality specific simulation training.
- Current practical curriculum and training method at CUT.

4.4.2.2 FOCUS GROUP AREA 2: PREPARATION OF PRE-SPECIALISATION CLINICAL TECHNOLOGY STUDENTS

Participants were asked to discuss how simulation could be used to prepare and train the pre-specialisation clinical technology students for the WIL phase of their qualification. The discussions took place around five guiding questions or themes. The responses of the participants are described below, according to each theme. Figure 4.5 summarise the main themes that were identified in this particular focus group area.

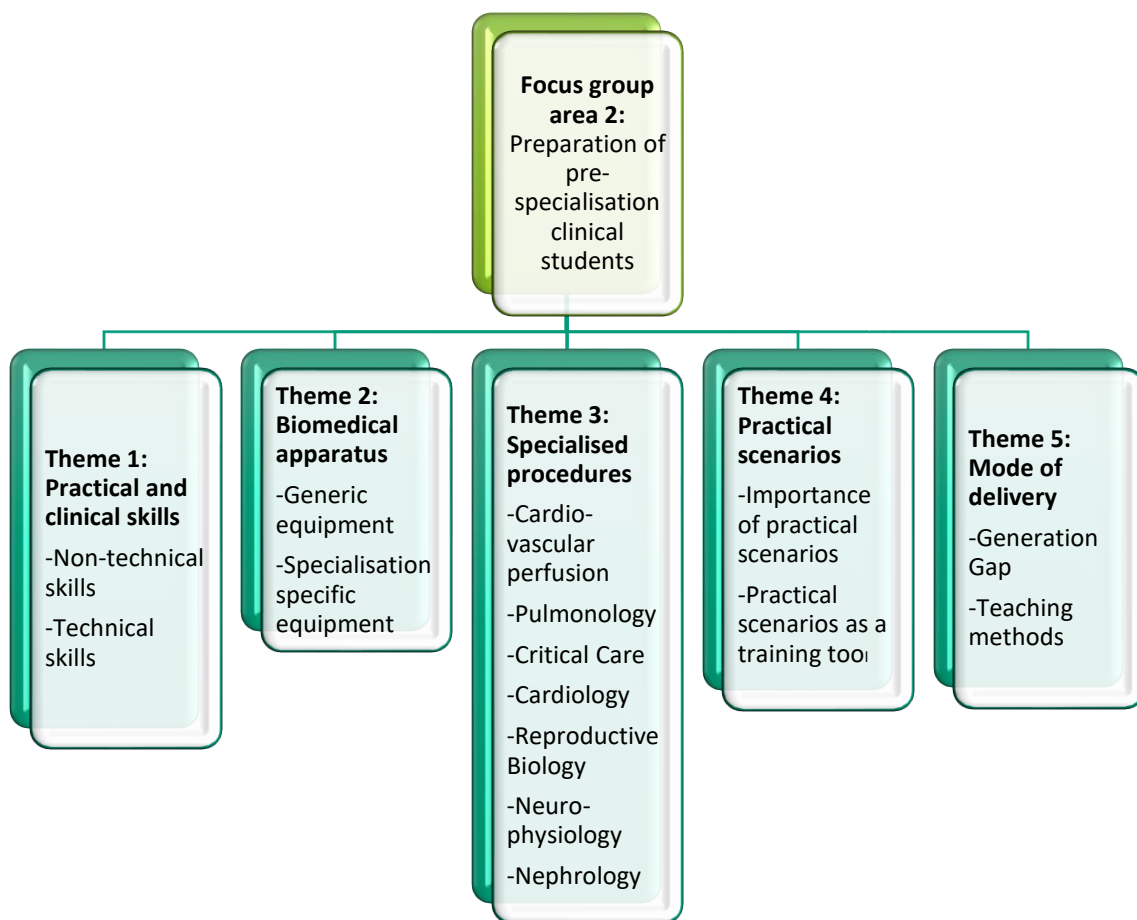


FIGURE 4.5 THEMES IDENTIFIED IN FOCUS GROUP AREA 2

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Theme 1: Practical and clinical skills

Responses from participants varied from students who should be taught generic or non-technical skills such as working with a patient to more specific technical skills, for example,

measuring a patient's blood pressure. As per the HPCSA published document related to core competencies, it is important for a clinical technologist to act in the correct manner. These competencies include communication, collaboration, health advocacy, professionalism, scholarship and leadership (HPCSA, 2014).

- *“And for that, I think that something about that must be brought in somewhere that this is how you work with a patient and then, obviously, you can go to taking the pulse of a patient, those vital signs we talk about here, blood pressure, and that kind of things” [F1].*

Participants emphasized that students should be trained in basic skills:

- *So, as previously mentioned, it's as simple things they actually have to start doing and the skills they build on that because you can't start with a specialized machine if you don't know your basics, actually. [W23]*
- *“The most important thing for me is that the students must be trained the basic skills.” [W40].*
- *“So just the basic things.....” [F19].*
- *“...just with the end goal, namely the second year so only basic things, not a specialization yet.” [F49]*

The second focus group area's central theme was separated and categorised simply in technical and non-technical skills. Technical skills mainly referred to skills such as working with a patient, whereas non-technical referred to skills a clinical technologist would need within the general healthcare environment. A summary of the required non-technical skills is illustrated in Figure 4.6 below. Non-technical skills can be grouped into three main groups: social skills, cognitive skills and personal resources and are illustrated in Figure 4.7.

Category: Non-technical skills

Sub-category: People skills

- *“...how you work with a patient....” [F1].*
- *“Another important thing that I feel is that because we all work with patients well, most of the categories work with patients and these people should be taught some people skills as well that they can at least work decently and properly and correctly with patients.....” [W6].*
- *“.....they need to have people's skills.....” [W18]*

- *“...they don’t know how to work with people...” [F22].*
- *“...getting the students to get to know how to work with patients.” [F27]*

Sub-category: Patient movement and transport

- *“One of the other things that were a bit of a problem at the beginning of the year was when I sent my students up to get a patient from the ward. They were not able to do that safely.” [F6].*
- *“...just to be able to turn the patients head....” [F7].*
- *“Another thing that might be included in your training is emergency evacuations how to do that because wherever we go, we need to know how to do that to evacuate if there’s a fire or something like that, that’s maybe something nice to add.” [F22].*

Sub-category: Patient awareness and needs

- *“Sometimes you have to lift the head a little bit or turn the head a little bit, and I need them to be sure that they don’t accidentally extubate the patient or, or that some tubing is disconnected and sometimes they don’t pick it up. I just need them to be vigilant regarding the normal activity, regarding saturation making sure that patients still on his ventilator and everything’s working well and just minding the tubing and all those things in the ICU. So that is all from my side” [F6].*
- *“.... a lot of times the patient needs to go to the bathroom or patient needs to unclamp his drip....” [F7].*

Sub-category: Communication

- *“.... answering a phone, and how to take a message.” [W25].*
- *“what the broad spectrum in training needs to be..... or answering a phone....” [W37].*
- *“.... how to communicate with patients as it said how to answer the phone.” [W38].*
- *“Communication and that once again comes down to people skills....” [W39].*
- *“As all of you have repeated, is the communication...” [W40].*
- *“.... communication definitely with patients. A lot of them struggle with how to talk to your patient, very important”. [F4].*

- *“And in my field, it is extremely important that you are able to distinguish and be able to communicate with your patient as effectively as possible. And to try and distinguish between a patient who is really confused and a patient who is able to communicate but not verbally” [F6].*
- *Reporting and documentation “And then for me very important what a lot of students struggle with his to-do ethical reporting and documentation.” [F22].*

Sub-category: Emotional maturity

- *“I’m picking up they don’t know how to work with people, they don’t know how to cope with stress. Emotional immaturity where they don’t understand that they now in the world.” [F22].*
- *“And also, the psychological effect of how to debrief with your stress how to debrief with what you see at work.” [F43].*

Sub-category: Infection control

- *“....and they know, and another important thing is just to teach them sterile technique because, you know, it’s, many times, quite difficult to get the student in the specialized area and they have no idea of how to be sterile and how to work in a sterile environment. And I think that can be a pre specialized good pre specialized thing to teach them in the simulation situation.” [W25].*
- *“This is a sterile environment, a lot of them don’t understand that if you’re working with a patient in theatre that it is a sterile environment, don’t touch this, don’t touch that keep your hands to yourself.” [F5].*



FIGURE 4.6 SUMMARY OF NON-TECHNICAL SKILLS
[COMPILED BY THE RESEARCHER, PERKINS 2020]

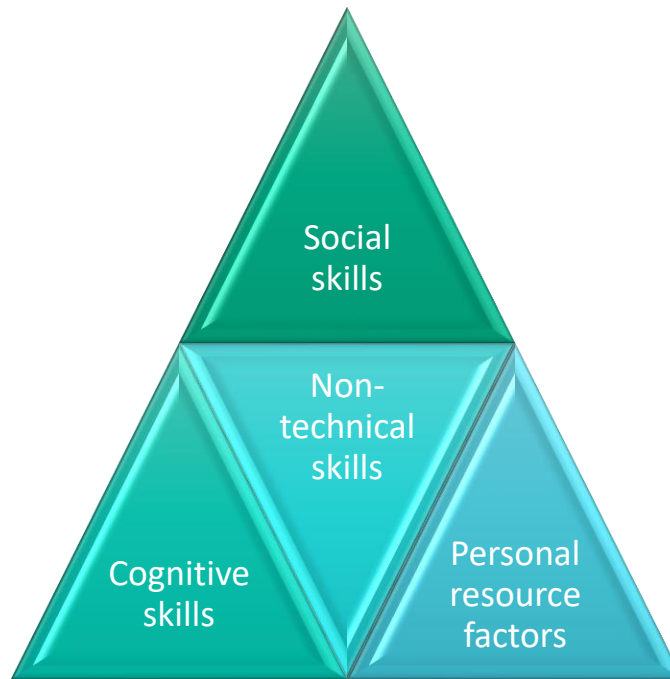


FIGURE 4.7 PRACTICAL SKILLS GROUPED

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Category: Technical skills

The technical or clinical skills participants deemed necessary a pre-specialised clinical technology student should be exposed to, revolved around two sub-categories as illustrated in Figure 4.8:

- Vital sign and patient monitoring.
- Basic life support.

Sub-category: Vital signs and patient monitoring

- *“I would say monitoring and that how to measure pulse is important.” [W19].*
- *“where to put on ECG stickers.” [W22].*
- *“We all need in all the categories we need to know how to take your blood pressure, even if you don’t do it in the daily.” [W25]*
- *“.... taking a blood pressure....” [W37].*
- *“.... how to do normal blood pressure...” [W38].*
- *“.... blood pressure, yes, it does have an effect on most categories.” [W39].*
- *“...and then, obviously, taking the pulse of a patient, those vital signs we talk about here, blood pressure...” [F1].*

- “what is actually the red line on a monitor for instance in theatre, arterial pressure, CVP, ECG.” [F2].
- “....to take a blood pressure... know the saturation to know the ECG to know the EEG yeah, so that’s from my side.” [F7].
- “I think it’s very important for them to know how to take a blood pressure accurately because that’s one of the things that I’ve noticed with students coming to us that they know nothing about blood pressure.” [F8].
- “And to monitor the SATS..... ” [F21].
- “.... how to do a proper blood pressure, and what to do if it’s high or low....” [F22].

Sub-category: Set-up of equipment

- “.... know how to set up a transducer, how to hang up a drip set, how to read labels on fluid..... You know, how to actually distinguish between fluids.” [W22].
- “You can teach students in a simulation situation and ECG set up how to set up your electrodes correctly.” [W25].
- “Just how to set up the equipment from a vital signs perspective, ECG, SATS.” [F11].

The suggested vital signs and general patient monitoring is summarised in Table 4.1 below.

TABLE 4.1 VITAL SIGNS AND GENERAL PATIENT MONITORING PARAMETERS
(COMPILED BY THE RESEARCHER, PERKINS 2020)

Vital Signs	Patient Monitoring
Blood pressure	ECG
Pulse rate	Arterial pressure
Oxygen saturation	Central venous pressure

Participants made it clear that students need to perform at least basic life support and understand their clinical emergency role.

Sub-category: Basic life support

- *“Little bit of CPR....” [W19].*
- *“CPR, as I previously said.” [W25]*
- *“...they must know what to do in an emergency, how to do basic resuscitation...” [W40].*
- *“BLS training is quite important. How to do basic CPR, how to do it with a heart attack with a seizure manual CPR, or AED CPR, when to start CPR.” [F22].*

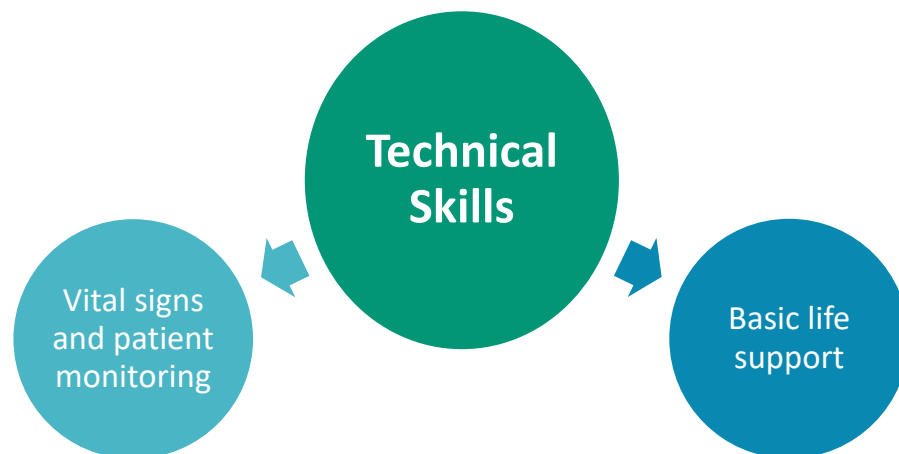


FIGURE 4.8 TECHNICAL SKILLS BREAKDOWN

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Theme 2: Biomedical apparatus

Participants indicated the necessity of pre-specialisation students being exposed to generic and speciality-specific medical apparatus with this theme. In general, participants agreed that students should be exposed to medical equipment in the pre-specialisation phase.

- *“I mean they need to know exactly how the apparatus works, so they need to play around with it....” [F20].*

An important aspect regarding the exposure of students vs the detailed training of students in specific medical apparatus was voiced during the discussion, and two participants made the comments (22%) that the focus of training should rather fall on the training of skills than training students to become equipment operators:

- *“So I thought perhaps it might be more practical and worthwhile to not think about necessarily just equipment or devices, that would be useful but perhaps skills that could be applied across all categories.” [W13].*
- *“I must say I stand with number 5 and I like what she said. I don’t like the idea that we get we become a profession of working with, like, for the last thirty years was equipment and that’s all we can think of, we really we not into equipment we don’t need to teach somebody how to use the equipment. The rep selling the equipment can also use that equipment, and he can teach the student and the qualified to use the equipment I think it’s more important teaching people skills....” [W15].*

Category: Generic equipment

Participants were fairly in agreement regarding the generic equipment pre-specialisation clinical technology students should be exposed to except for the blood gas machine. Two participants (22%) questioned the viability of including a blood gas machine but did agree that exposing students to a blood gas machine in a stimulatory environment could be beneficial:

- *“Blood gas machine I don’t think it’s going to be viable for you to, for instance, to purchase something like that. Because it’s not used regularly but to expose a patient in a stimulatory environment where they can simulate these should definitely assist in preparing them for a real scenario.” [F9].*
- *“But I agree with the simulation there will be more viable to have a simulation of a blood gas machine, just to understand how it would work.” [F11].*

The use of a blood gas machine in a simulation environment was confirmed by another participant that stated it would be better for students to be exposed to a blood gas machine in a training or simulation environment rather than in a real-life hospital setting where the damage to equipment was a real possibility, resulting in financial and possibly other complications.

- *“You know, they wouldn’t be allowed to touch the equipment or to use it, even a blood gas; I mean if they did it incorrectly and, you know, clogged up the machine then they would be responsible. So, I think it’s important that they see*

it, but then I think this whole simulation factor then comes into play, that then they go back on site to CUT, and they practice doing, for example, blood gasses...” [W42].

Herewith statements from participants that agreed that students should be exposed to a blood gas machine.

- *“But like I say the only thing I can think of in terms of equipment, procedures that would go universally across the categories would be the arterial blood gas.” [W22].*
- *“It is specialized, and we have a diverse group of people that have to go into units at the end of the day to teach them something that will be universal at the end. Blood gas, ECG’s or a monitor that they would actually be able to set up.” [W23].*

The other generic equipment participants agreed on that pre-specialised students should be exposed to are listed below and illustrated in Figure 4.9.

- *“With this, I mean we’re studying, we had that biomedical apparatus subject where you actually introduced to things like syringe pumps, transducers, ECG’s” [W27].*
- *“.... setting up transducers...” [W42].*
- *“...there should be an ECG machine, a defib, and I think blood gas as well, for that matter, would be important as well....” [F8].*
- *“.... a blood pressure monitoring or monitor that shows vital signs.” [F9].*
- *“I agree with all the vital signs a vital signs monitor...” [F11].*
- *“So if they can play around with machines like blood pressure and ECG it would be very good for them. I can’t think of too many other things but just the fact that they can play around with the machine physically would be nice but I think especially blood pressure and ECG.” [F12].*
- *“Okay, what I would add is a drip stand or drip monitor, ECG, BP machine that everyone mentioned, oxygen, machine, even if it’s just a manual one... I’ll add a defib, a suction machine. Blood gas everyone mentioned....” [F14].*
- *“So I think with regards to basic biomedical apparatus, I think it’s also important for the students to really know the basics as well. With regards to different type of syringes, needle size where would a physician use, for example,*

what needle. And those are really the basic things that I've seen that students lack in the clinical setting." [F15].

- *"All monitors are basically the same..... really basics. If they can be exposed to these in the simulation environment, it would be immensely helpful for us, definitely."* [F17].
- *".....how to work with Ivacs to set it up, because we work a lot with the equipment... So just the basic things how to set it up....."* [F19].
- *"And as I mentioned before, equipment-wise sonar...."* [F19].
- *"Then they don't know how to work the oxygen cannula they don't know how to work the oxygen...."* [F21].
- *"...my list is obviously what everyone mentioned the blood pressure machine..."* [F22].
- *"...how to use a suction machine..."* [F22].

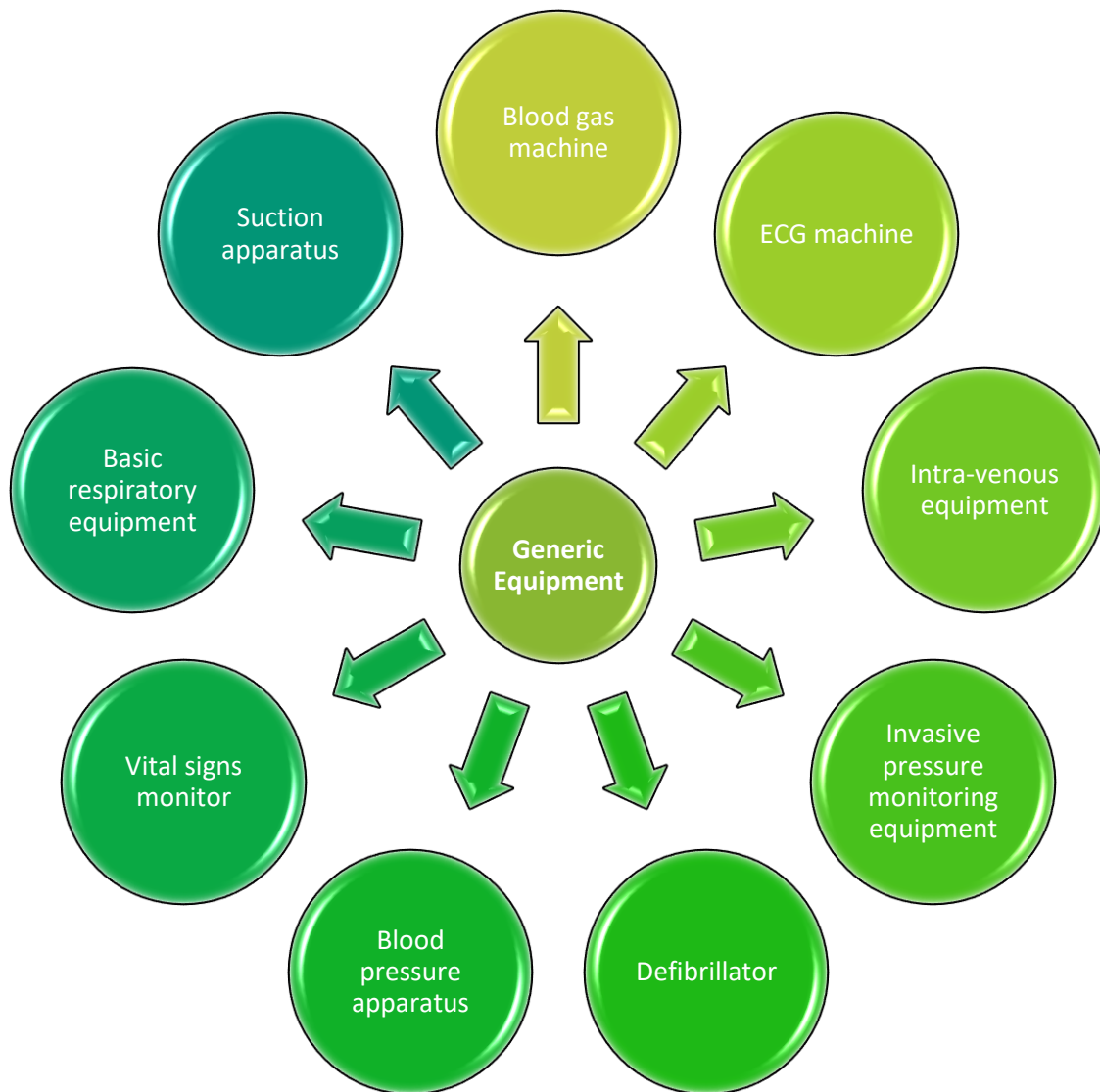


FIGURE 4.9 GENERIC EQUIPMENT

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Category: Specialisation specific equipment

Participants felt that it would be necessary to expose the pre-specialisation clinical technology students to generic equipment and one or two medical apparatus specifically used within a particular clinical technology speciality and are demonstrated in Figure 4.10.

- “I think it could be important for them to just be exposed to the different equipment related to each category.” [W3].

Sub-category: Pulmonology

- *“I think for pulmonology, spirometry, diffusion, and plethysmography are probably the key biomedical apparatus tests that need to be dealt with in your second year.” [W10].*

Sub-category: Perfusion

- *“If I look at perfusion alone, we only really have three small devices that you could say are for ‘testing’: the ACT the (activated clotting time), the blood gas machine and perhaps the little Hemocue machine. But the rest of our equipment is all related to support, so it’s the heart-lung machine, the intra-aortic balloon pump, the ECMO machine, the cardiac ablation machine, and then cell-saving which is obviously processing shed blood, so it would be very difficult to try and give you a list just speaking for perfusion.” [W13].*
- *“I think for the perfusion side ACT machine, and a blood gas machine would be the most important to know what we use and how it can be used, and what results at the end of the day means.” [W24].*

Sub-category: Reproductive Biology

- *“From the reproductive side. I don’t think there’s any apparatus that you can really use to train the students before they actually go to the unit” [W16].*

Sub-category: Cardiology

- *“The previous speakers also said that blood gas and ACT is also important because cardiology and it will be nice if they have a backup knowledge of how to do that.” [W25].*

Sub-category: Critical Care

One participant from focus group 1 asked which piece of equipment should represent the critical care speciality?

- *“I mean in the critical care you’re going to take a dialysis machine or are you going to take the ventilator and that’s my question?” [W11].*

On the other hand, one of the critical care representatives from focus group 2 suggested that both the dialysis and ventilator are included in a simulation programme:

- “In critical care, so many equipment. Maybe a sonar machine.... any dialysis machine..... they should be able to work with any other dialysis machine.... just a basic ventilator” [F11].

Sub-category: Nephrology

- “...and the dialysis machine...” [F14].

Sub-category: Neurophysiology

- “Regarding simulation, I don’t really have any options here. Because as you know that the simulation doesn’t really give you brain activity or nerves to work with, so that is a bit difficult. I usually do all that training I in the unit myself. And so regarding that, I don’t have any anything in their first few years that they can really learn. Regarding this speciality” [F13].

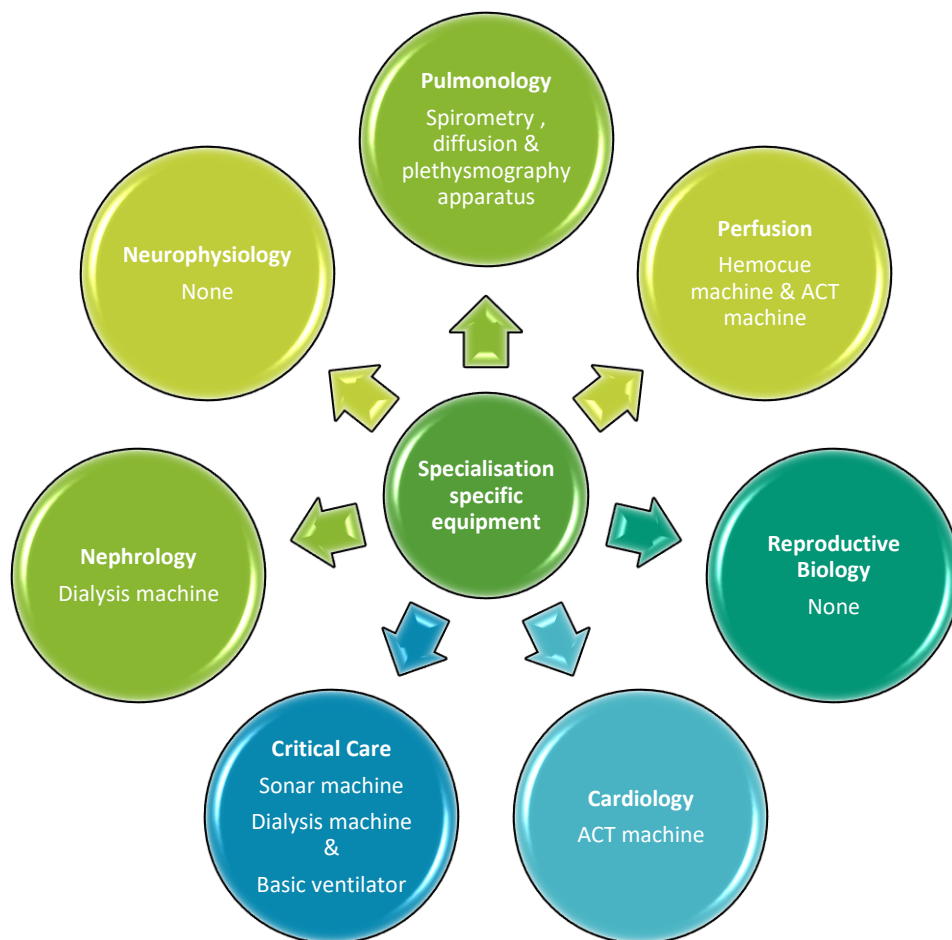


FIGURE 4.10 SPECIALISATION SPECIFIC EQUIPMENT

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Theme 3: Specialised procedures

The third theme of focus group area two dealt with the specialised procedures participants felt pre-specialised clinical technology students should be trained in before entering the clinical environment. Participants mentioned generic and speciality specific procedures.

- *“I think just to reiterate the importance of having students become familiar with skills. You know, a lot of the skills, although they may not use a specific one in a specific way, they would’ve learned it. A lot of the skills are generic and cross over each other.” [W22].*
- *“So, as previously mentioned, it’s as simple things they actually have to start doing and the skills they build on that because you can’t start with a specialized machine if you don’t know your basics, actually.” [W23].*
- *“Yes, I do think there’s a lot of pre skills that we can teach students before they get to the specialized area.” [W25].*
- *“.... there is numerous stuff you can teach the students in the pre specialization skill area where they can actually pick up on skills that will be necessary somewhere in the profession and make it as soon as they get into a specialized area make it much easier for us if they already have a skill.” [W25].*

One participant felt that students should only be informed what type of investigations are being done and that specialised procedures should be taught in the specialised unit itself.

- *“And then the practical part we will do in the specialized units, that’s my feeling.” [W21].*

Herewith some of the generic specialised procedures participants agreed to, a pre-specialisation clinical technology student should be trained in and are illustrated in Figure 4.11.

Category: Generic

- *“.....basically monitor setups in critical care in a lot of quite a few categories that have to do the monitoring.” [W19].*
- *“.... procedures that would go universally across the categories would be the arterial blood gas.” [W22]*
- *“And it’s something you can teach them early on in the simulation situation, even to draw blood.” [W25].*
- *“...monitoring ABG’s...” [W38].*

- *“Then maybe I do believe the simulation has something where they can practice to draw blood from a patient, not particularly to draw a blood, just to have that feeling....” [F19].*
- *“.... giving oxygen while the patient is feeling out of breath will also be helpful I think even, not only in my department but also in some of the other departments I think in cardiology and pulmonology as well” [F21].*
- *“ECG how to do basic ECG, 3-lead and 12-lead.” [F22].*
- *“My second point would be oxygen on how to give oxygen when to give oxygen also how to monitor the oxygen that’s been given.” [F22].*
- *“My fifth point will be how to set up a drip.” [F22]*
- *“My sixth point is how to draw blood or, and why certain types of blood are taken at certain spots in the body.” [F22].*

Category: Cardiovascular Perfusion

- *“I think for the perfusion side ACT machine, and a blood gas machine would be the most important to know what we use and how it can be used, and what results at the end of the day means.” [W24].*

Category: Pulmonology

- *“I think, looking at pulmonology, definitely doing blood gasses and being able to interpret blood gasses.....But I think, having the knowledge, and then definitely, do a bit of practical stuff for pulmonology definitely be able to do spirometry, as number 2 mentioned way earlier,.....they need to know how to perform the test they don’t need to know exactly how to interpret everything but at least know a bit of basic” [W18].*
- *“Spirometry, in lung-function pulmonology, a basic lung function.” [W19].*

Category: Critical Care

- *“I think when it comes to critical care, there’s a lot of stuff I think being able to do and set up, insert an A-line set up A-line zeroing of an A-line. I think being able to intubate patients, and interpreting ventilation doing different loops and graphs.....” [W18].*
- *“With regards to specialized procedures, and so I’m from the field of critical care. So I will try not to be biased, but with regard to critical care, it is really*

important for the students to be able to know how to draw blood from an A-line, how to help set up an intravenous infusion how to set up an A-line, and how to work obviously a monitor, and how to interpret these values as well.” [F15].

- *“Number 6 may already have touched on the things for critical care. Definitely important things like the A-lines and that IV’s....” [F19].*
- *“And like I said with a ventilator if they can know how to set up a ventilator that really helps.” [F19].*

Category: Cardiology

- *“how to set up your electrodes correctly teach them how to do A-line or venous line, Swan-Ganz and all that stuff.” [W25].*
- *“For me, from working in a cardiology scenario, I would say if every time it comes if we speak to the basic stuff. Every time it comes down for me to the blood pressure and the ECG.” [F16].*

Category: Reproductive Biology

- *“Everything is practically based on your skill, also in the lab, but that the student can only learn over time because it is very specialized..... But unfortunately, it has to happen inside the unit. And that’s the sad part of the reproductive field..... So, unfortunately, there are not any specialized procedures that they can be exposed to before they actually decide to specialize in reproductive biology....” [W26].*

Category: Neurophysiology

- *“...the EEG that Neuro does it’s just a basic amplified one, but they’ve also just the placement of the electrodes how to work with the electrodes...” [F11].*

Category: Nephrology

- *“My third point will be how to use a suction machine, and when to use the suction machine.” [F22]*
- *“And my fourth point will be how to interpret basic x-rays, and how to interpret basic pathology.” [F22].*

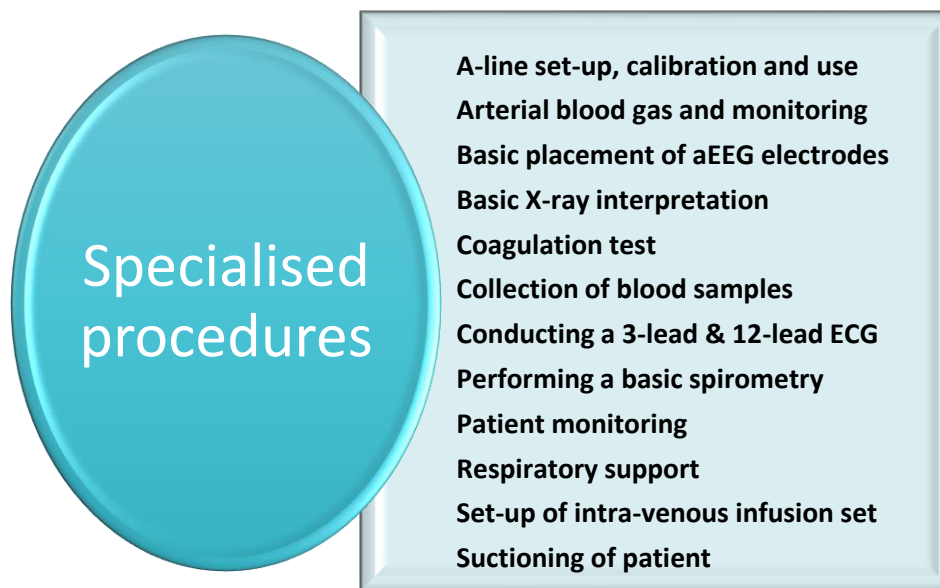


FIGURE 4.11 SPECIALISED PROCEDURES

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Theme 4: Practical scenarios

The fourth theme that surfaced from focus group area two was pre-specialised students' exposure to realistic, practical scenarios. Under this theme, two categories were identified: the importance of practical scenarios and practical scenarios' role as a training tool for students.

Category: Importance of practical scenarios

- *"Yes, so I think practical scenarios is very important, I think we need to remember the so students that come from the university and have no hospital experience. And with critical care and pulmonology and I guess with each speciality there is always an emergency case. And you need to handle the pressure and need to know what to do, and I think that comes down to having the proper knowledge with your physiology anatomy and pathophysiology, so I think scenarios are important."* [W28].
- *"I think we're all answering along the same lines, but I think, obviously, practical exposure is important."* [W32].
- *"I think it's important that the students be able to see the skills, and in different scenarios"* [W42].

Category: Practical scenarios as a training tool

- *“I think on this topic; they said everything actually because practical scenarios are sometimes actually the best way to learn something and to make the essence of it stick forever.” [W31].*
- *“Yes. Yeah, I agree with that I think it’s especially in the pre-specialisation scenario, you can get a lot of knowledge to the students. With regards to what’s happening. I agree with number 5 and number 2 and all those people that said, you can never have a real scenario on a video only you when you are in the situation, but it gives the student, I mean it’s if they see what happens during infarction and resuscitation and the defibrillation and everything.” [W34].*
- *“I think it will be a very good thing to have them exposed to practical scenarios before they specialize just to see what’s happening there now I mean, that can even be in all the categories even reproductive biology and stuff like that, to see, you know, that’s the environment you’re going to work in. So I think that will be a very good place to start with these scenarios, practical scenarios, and to expose students to that” [W34].*
- *“So to me, those things would be necessary to also been set out in the scenario so that you can teach a student and see if you actually did something to get the knowledge to them in a way” [W37].*
- *“And that is with real surgeons and real sisters working in the simulation lab.” [F37].*
- *“...with some of the medical students where they in training they actually have a real people..... I think that’s something one can also maybe look into with regard to giving them exposure to handling physical people rather than just dummy.” [F39].*
- *“It must be a very stressful environment to simulate the real world like in theatre or anything that goes wrong with our patients, it’s for them to understand, and they need to know how to react to it.” [F50]*
- *“I do feel simulation should not replace your practical exposure and your simulation, the approach needs to be changed to be to be on the same level as the clin techs it, and it needs to be most realistic scenario possible that it can be, then I think it will work.” [F52].*

Theme 5: Mode of delivery

Participants were asked to comment on what they would perceive the best mode of delivery would be to transfer knowledge and skills to the pre-specialisation clinical technology student. One of the main categories that emerged from this theme was that WIL supervisors and trainers

were very well aware that students' current generation needs an alternative approach to teaching and learning. Herewith the comments and suggestions as voiced by some of the participants:

Category: Generation Gap

- *"....., the overall teaching method is also changing. So we need to look at the generation we are working with. Currently, we are all experiencing problems with the current generation....." [F35].*
- *"I think it's a very difficult topic to touch on here as many of the younger generations. Everything is cyber-based they're all doing everything on their phone or through computers and everything." [F41].*
- *"Okay, for me the best the mode to deliver training to these students is number one, we need to realize that we're dealing with millennials and millennials are very different people. We need to get on their level; otherwise, we are not going to get anywhere with these people.... You need to relate on their level and guide them" [F43].*

The ideas participants shared specifically towards the best teaching methods included the following and are listed below:

Category: Teaching methods

Sub-category: Knowledge retention

- *"And modes of delivery always come back to your skills because your skills are your basic and your basic skills like I said is you're stepping stone that you have to start from. And I think that's why it's so important to make sure that's actually in place." [W41].*

Sub-category: Mentoring

- *"Everyone knows that when you train someone in a skill, mentoring comes into it, but it's basically 'see one few times', 'do one with someone watching you', a few times" [W42].*

Sub-category: Demonstration

- *"I think it's important that the students be able to see the skills, and in different scenarios." [W42].*

- “.... they can still go back to that video on the website, and then see how it’s done.” [W44].

Sub-category: Integration

- “I would just add then here, that reasoning needs to come in here somewhere as well because you can just show someone what to do, but they don’t know why we’re doing it.” [W43].
- “...you’ve got the theoretical knowledge, but I think the practical exposure is very important as well I don’t know how to integrate that, but I think it’s a very important thing.” [F38].

Sub-category: Repetition

- “I think I touched on it when I said, repetition if we can do more simulations more frequently..... But your repetition of things like that. I think that’s the only mode of delivery” [F40].

Sub-category: Technology

- “So we need to understand that they love technology, they love their phones they love the internet, they love music. So we need to incorporate our training by using these tools.” [F43].

4.4.2.3 FOCUS GROUP AREA 3: THE ROLE SIMULATION PLAYS IN THE TRAINING AND ASSESSMENT OF PRE-SPECIALISATION CLINICAL TECHNOLOGY STUDENTS

Focus group area 3 explored the role clinical simulation may play in the training and assessment of pre-specialisation clinical technology students to ensure that the students are not only prepared when entering the work environment but are also confident, skilled and equipped with sufficient background knowledge to integrate into any of the seven different specialities within clinical technology. Participants expressed their opinions mainly along one concept, namely “What they expected from a clinical simulation programme in specific areas student, knowledge and skills”. Some of the participants reiterated the importance of clinical simulation as already established in the first theme of focus group area 1, as described earlier. Comments from these participants are displayed below:

- “I really agree that simulation will definitely make a difference. We’re still in a learning curve with the simulation programme running for the first and second years. So every input every year, every struggle that we get and that we give back

feedback to you. I think we will definitely be able with the research to fill those gaps. Everything will not be covered. But if basics can be covered. I really agree that will definitely better outcome.” [F55].

- *“I do think the simlab is in important. I think it’s gonna play a bigger role in future.” [F56].*
- *“I do believe that simulation like this. It could have a lot of potential for the students if it’s done correctly.” [F59].*
- *“Hi, I’m regarding simulation lab I’m not entirely sure that it’s going to really benefit neurophysiology that much, and I would really have to see what the simulation lab can give us, but I think for the overall students in clinical technology it will definitely be beneficial.” [F60].*

One participant (11%) stated that a clinical simulation programme has a limited place and advantage; however, the participant also mentioned that simulation might be successful if used in “another way”.

- *“I think the simulation is just a limited it’s got a limited advantage at this stage. I don’t know if we do it another way, apply it in another way, maybe it can work.” [F45].*
and
- *“If they can maybe incorporate more time in that simulation lab of theirs, maybe it will help that’s my opinion.” [F54].*

One of the significant themes noticed from the participants’ discussions is what they, as WIL supervisors and trainers, expect from a simulation programme or what supervisors will like students to gain from such a programme.

Theme: Expectations from a clinical simulation programme

The expectations in the specific areas of the training of pre-specialisation clinical technology students are categorised and displayed in Figure 4.12 below:

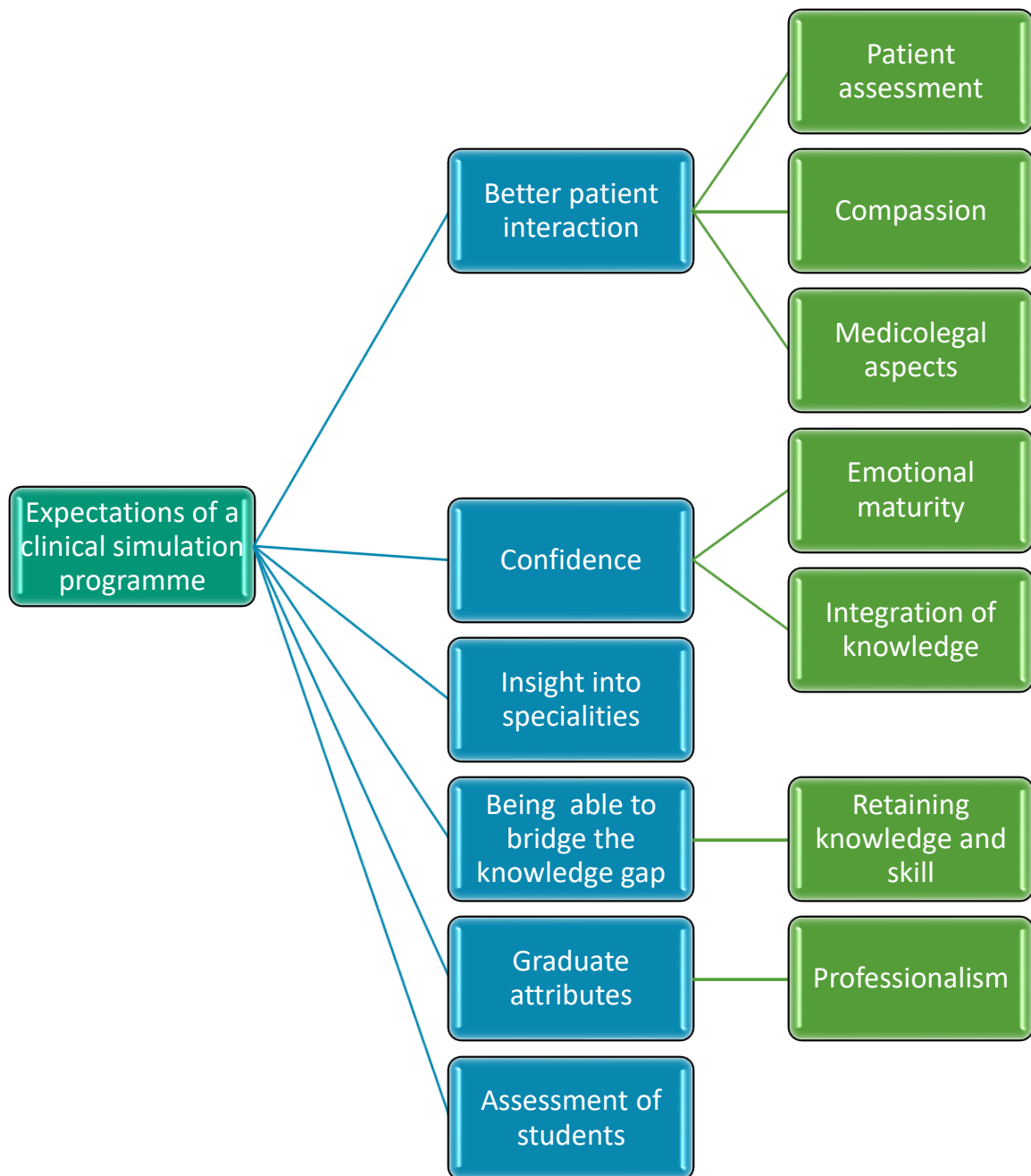


FIGURE 4.12 EXPECTATIONS FOR A SIMULATION PROGRAMME

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Category: Better patient interaction

Clinical technology being a profession directly involved with either the treatment or diagnostic process of patients, quite a few participants felt that simulation might be able to prepare students to have better people skills and patient interaction.

Sub-category: Patient assessment

- *“...if the students can sort of learn how to identify these patients and see who needs more help than the next person... So if that can just identify patients a little bit better and see who needs help more than the next person.” [F32].*
- *And then the other thing I want to point out is assessment, being observant....so observation skills will be quite helpful.” [F33].*
- *So the most important part of the simulation unit that I would like to emphasize again is just observation skills of the students if we can just get them to actually notice things and know how to act, just the basic things with their vital signs.” [F58].*

Sub-category: Compassion

- *“...be a little bit more compassionate...” [F32].*
- *“I do believe that practical will teach these students to have empathy with patients and not sympathy.” [F34].*
- *“you’re still working with the human being and even though, you know if the person seems strange to you, the patient still got the right to do being treated humanely.” [F42].*

Sub-category: Medicolegal aspects

- *“Sometimes, a patient is not able to give consent, and you have to get consent from the family to go on with the procedure.” [F42]*
- *“Sometimes, a patient is confused or not working with you, and you sometimes have to restrain a patient, then you have to know what the patient’s rights are regarding that.” [F42].*
- *“Even in situations, you could teach them some legal stuff via simulation, in the medical environment, this will be a good thing before they get to a specialised area to know some legal things” [W25]*
- *“I don’t think they understand the seriousness of a court case.” [F43].*

Category: Confidence

Participants also expressed their concern about students being overwhelmed in the “new” environment, being bombarded with information.

- *“When they get into theatre that they’re not totally thrown out of: “What am I seeing?” because we literally in the third year have to do these basic, basic things in a theatre environment for instance.” [F2]*
- *“I just think many times we go to neonatal ICU and stuff and it’s overwhelming....” [F30].*
- *“When they do get into the hospital and work with patients and then it’s different for them, and it’s a bit overwhelming, especially the ICU environment and all its monitors.” [F31].*
- *“To give them more practical experience when there are no cases actually and assist them to be more comfortable during a case as well.” [W2].*
- *“And you can actually start building confidence in the student itself to actually handle the machines or the scenario itself.” [W52].*

Sub-category: Emotional maturity

- *“I’m picking up they don’t know how to work with people, they don’t know how to cope with stress. Emotional immaturity where they don’t understand that they now in the world.” [F22].*
- *“And also, the psychological effect of how to debrief with your stress how to debrief with what you see at work.” [F43].*

Sub-category: Integration of knowledge

- *“...you have to combine everything and integrate that knowledge I think sometimes they don’t have the basic knowledge, and now they have to integrate different things..... I do think simulation has its place.” [F30].*

Category: Insight into a speciality

- *“And I think that is really something that the students lack is they don’t have any insight in clinical, practical, biomedical apparatus or any procedures with within a field.” [F15]*
- *“With simulating and unit visits, we could give them a more balanced way of making an informed decision than with just viewing in the units....” [W3].*
- *“When you have a simulation that they can see all the tests the pulmonology department is doing or what the people is doing in critical care then the students will be much better informed in what category, they actually want to specialize... So, I just*

think in that case simulation will help a lot that the students can really see what the category entails.” [W7].

- *“If I think of this, you know, my honest, is that I think that on the second-year level, it is more important than at that stage that you must tell them what the type of investigations is or what is the type of treatments we are doing and why we are doing it.” [W21].*
- *“Yes, I think it can be used, I think, for me personally I think it’s important to do this. So if you get exposure as to what each specialisation has to offer you.... or at least experiencing what each speciality is offering, so I think simulation is a good idea, I think, if it’s done correctly” [W47].*
- *“I think simulation can work very well. And especially if it can help the future students that they can choose the category which they think that will be the most interesting and that they will be informed very well of all the different categories and what the investigations and what the treatment is happening within each category, and so they will make an informed decision.” [W59].*
- *“So I will add that, they actually use this to equip the students as best as possible to make an informed decision after their first two years, what will be the future about what they’re actually going to specialize in.” [W60].*
- *“So I think, as everyone’s been telling, is I think it’s a fantastic idea just to help people to select the category, with a more holistic picture” [W61].*
- *“I really do think the simulation could benefit us a lot, and then when they come and decide which specialization there have been we focus on the specialization itself and not have to go back to the basics with all the students.” [F58].*

Category: Being able to bridge the knowledge gap

- *“So, the gap is so big that I think those basic things will have to be incorporated in one way or another...” [F16].*
- *“And many students when they come from the university that doesn’t, it seems like they don’t understand the basic concept of general measurements like a BP and because they don’t understand the basic concept, they don’t know they don’t act on it if it’s abnormal.” [F22].*

Sub-category: Retaining knowledge and skill

- *“In our unit, the gap seems to come in....my students passing a basic practical, and then thereafter, we struggle with them maintaining the practical they passed... [F17].*
- *“I mean there’s a lot of knowledge that goes past students due to the fact that they have to learn many of the situations they will be in, in the work environment and if you can teach students certain concepts before they reach the specialization area.” [W5].*
- *“And there are many such situations...we can widen the knowledge of all the students so much more if you if you use technology if you use the simulation programs, rather than having somebody teaching them that.” [W5].*
- *“And, I also think, students who are very practically inclined, pick up the skills quickly in the beginning. And those are more theoretically inclined take a little bit longer, which at the end of the day, doesn’t matter because, by the end of the year, they’re in the same place, but I do just think it would help those who are more theoretically inclined and not very adept, you know”. [W22].*
- *“.... add a new dynamic, which to me seems new in this forum, where they would be semi-prepared, you know, with a baseline skill that they would actually sort of already be familiar with and we wouldn’t have to start teaching them literally from scratch on day one, but that they would have some level of skills.” [W61].*

Category: Graduate attributes

Sub-category: Professionalism

- *“...so the only thing I’ve picked up with the students in a professional environment. Previously we had “tannie” and “oom” not doctor, mister or missus little ethical things like.” [F27].*
- *“And as soon as they start working the reality sets in off long hours and, actually, they need to do the work, and they need to play their parts.” [F34].*
- *“I think that’s quite important how to manage your time.” [F43].*

Category: Assessment of students

- *“And, in other words, to assess yes, no use to show them how to do a thing, and teaching them how to do a thing....” [W50].*
- *“I think simulation can definitely help the students because they can actually assess your students and see how they developed on a practical side as well.” [W52].*

- “So I think I would agree along the lines of what number 2 was saying that there’s definitely a place for training and assessment, you know, of different skills and perhaps 1,2 or 3 of the devices that would go across the board.....” [W53].
- “I really do think we can use it as assessment for first and second years...” [F49].

4.4.2.4 FOCUS GROUP AREA 4: IMPORTANT ISSUES REGARDING PRACTICAL AND SKILLS TRAINING

The important themes that were identified from focus group area 4 are summarized in Figure 4.13.

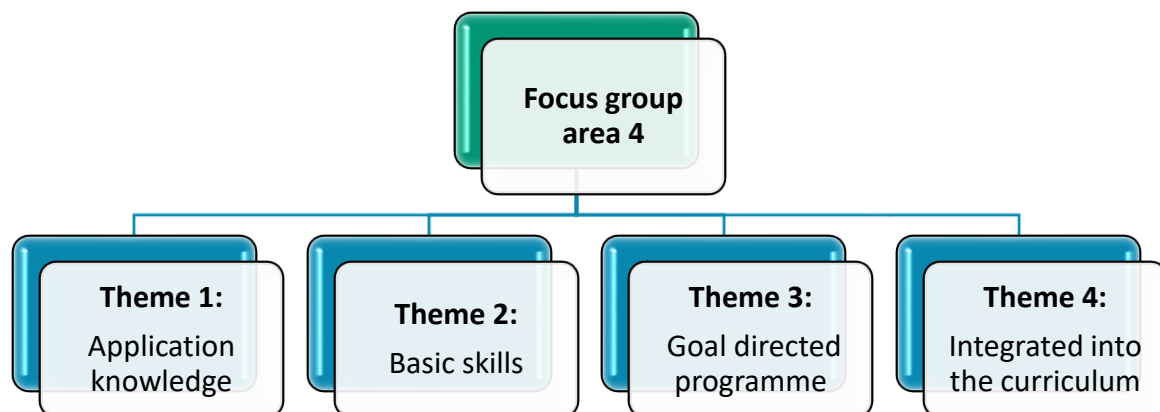


FIGURE 4.13 THEMES IDENTIFIED IN FOCUS GROUP AREA 4

[COMPILED BY THE RESEARCHER, PERKINS 2020]

A few take-home messages emerged from both focus group discussions as participants voiced their concerns regarding specific issues related to the clinical and practical training of pre-specialisation clinical technology students. The comments related to these important issues are depicted below:

Theme 1: Important aspects of clinical and practical training

Category: Application of knowledge

- “So you actually have to be able to apply what you’ve learned, and I think that’s the main thing that they’ll be able to apply what they’ve learned in the background.” [W23].
- They know, and they take in their surroundings. They know how to apply basic things.” [F61].

Category: Basic skills

- *“I think it’s, as I said, it’s important that they know the basic skills, the basic things.” [W51].*
- *“.... going back to start with the basics to fill the gaps that we currently experience.” [F46].*
- *“So I do think there is some positivity in the simulation lab for the basic stuff like basic imaging, how to handle a patient and all the basic stuff.” [F47].*
- *“.... starting with the basics and working the students through with that.” [F53].*
- *“But if basics can be covered.” [F55].*
- *“And what I’m what my final message will be for these students or my wish for these students is that they know the basic things. [F61].*

Sub-category: Skill focused

- *“So I think the importance is more the skills than the equipment.” [W22].*
- *“But the main thing again is to teach them skills, not equipment.” [W25].*

Category: Goal-directed

- *“It depends on what your aim is for the simlab.” [F47]*
- *“...as I mentioned, also just have to know what your end goal is.” [F49].*
- *“And then once a person has clearly set goals, we can take the students through that and maybe review the simulation programme over a few years again.” [F53].*

Category: Integrated into the curriculum

- *“And if we have it as simulation as basically almost like a subject that they can do.” [F49].*
- *“...or is it just like advanced biomedical apparatus subjects that we had before we were introduced to these things, but now it’s going to be more of a kind of a simulation if this is for that and I mean I fully agree.” [W57].*
- *“You know, I was very sceptical in the beginning in England when they introduced it, and it worked so well, and I always thought why didn’t we use it in South Africa, why don’t we have a system like that, so it’s. To me, it’s a very nice thing to hear that. This might be on the charts for it but yeah I, I’m all for it, and I think it’s if it’s been done correctly. It will be a very good thing. No doubt about it.” [W63].*

4.5 SUMMATIVE DISCUSSION

The findings of the two focus group interviews provided answers to the research questions presented in Chapter 1. The themes and categories identified from the data were discussed and supported by quotes from the participants. The focus areas and themes are summarised in Figure 4.14 below.

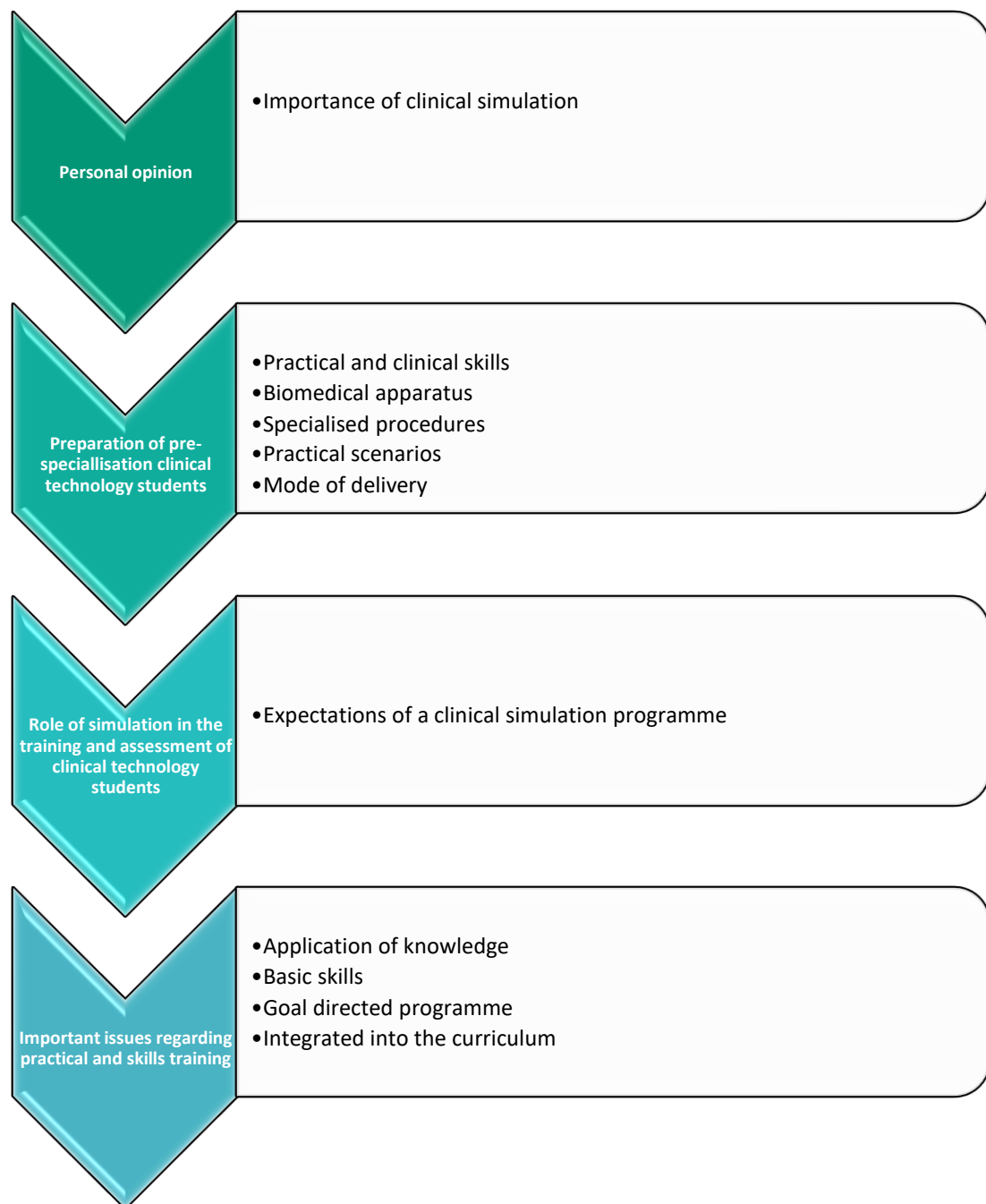


FIGURE 4.14 FOCUS GROUP AREAS AND THEMES

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Focus group area 1 and focus group area 3 provided answers to research question 1 relating to how clinical simulation may enhance pre-specialisation clinical technology students' practical training. The importance of clinical simulation and the expectations from a simulation programme was highlighted if such a programme was implemented.

Focus group area 2 and focus group area 4 provided answers to research question 2. The before-mentioned is true because both focus areas demonstrated how a simulation programme could be implemented into the curriculum. The focus areas further described how a simulation programme could be delivered to students and ensure the programme's sustainability by ensuring that it is applied correctly and has specific training goals.

Focus group area 2 and focus group area 3 further provided detailed answers to research question 3 by addressing the specific practical and clinical skills and graduate attributes expected from a student before entering WIL.

4.6 CONCLUSION

Chapter 4 provided an overview of the findings for the data that were generated from the focus group interviews. The focus groups were used to provide insight into how WIL trainers and supervisors of clinical technology students experience clinical technology students' knowledge and skills when entering into the work-integrated phase of their training. The focus groups also provided answers to whether WIL lecturers perceive a clinical simulation programme utilisation as part of pre-specialised clinical technology students' training. The WIL lecturers identified various areas of how a clinical simulation programme could produce a better informed and experienced second-year student who will be able to enter the WIL programme with confidence.

In the next chapter, Chapter 5, the findings of the nominal group interviews are discussed.

CHAPTER 5: RESULTS OF THE NOMINAL GROUP INTERVIEWS: ANALYSIS AND DISCUSSION

5.1 INTRODUCTION

This chapter reports on the results and findings of the three nominal group interviews conducted with the personnel of the tertiary institutions in South Africa offering a qualification in clinical technology. The nominal group interviews formed part of the third phase for this research study. The three institutions included CUT, DUT and TUT.

To ensure validity and repeatability, an independent facilitator conducted each of the nominal group interviews using a nominal group interviews guide (Varga-Atkins *et al.*, 2011). Reliability was ensured by using a specific target population, namely academics involved with clinical technology students' training at their respective institutions. All meetings were digitally recorded, ensuring internal reliability (Zohrabi, 2013). Trustworthiness was assured by using a recognised nominal group interviews technique and using an independent facilitator that presented the participants of all three nominal groups with the same two research questions (Peña *et al.*, 2012).

All the meetings were conducted online via the Microsoft® Teams application platform. Permission to approach personnel was obtained from the respective department heads for each one of the three institutions. Additional approval was obtained from TUT's research and ethical committee as the before-mentioned is one of the institutions internal policies and requirements if data from personnel or students were analysed for a research study.

Analysis of the nominal group data was done by using Van Breda's seven suggested steps in analysing multiple nominal group's data and are discussed in detail under the analysis section of this chapter. Reporting of the nominal group data was done by describing the entire nominal group technique process as proposed by Hugé and Makherjee (2018) and illustrated in Figure 5.1 below:

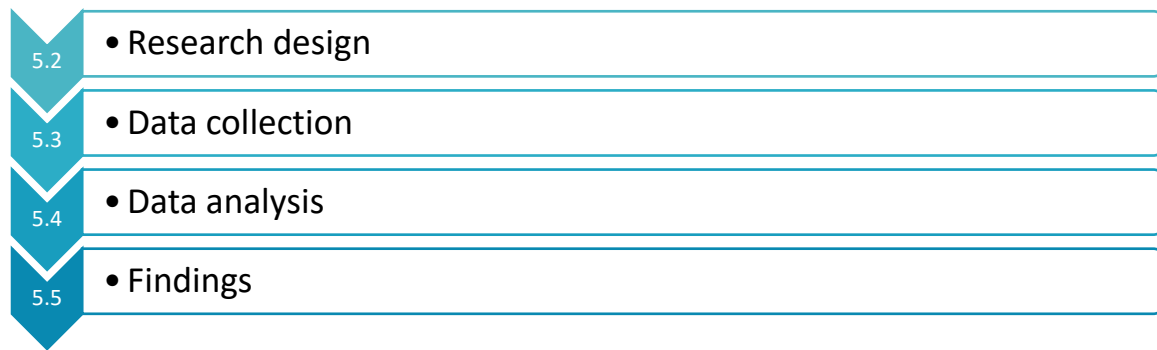


FIGURE 5.1 NOMINAL GROUP PROCESS

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (HUGÉ AND MAKHERJEE, 2018)]

5.2 RESEARCH DESIGN

The standard nominal group technique, as initially designed by Delbecq and Van de Ven, was used in all three nominal groups and consisted out of four key stages (Hugé & Mukherjee, 2018) :

- Silent generation of ideas.
- Sharing and recording ideas, also known as the round-robin phase.
- Group discussion and clarification of ideas.
- Prioritising, voting and ranking of ideas.

The nominal group interviews allowed the researcher to record ranked suggestions from experts, in this case, the personnel responsible for the teaching and lecturing of pre-specialised clinical technology students, regarding the use of clinical simulation in the training of the mentioned students (Søndergaard *et al.*, 2018). The following two questions were posed to all three the nominal group participants:

Question 1: *“In your opinion, what role can simulation play in the training and assessment of pre-specialisation clinical technology students?”*

Question 2: *“Which graduate attributes would you have a student clinical technologists be trained in?”*

Participants were invited to participate in the nominal group interviews once their respective institutions granted permission. The correspondence was done via e-mail, and all the

participants were invited to participate using a “*Letter of invitation*” (Appendix A1). Participants that indicated their willingness to participate were also requested to confirm their participation through an “*Informed consent*” document (Appendix A2). None of the participants that were invited declined to participate or requested that their data are removed from the study. The complete methodology and ethical aspects related to the nominal group interviews were described in Chapter 3.

The CUT nominal group (Group 1) consisted of eight participants (five males and three females), the DUT nominal group (Group 2) consisted of four participants (one male and three females), whereas the TUT nominal group (Group 3) consisted of five participants (one male and four females) as reflected in Table 5.1. All of the participants were at the time of the data collection phase full-time lecturers at their various tertiary institutions and are responsible for lecturing clinical technology students.

TABLE 5.1 TOTAL NUMBER OF PARTICIPANTS PER NOMINAL GROUP
(COMPILED BY THE RESEARCHER, PERKINS 2020)

Group	Number of participants (n)
1	n = 8
2	n = 4
3	n = 5

5.3 DATA COLLECTION

The same independent facilitator who conducted the focus group discussions also conducted the nominal group interviews. The facilitator used a nominal group interviews guide (Appendix A3) to pose the participants’ two questions and facilitate the meeting according to an established and known nominal group technique.

Participants’ statements and suggestions were recorded and captured on a Microsoft® Excel spreadsheet (Van Breda, 2005). The complete data collection process was described in Chapter 3. The following section explains how the data captured from the three different nominal groups were analysed to identify significant statements and specific themes and rank the identified themes in order of importance.

5.4 DATA ANALYSIS

Data analysis were completed by combining Van Breda's suggested method of evaluating the “*sum of the scores*” and calculating an “*average*” weight value for each statement together with McMillan's and her fellow researchers used method of reporting on “*relative importance*” and “*frequency of voting*” (Van Breda, 2005; McMillan *et al.*, 2016).

“*Sum of the scores*” refers to the sum of the weights each statement received per participant that voted for the specific statement. For example, if a statement received three votes with the following ranked weights allocated to each vote, namely 5;2;3, the “*sum of the scores*” will then be equal to the sum of the weights: $5+2+3 = 10$. This value can be used to determine the importance of a statement within a group (Breedt & Labuschagne, 2019).

When multiple nominal groups are used, it is recommended that the “*average*” score is also calculated. The “*average*” value indicates the average score or weight a statement will receive when this value is calculated by dividing the “*sum of scores*” for each statement by the total amount of participants in a specific nominal group, see Eq. 5.1 below:

Eq. 5.1:

$$Average = \frac{\text{Sum of scores}}{\text{Participants (n)}}$$

(Van Breda, 2005)

The “*relative importance*”, a value depicted as a percentage, is calculated by dividing the sum of scores for an item with the maximum possible points for a specific group, as demonstrated in Eq. 5.2 below:

Eq. 5.2:

$$Relative\ importance = \frac{\text{Sum of scores}}{\text{Maximum possible points (n x 15)}}$$

(McMillan *et al.*, 2016)

“*Frequency of voting*” simply reflects how many times participants have voted for a specific statement or idea. The purpose of investigating “*frequency of voting*” refers to the fact that certain statements, the “*sum of scores*”, between these two statements may be equal. By assessing the number of times participants have voted (“*frequency of voting*”) for a specific

statement, the statement with the highest number of votes are ranked as more important (McMillan *et al.*, 2016).

Question 1 related to the role clinical simulation may play in training and assessing pre-specialised clinical technology students. A total number of eighteen statements were generated by group 1 for question 1. Table 5.2 shows the statements recorded for question 1, group 1, and the votes each statement received. The “*top five*” statements ranked according to the “*sum of scores*” from the votes these statements received are highlighted in green.

TABLE 5.2 STATEMENTS AND VOTING SCORES FOR QUESTION 1, GROUP 1

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Nr.	Statement	P1	P2	P3	P4	P5	P6	P7	P8	Sum of scores	Frequency of voting
1.	Assist with peer-assisted learning and address issues in work-integrated learning (WIL).		2	5	2	5	4	3		21	6
2.	Provide the students with direct access to skills and assist with problem-solving g skills and critical thinking.	4	3	2		3		2	5	19	6
3.	Bring real-life situations into the classroom/laboratory.	5		3	4		1		3	16	5
4.	Play an important role as a methodology in lockdown situations, resource and administration limitation.	1		1		4	3	4		13	5
5.	Provide students with an advantage in obtaining skills, e.g. improve bedside manners and general clinical skills.							5	4	9	2
6.	Use as an assessment tool to assess the skills and techniques required.	3					5			8	2
7.	Provide advantage in the training of general apparatus, e.g. ECG machine.	2			3				2	7	3
8.	Exposing students to different specialities and assist with decision making in which speciality to pursue.		4				2			6	2
9.	Standardization of quality of assessments.			4		1				5	2
10.	Address equity issues and level the playing field.		5							5	1
11.	Understanding risk and impact on learning – Safer method of teaching.				5					5	1
12.	Contributing to knowledge gain.					2				2	2
13.	Assisting students in boosting communication skills.							1		1	2
14.	Communicate and understand people better, e.g. “language barriers “.				1					1	1
15.	Teach students to work as a team.								1	1	1
16.	Assist in making informed decisions.		1							1	1
17.	Providing a better “view” of the different specialities.									0	0
18.	Process systems and approvals, e.g. ethical clearance, can be bypassed due to simulation being used.									0	0

[■ Top five statements; ■ Statements that received votes; ■ Statements that received no votes]

The “*top five*” statements from group 1 are listed below:

1. Assist with peer-assisted learning and address issues in WIL.
2. Provide the students with direct access to skills and assist with problem-solving g skills and critical thinking.
3. Bring real-life situations into the classroom/laboratory.
4. Play an important role as a methodology in lockdown situations, resource and administration limitation.

5. Provide students with an advantage in obtaining skills, e.g. improve bedside manners and general clinical skills.

Statement 1 received the highest “*sum of scores*”, namely 21, with six of the eight participants that voted for this statement. Statements 6 to 16 received between 1 to 3 votes, with Statements 17 and 18 receiving no votes.

From the nominal group interview held with Group 2, a total number of eleven statements were recorded from this meeting.

Table 5.3 describes the statements recorded for question 1, group 2 and the votes each statement received with the “*top five*” statements ranked according to the “*sum of scores*” each statement received. The “*top five*” statements are highlighted in green.

TABLE 5.3 STATEMENTS AND VOTING SCORES FOR QUESTION 1, GROUP 2
[COMPILED BY THE RESEARCHER, PERKINS 2020]

Nr.	Statement	P1	P2	P3	P4	Sum of scores	Frequency of voting
1.	Being able to create different scenarios for the student to learn better – Scenario creation.	5	3	3	5	16	4
2.	Introduce the clinical aspects of the field through this module in a neutral and safe environment.			5	4	9	2
3.	Allow the student to transition into the healthcare environment.		5		3	8	2
4.	Basic skills development while students are at university.	4	2			6	2
5.	Assessment of pre-specialization - Integration of different categories.	2		1	2	5	3
6.	The opportunity of the facilitator to integrate the theory with the practical.		4		1	5	2
7.	The opportunity of facilitator to focus on what the core aspects of the graduate attributes are, e.g. soft skill development.	3	1			4	2
8.	Professionalism – Teaching students to be and act professionally.			4		4	1
9.	Responsibility - Teaching students how to be and own responsibility for patients and their work.			2		2	1
10.	Reduce the burden of the industry to expose students to specialities.	1				1	1
11.	Assisting with student knowledge regarding, e.g. physiology and anatomy.					0	0

[■ Top five statements; ■ Statements that received votes; ■ Statements that received no votes]

The “*top five*” statements from group 2 are listed below:

1. Being able to create different scenarios for the student to learn better – Scenario creation.

2. Introduce the clinical aspects of the field through this module in a neutral and safe environment.
3. Allow the student to transition into the healthcare environment.
4. Basic skills development while students are at university.
5. Assessment of pre-specialization - Integration of different categories.

Statement 1 received the highest sum of the score in the group, namely 16, with all four the participants voting for this statement. Statements 6 – 8 received between 1 and 2 votes, with statement 11 receiving no votes.

Group 3 tabled twelve statements in total when asked to comment on question 1. In this group, six statements were ranked under the “*top five*”. Statement 5 and statement 6 both scored equally on the “*sum of scores*” and the “*frequency of voting*” and was. Therefore, both statements were included in the “*top five*” and highlighted in green.

Table 5.4 describes the statements recorded for question 1, group 2, and the votes each statement received.

TABLE 5.4 STATEMENTS AND VOTING SCORES FOR QUESTION 1, GROUP 3

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Nr.	Statements	P1	P2	P3	P4	P5	Sum of scores	Frequency of voting
1.	Prepare the students for the type of techniques and assessment they would be exposed to in the industry.	4	3	3	2	4	16	5
2.	Introduction to the different apparatus – In order to provide an idea to the students what a specific category entails.	5	5	1		2	13	4
3.	Allow the student to make mistakes in a safe environment and reflect on them.		1	5	3	1	10	4
4.	Allows the student to test theory and apply it in a clinical setting.		4		4		8	2
5.	Allows for interdisciplinary collaboration in a safe environment.	1		4	1		6	3
6.	Give the students more time to practise skills.	2	2	2			6	3
7.	Basic exposure to categories, the simplest equipment used in each category.				5		5	1
8.	Logistics and a large number of consumables required.					5	5	1
9.	Introduce the student to how different body systems get monitored.	3					3	1
10.	Assist in preparing students to accomplish simple clinical procedures.					3	3	1
11.	An essential requirement for all clinical technology students.						0	0
12.	Allows the student to experiment with theory and compare that with the practice.						0	0

[■ Top five statements; ■ Statements that received votes; ■ Statements that received no votes]

The following statements were voted as most important and are listed below:

1. Prepare the students for the type of techniques and assessment they would be exposed to in the industry.
2. Introduction to the different apparatus – In order to provide an idea to the students what a specific category entails.
3. Allow the student to make mistakes in a safe environment and reflect on them.
4. Allows the student to test theory and apply it in a clinical setting.
5. Allows for interdisciplinary collaboration in a safe environment.
6. Give the students more time to practise skills.

Statement 1 received the highest sum of scores, 16, with all five participants voting for this statement. Statement 7 – 10 received only one vote, with statements 11 and 12 receiving no votes from the participants.

Combining all the statements from all three nominal groups and evaluating the combined statements using the “average” and “relative importance,” all the statements related to question 1 can be ranked from most important to least important and presented in Table 5.5.

TABLE 5.5 COMBINED STATEMENTS FROM ALL THREE GROUPS RANKED FROM MOST IMPORTANT TO LEAST IMPORTANT - QUESTION 1

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Nr.	Statement	Scores	Sum of Scores	Average	Relative importance (%)
1.	Being able to create different scenarios for the student to learn better – Scenario creation.	3,3,5,5	16	4	26,67
2.	Prepare the students for the type of techniques and assessment they would be exposed to in the industry.	2,3,3,4,4	16	3,2	21,33
3.	Assist with peer-assisted learning and address issues in work-integrated learning (WIL).	2,2,3,4,5,5	21	2,625	17,50
4.	Introduction to the different apparatus – In order to provide an idea to the students what a specific category entails.	1,2,5,5	13	2,6	17,33
5.	Provide the students with direct access to skills and assist with problem-solving g skills and critical thinking.	2,2,3,3,4,5	19	2,375	15,83
6.	Introduce the clinical aspects of the field through this module in a neutral and safe environment.	4,5	9	2,25	15,00
7.	Bring real-life situations into the classroom/laboratory.	1,3,3,4,5	16	2	13,33
8.	Allow the student to transition into the healthcare environment.	3,5	8	2	13,33
9.	Allow the student to make mistakes in a safe environment and reflect on them.	1,1,3,5	10	2	13,33
10.	Play an important role as the methodology in lockdown situations, resource and administration limitation.	1,1,3,4,4	13	1,625	10,83
11.	Allows the student to test theory and apply it in a clinical setting.	4,4	8	1,6	10,67
12.	Basic skills development while students are at university.	2,4	6	1,5	10,00
13.	Assessment of pre-specialization - Integration of different categories.	1,2,2	5	1,25	8,33
14.	The opportunity of the facilitator to integrate the theory with the practical.	1,4	5	1,25	8,33
15.	Allows for interdisciplinary collaboration in a safe environment.	1,1,4	6	1,2	8,00
16.	Give the students more time to practise skills.	2,2,2	6	1,2	8,00
17.	Provide students with an advantage in obtaining skills, e.g. improve bedside manner and general clinical skills.	4,5	9	1,125	7,50
18.	Use as an assessment tool to assess the skills and techniques required.	3,5	8	1	6,67
19.	The opportunity of facilitator to focus on what the core aspects of the graduate attributes are, e.g. soft skill development.	1,3	4	1	6,67

Nr. (cont.)	Statement (cont.)	Scores (cont.)	Sum of Scores (cont.)	Average (cont.)	Relative importance (%) (cont.)
20.	Professionalism – Teaching students to be and act professionally.	4	4	1	6,67
21.	Basic exposure to categories, the simplest equipment used in each category.	5	5	1	6,67
22.	Logistics and a large amount of consumables required.	5	5	1	6,67
23.	Provide advantage in the training of general apparatus, e.g. ECG machine.	2,2,3	7	0,875	5,83
24.	Exposing students to different specialities and assist with decision making in which speciality to pursue.	2,4	6	0,75	5,00
25.	Standardization of quality of assessments.	1,4	5	0,625	4,17
26.	Address equity issues and level the playing field.	5	5	0,625	4,17
27.	Understanding risk and impact on learning – Safer method of teaching.	5	5	0,625	4,17
28.	Introduce the student to how different body systems get monitored.	3	3	0,6	4,00
29.	Assist in preparing students to accomplish simple clinical procedures.	3	3	0,6	4,00
30.	Responsibility - Teaching students how to be and own responsibility for patients and their work.	2	2	0,5	3,33
31.	Contributing to knowledge gain.	2	2	0,25	1,67
32.	Reduce the burden of the industry to expose students to specialities.	1	1	0,25	1,67
31.	Assisting students in boosting communication skills.	1	1	0,125	0,83
33.	Communicate and understand people better, e.g. “ <i>language barriers</i> ”.	1	1	0,125	0,83
34.	Teach students to work as a team.	1	1	0,125	0,83
35.	Assist in making informed decisions.	1	1	0,125	0,83
36.	Providing a better “ <i>view</i> ” of the different specialities.		0	0	0,00
37.	Process systems and approvals, e.g. ethical clearance, can be bypassed due to simulation being used.		0	0	0,00
38.	Assisting with student knowledge regarding, e.g. physiology and anatomy.		0	0	0,00
39.	An essential requirement for all clinical technology students.		0	0	0,00
40.	Allows the student to experiment with theory and compare that with the practice.		0	0	0,00
41.	An essential requirement for all clinical technologists.		0	0	0,00

[■ Top five statements; ■ Statements that received votes; ■ Statements that received no votes]

The three nominal groups generated a total of forty-one statements regarding question 1. Using the “*average*” and “*relative importance*” calculations, a better understanding of the statements in relation to the entire group of statements can be reached. Statement 3 received the highest “*sum of scores*” with a final score of 21. However, evaluating this statement’s “*average*” score and “*relative importance*” value in comparison to the rest of the statements, statement 1 and 2

(Table 5.5) indicated a significantly higher “*average*” and “*relative importance*” score and was, therefore, ranked higher than statement 3.

5.4.1 THEMATIC REVIEW OF QUESTION 1

In continuation with Van Breda’s steps in analysing multiple nominal group data, specific themes were identified. Clarification and consolidation of statements were done during the nominal group interviews, and statements that communicated the same “*message*” or covered a similar topic were with the approval of the nominal groups’ members consolidated into single statements. However, statements with a similar theme could still be identified, especially when all three nominal groups’ statements were tabled together (Van Breda, 2005).

Fifteen themes were identified from the data and are listed below:

1. Peer-assisted learning and work-integrated learning
2. Practical and clinical skills
3. Practical scenarios
4. Resources
5. Student assessment
6. Introduction to biomedical apparatus
7. Exposure to clinical technology specialities
8. Student confidence
9. Student equity
10. Safe learning environment
11. Expanding on knowledge
12. People skills
13. Integration of knowledge
14. Graduate attributes
15. Programme requirement

The following section provides a more detailed explanation regarding the themes identified from the data collected for the three nominal groups about question 1, where participants were asked to voice their opinion regarding the role simulation might play in the training and assessment of pre-specialised clinical technology students?

5.4.1.1 QUESTION 1: THEME DESCRIPTION

1. **Peer-assisted learning and work-integrated learning:** Clinical simulation may contribute to peer-assisted learning and play a role in addressing and possibly resolve issues identified during work-integrated learning.
2. **Practical and clinical skills:** Clinical simulation may help students obtain practical and clinical skills and provide an opportunity for students to gain more experience in specific clinical and practical areas.
3. **Practical scenarios:** With this theme, the opportunity to expose students to real-life practical scenarios and realistic clinical environments through clinical simulation was proposed.
4. **Resources:** The lack of sufficient resources and time may contribute to students not being completely exposed to the required practical syllabus. Using clinical simulation, the limitations experienced due to the lack of resources and time may be addressed in a simulation laboratory.
5. **Student assessment:** Clinical simulation may provide an additional and standardised means of assessing students on specific clinical and practical skills.
6. **Introduction to biomedical apparatus:** Clinical simulation may be used to expose the students to specific biomedical instruments and equipment used within clinical technology and specifically within the different specialities in clinical technology.
7. **Exposure to clinical technology specialities:** Exposure of students to all seven different clinical technology specialities is not always possible and clinical simulation may provide an additional means of introducing students to the different specialities.
8. **Student confidence:** Clinical simulation may combine with additional practical and clinical skills training to contribute to students' confidence, especially when entering the work-integrated environment.
9. **Student equity:** Not all students have the same technological and financial means to acquire knowledge in specific areas, for example, by having access to audio and/or visual material on clinical and practical skills to obtain a better understanding of the required skills. Clinical simulation may provide these students with the opportunity to obtain those essential skills.
10. **Safe learning environment:** Clinical simulation may provide a safe teaching environment for the student to practise and make mistakes without the fear of causing harm to a patient.
11. **Expanding on knowledge:** Clinical simulation may provide students with the opportunity to build on their current theoretical and practical knowledge.

- 12. People skills:** Placing students in specific clinical simulation scenarios may help them acquire the necessary people skills to function effectively within a specific clinical setting and the healthcare environment.
- 13. Integration of knowledge:** Being exposed to clinical technology's practical side through clinical simulation may allow the students to integrate what they have learned in theory with its practical application.
- 14. Graduate attributes:** Obtaining the necessary people skills to work and function within the healthcare environment is important. However, being professional, have a good work ethic etc., may be skills that can be taught and learned within a clinical simulation environment.
- 15. Programme requirement:** Clinical simulation should be compulsory and part of the clinical technology training programme.

The identified themes for question 1 with their corresponding statements and the groups from which the statements were captured are demonstrated in Table 5.6.

TABLE 5.6 QUESTION 1: THEMES AND STATEMENTS
[COMPILED BY THE RESEARCHER, PERKINS 2020]

Nr.	Theme	Statements	Group
1.	Peer-assisted learning and work-integrated learning	Assist with peer-assisted learning and address issues in work-integrated learning (WIL).	1
2.	Practical and clinical skills	Provide students with direct access to skills and assist with problem-solving skills and critical thinking.	1
		Provide students with an advantage in obtaining skills, e.g. improve bedside manner and general clinical skills.	1
		Basic skills development while students are at university.	2
		Give the students more time to practise skills	3
		Assist in preparing students to accomplish simple clinical procedures	3
3.	Practical scenarios	Bring real-life situations into the classroom/laboratory	1
		Being able to create different scenarios for the student to learn better – Scenario creation.	2

Nr. (cont.)	Theme (cont.)	Statements (cont.)	Group (cont.)
4.	Resources	Play an important role as a methodology in lockdown situations, resource and administration limitation.	1
		Logistics and a large number of consumables required	3
5.	Student assessment	Use as an assessment tool to assess the skills and techniques required.	1
		Standardization of quality of assessments.	1
		Assessment of pre-specialization - Integration of different categories.	2
6.	Introduction to biomedical apparatus	Provide advantage in the training of general apparatus, e.g. ECG machine.	1
		Introduction to the different apparatus – In order to provide an idea to the students what a specific category entails.	3
7.	Exposure to clinical technology specialities	Exposing students to different specialities and assist with decision making in which speciality to pursue.	1
		Assist in making informed decisions.	1
		Providing a better “view” of the different specialities.	1
		Reduce the burden of the industry to expose students to specialities.	2
		Basic exposure to categories, the simplest equipment used in each category.	3
8.	Student equity	Address equity issues and level the playing field.	1
9.	Safe learning environment	Understanding risk and impact on learning – Safer method of teaching.	1
		Process systems and approvals, e.g. ethical clearance, can be bypassed due to simulation being used.	1
		Introduce the clinical aspects of the field through this module in a neutral and safe environment.	2
		Allow the student to make mistakes in a safe environment and reflect on them.	3
		Allows for interdisciplinary collaboration in a safe environment.	3
10.	Expanding on knowledge	Contributing to knowledge gain.	1
		Assisting with student knowledge regarding, e.g. physiology and anatomy.	2
		Introduce the student to how different body systems get monitored.	3

Nr. (cont.)	Theme (cont.)	Statements (cont.)	Group (cont.)
11.	People skills	Assisting students in boosting communication skills.	1
		Communicate and understand people better, e.g. “ <i>language barriers</i> ”.	1
		Teach students to work as a team.	1
12.	Integration of knowledge	The opportunity of the facilitator to integrate the theory with the practical.	2
		Allows the student to test theory and apply it in a clinical setting.	3
		Allows the student to experiment with theory and compare that with the practice.	3
13.	Graduate attributes	The opportunity of facilitator to focus on what the core aspects of the graduate attributes are, e.g. soft skill development.	2
		Professionalism – Teaching students to be and act professionally.	2
		Responsibility - Teaching students how to be and own responsibility for patients and their work.	2
14.	Student confidence	Allow the student to transition into the healthcare environment.	2
		Prepare the students for the type of techniques and assessment they would be exposed to in the industry.	3
15.	Programme requirement	An essential requirement for all clinical technology students.	3

[Highlighted colours to differentiate between themes]

Specifically, by using Step 5 of Van Breda’s steps in analysing nominal group data, the identified themes were ranked from most important to least important. Calculations were done taking the following into consideration:

- Amount of statements ranked in the “*top five*”.
- The number of statements that contributed to a specific theme.
- The calculated average score for each theme

Themes were ranked according to the listed criteria above, with a specific ranking weight allocated to each one of the criteria for every statement. The sum of ranked weights for all three criteria was calculated in order to obtain a final ranking order. The subsequent outcome was

that themes with more statements within the “*top five*”, a higher number of total statements that contributed to the theme and a higher “*average*” score resulted in a theme being ranked more important than a theme with fewer or no statements in the “*top five*”, a smaller number of statements contributing the theme and a lower “*average*” score. The finally ranked themes are shown in Table 5.7 and Figure 5.2, with the more important themes indicated with the higher final ranking value.

TABLE 5.7 FINAL RANKED THEMES FOR QUESTION 1 IN ORDER OF IMPORTANCE
[COMPILED BY THE RESEARCHER, PERKINS 2020]

Theme	Top 5	Top 5 Ranking	Number of statements	Number of statements ranking	Average	Average ranking	Final Ranking
Practical and clinical skills	4	15	5	14	1,36	11	40
Safe learning environment	3	14	5	14	1,23	9	37
Practical scenarios	2	12	2	5,5	3	15	32,5
Student confidence	2	12	2	5,5	2,60	13	30,5
Integration of knowledge	2	12	3	10	0,95	7	29
Student assessment	1	8,5	3	10	0,96	8	26,5
Introduction to biomedical apparatus	1	8,5	2	5,5	1,74	12	26
Peer assisted learning and work integrated learning	1	8,5	1	2	2,63	14	24,5
Resources	1	8,5	2	5,5	1,31	10	24
Exposure to clinical technology specialities	0	3,5	5	14	0,43	4	21,5
Graduate attributes	0	3,5	3	10	0,83	6	19,5
Expanding on knowledge	0	3,5	3	10	0,28	3	16,5
People skills	0	3,5	3	10	0,13	2	15,5
Student equity	0	3,5	1	2	0,63	5	10,5
Programme requirement	0	3,5	1	2	0	1	6,5

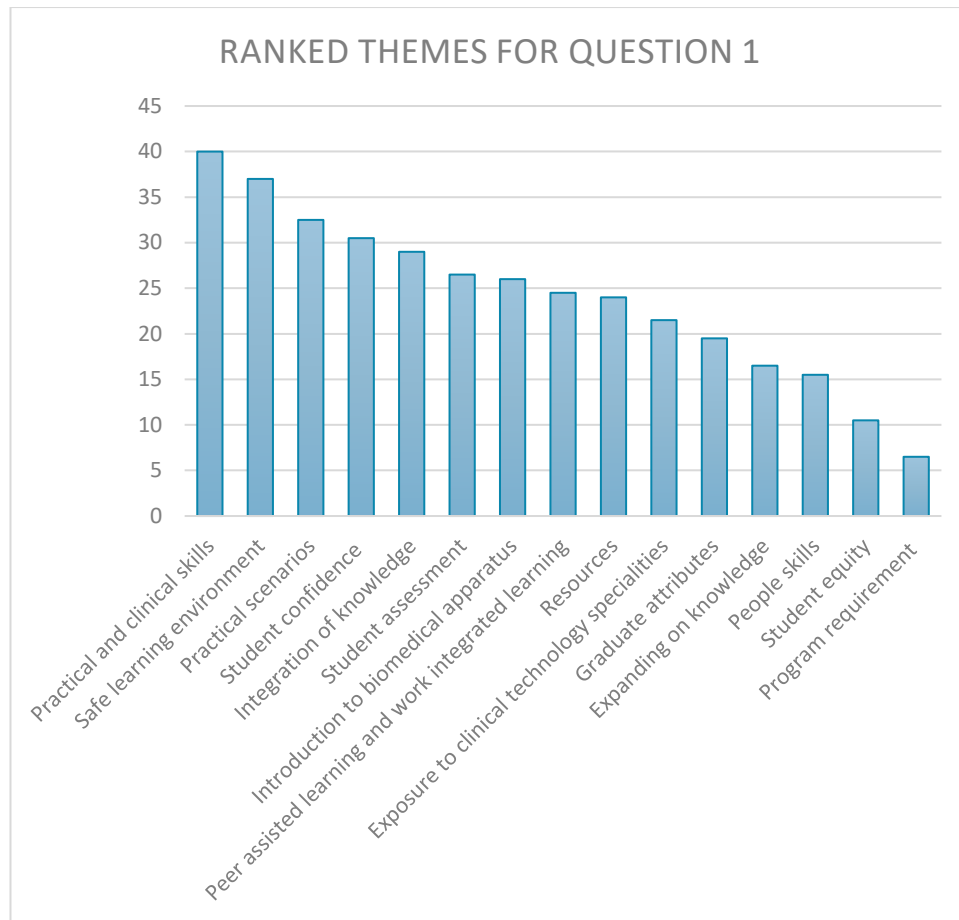


FIGURE 5.2 THEMES RELATED TO QUESTION 1 RANKED IN ORDER OF IMPORTANCE
[COMPILED BY THE RESEARCHER, PERKINS 2020]

Question 2 explored the participant's ideas on which specific graduate attributes they deemed important and necessary pre-specialisation clinical technology students are to be trained in before entering the WIL environment. Statements were ranked within the “*top five*” statement because of their higher calculated “*sum of scores*” (Breedt & Labuschagne, 2019).

Ten statements were recorded from the nominal group interviews with group 1 in reference to question 2 and are shown in Table 5.8.

TABLE 5.8 STATEMENTS AND VOTING SCORES FOR QUESTION 2, GROUP 1
[COMPILED BY THE RESEARCHER, PERKINS 2020]

Nr.	Statement	P1	P2	P3	P4	P5	P6	P7	P8	Sum of scores	Frequency of voting
1.	Teamwork, problem-solving skills.	5	2	4	4	3	1	5	5	29	8
2.	Technical and conceptual competence, e.g. effective diagnosis.		3	1	5	5		3	2	19	6
3.	General work ethic – Being polite be on-time, patient confidentiality.	2	5	2	2	4			3	18	6
4.	Technologically literate.	3		5		1	4		4	17	5
5.	Entrepreneurship and innovation.	4			1	2	3	4		14	5
6.	Good communication skills – listen to the patient.				3		5		1	9	3
7.	Community engagement.	1					2	2		5	3
8.	A better understanding of speciality.		4							4	1
9.	Compassion.		1	3						4	2
10.	Citizenship and global leadership.							1		1	1

The following statements from group 1 regarding question 2 were ranked under the “*top five*”:

1. Teamwork, problem-solving skills.
2. Technical and conceptual competence, e.g. effective diagnosis.
3. General work ethic – Being polite be on-time, patient confidentiality.
4. Technologically literate.
5. Entrepreneurship and innovation.

The “*Teamwork, problem-solving skills*” statement received the highest “*sum of scores*”, namely 29, with all eight participants voting for this statement. Statements 6 – 8 received between 9 to 1 in the “*sum of scores*”, with one to three of the participants voting for these statements, respectively.

The statements recorded for question 2 from the nominal group interviews held with group 2 are displayed in Table 5.9, with the “*top five*” statements highlighted in green.

TABLE 5.9 STATEMENTS AND VOTING SCORES FOR QUESTION 2, GROUP 2

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Nr.	Statement	P1	P2	P3	P4	Sum of scores	Frequency of voting
1.	Independent learning	5	1	5	4	15	4
2.	Professional ethics	3	3	4	3	13	4
3.	Actively engaging and reflection	4	2		5	11	3
4.	Understanding diversity		4	3		7	2
5.	Computer literacy		5		1	6	2
6.	Critical thinking skills	2			2	4	2
7.	Competent in the area of specialisation			2		2	1
8.	Interpersonal skills and communication (written and oral)	1		1		2	2

The following statements regarding question 2 from group 2 were ranked under the “*top five*”:

1. Independent learning
2. Professional ethics
3. Actively engaging and reflection
4. Understanding diversity
5. Computer literacy

All of the statements received votes from all the participants, with statement 1, “*Independent learning*”, receiving the highest score of 15 and all four of the participants voting for this statement. Statements 6 – 8 received scores between 2 and 4, with between one to two of the participants voting for these statements.

Statements related to question 2 captured from the nominal group interviews held with group 3 are displayed in Table 5.10. The “*top five*” statements are highlighted in green.

TABLE 5.10 STATEMENTS AND VOTING SCORES FOR QUESTION 2, GROUP 3

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Nr.	Statement	P1	P2	P3	P4	P5	Sum of scores	Frequency of voting
1.	Act ethically, morally with honesty and integrity	4		5	2	3	14	4
2.	Teamwork and collaboration	5	5	3			13	3
3.	Responsible and accountable				4	5	9	1
4.	Problem-solving skills and troubleshooting	3		4			7	2
5.	Diligent and a precision worker and being competent in work			2	1	4	7	3
6.	Disciplined		2		3	1	6	3
7.	Time management	1	3			2	6	3
8.	Cope with stress and a stressful environment				5		5	1
9.	Professionalism & conflict management		4				4	1
10.	Good communicator	2					2	1
11.	Sense of community		1	1			2	2
12.	Adaptable & innovative						0	
13.	Lifelong learners & curious – inquisitive						0	
14.	Write correct reports & being analytical						0	
15.	Work independently						0	

The following statements from group 3 were ranked under the “*top five*”:

1. Act ethically, morally with honesty and integrity.
2. Teamwork and collaboration.
3. Responsible and accountable.
4. Problem-solving skills and troubleshooting.
5. Diligent and a precision worker and being competent in work.

Statement 1, “*Act ethically, morally with honesty and integrity*”, received the highest score, namely 14, with four of the five participants voting for this statement. Statements 6 - 11 received voting scores of 2 – 6, with one to three of the participants voting for these statements. Statements 12 – 15 received no votes from any of the participants.

A total number of thirty-three statements were captured from all three nominal groups. The combined statements across all three nominal groups were tabled together to attain which of the statements were perceived as the most important and least important. The before-mentioned

was achieved by calculating and evaluating each statement's “average” and “relative importance” scores.

The most important statements are listed in Table 5.11 below and are highlighted in green.

TABLE 5.11 COMBINED STATEMENTS FROM ALL THREE GROUPS RANKED FROM MOST IMPORTANT TO LEAST IMPORTANT FOR QUESTION 2

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Nr.	Statement	Votes	Sum of scores	Average	Relative Importance (%)
1.	Independent learning	1,4,5,5	15	3,75	25,00
2.	Teamwork, problem-solving skills	1,2,3,4,4,5,5,5	29	3,63	24,17
3.	Professional ethics	3,3,3,4	13	3,25	21,67
4.	Act ethically, morally with honesty and integrity	2,3,4,5	14	2,80	18,67
5.	Actively engaging and reflection	2,4,5	11	2,75	18,33
6.	Team work and collaboration	3,5,5	13	2,60	17,33
7.	Technical and conceptual competence e.g. effective diagnosis	1,2,3,3,5,5	19	2,38	15,83
8.	General work ethic – Being polite be on-time, patient confidentiality.	2,2,2,3,4,5	18	2,25	15,00
9.	Technologically literate	1,3,4,4,5	17	2,13	14,17
10.	Responsible and accountable	4,5	9	1,80	12,00
11.	Entrepreneurship and innovation	1,2,3,4,4	14	1,75	11,67
12.	Understanding diversity	3,4	7	1,75	11,67
13.	Computer literacy	1,5	6	1,50	10,00
14.	Problem solving skills and trouble shooting	3,4	7	1,40	9,33
15.	Diligent and a precision worker and being competent in work	1,2,4	7	1,40	9,33
16.	Disciplined	1,2,3	6	1,20	8,00
17.	Time management	1,2,3	6	1,20	8,00
18.	Good communication skills – listen to the patient	1,3,5	9	1,13	7,50

Nr. (cont.)	Statement (cont.)	Votes (cont.)	Sum of scores (cont.)	Average (cont.)	Relative Importance (%) (cont.)
19.	Cope with stress and a stressful environment	5	5	1,00	6,67
20.	Critical thinking skills	2,2	4	1,00	6,67
21.	Professionalism & conflict management	4	4	0,80	5,33
22.	Community engagement	1,2,2	5	0,63	4,17
23.	Better understanding of speciality	4	4	0,50	3,33
24.	Compassion	1,3	4	0,50	3,33
25.	Competent in area of specialisation	2	2	0,50	3,33
26.	Interpersonal skills and communication (written and oral)	1,1	2	0,50	3,33
27.	Good communicator	2	2	0,40	2,67
28.	Sense of community	1,1	2	0,40	2,67
29.	Citizenship and global leadership	1	1	0,13	0,83
30.	Adaptable & innovative		0	0,00	0,00
31.	Lifelong learners & curious – inquisitive		0	0,00	0,00
32.	Write correct reports & being analytical		0	0,00	0,00
33.	Work independently		0	0,00	0,00

5.4.2 THEMATIC REVIEW QUESTION 2

Theme identification for question 2 was completed exactly as for question 1 using Van Breda's steps in analysing multiple nominal group data. Clarification and consolidation of statements for this question were also done during the nominal group interviews and statements that communicated the same "*message*" or covered a similar topic were with the approval of the nominal groups' members consolidated into single statements.

Overall themes were identified and displayed in Table 5.12 with their corresponding statements and the groups from which each statement was captured (Van Breda, 2005).

TABLE 5.12 QUESTION 2 THEMES AND STATEMENTS

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Nr.	Theme	Statement	Group
1.	Professionalism and Ethical behaviour	Professional ethics	2
		Act ethically, morally with honesty and integrity	3
		General work ethic – Being polite be on-time, patient confidentiality	1
		Responsible and accountable	3
		Disciplined	3
		Time management	3
		Cope with stress and a stressful environment	3
		Professionalism & conflict management	3
		Compassion	1
		Write correct reports & being analytical	3
2.	Teamwork & Problem solving	Teamwork, problem-solving skills	1
		Teamwork and collaboration	3
		Problem-solving skills and troubleshooting	3
		Critical thinking skills	2
3.	Receptive learning	Independent learning	2
		Actively engaging and reflection	2
		Lifelong learners & curious – inquisitive	3
4.	Competency	Technical and conceptual competence, e.g. effective diagnosis	1
		Diligent and a precision worker and being competent in work	3
		Competent in the area of specialisation	2
		Work independently	3
5.	Technologically literate	Technologically literate	1
		Computer literacy	2
6.	Community engagement	Understanding diversity	2
		Community engagement	1
		Sense of community	3
7.	Innovation	Entrepreneurship and innovation	1
		Adaptable & innovative	3
8.	Communication	Good communication skills – listen to the patient	1
		Interpersonal skills and communication (written and oral)	2
		Good communicator	3
9.	Knowledgeable about the specialities	A better understanding of speciality	1
10.	Global citizenship	Citizenship and global leadership	1

Ten themes were identified regarding question 2 of which graduate attributes academics would have a student clinical technologists be trained in before entering the work-integrated environment. The ten themes are listed below:

1. Professionalism and ethical behaviour

2. Teamwork & problem solving
3. Receptive learning
4. Competency
5. Technologically literate
6. Community engagement
7. Innovation
8. Communication
9. Knowledgeable about the specialities
10. Global citizenship

5.4.2.1 QUESTION 2: THEME DESCRIPTION

1. **Professionalism and ethical behaviour:** A variety of statements recorded from the nominal group interviews indicated that clinical simulation might help students obtain a better understanding of professionalism and ethical work behaviour within the clinical technology work environment.
2. **Teamwork & problem solving:** Participants also indicated that students through simulation might learn how to work as a team and obtain the necessary skills to solve problems effectively.
3. **Receptive learning:** Clinical simulation may stimulate students to be more engaging and more open to learning, not just as students but as qualified clinical technologists.
4. **Competency:** Clinical technologists as healthcare workers need to be confident and competent in their field of speciality. By using clinical simulation, student's competence can be evaluated and assured.
5. **Technologically literate:** Clinical technologists use computers and computer-based equipment daily, and teaching students in a pre-specialisation phase to be computer literate by means of simulation may benefit these students.
6. **Community engagement:** Clinical technologists as healthcare workers directly involve patients from a clinical perspective but from a social as well economic perspective. Therefore, clinical technologists must have a good sense of community, which may be achieved through clinical simulation.
7. **Innovation:** Clinical technologists being experts within very specific specialised fields, should be able to sell their expertise and skills and contribute to the advancement of medical knowledge and care.

- 8. Communication:** Communication plays a vital role within the healthcare environment, and clinical technologists should be able to communicate effectively with patients and other healthcare workers.
- 9. Knowledgeable about the specialities:** Even though most clinical technologists specialise within a specific speciality, it is important to have a good understanding and knowledge about the other specialities within clinical technology.
- 10. Global citizenship:** Even though global citizenship relates to the community, it is a much wider term than just participating in the community. Clinical technologist within the healthcare environment should have a good understanding of diversity, social justice and what it means to be a responsible citizen.

By systematically consulting Van Breda's research, specifically Step 5 of the seven steps in analysing nominal group data, the identified themes were ranked from most important to least important. Calculations were completed considering the following as were done with the identified themes for question 1:

- Amount of statements ranked in the "*top five*".
- The number of statements that contributed to a specific theme.
- The calculated average score for each theme.

Themes were again ranked according to the listed criteria above, with a specific ranking weight allocated to each one of the criteria for every statement. The sum of ranked weights for all three criteria was calculated in order to obtain a final ranking order. A similar outcome as with question 1 regarding the themes was observed. Themes with more statements within the "*top five*", a higher number of total statements that contributed to the theme and a higher "*average*" score resulted in a theme being ranked more important than a theme with fewer or no statements in the "*top five*", a smaller number of statements contributing the theme and a lower "*average*" score. The finally ranked themes are shown in Table 5.13 and Figure 5.3, with the more important themes indicated with the higher final ranking value.

TABLE 5.13 FINAL RANKED THEMES FOR QUESTION 2 IN ORDER OF IMPORTANCE
[COMPILED BY THE RESEARCHER, PERKINS 2020]

Theme	Top5	Top 5 Ranking	Number of statements	Number of statements ranking	Average	Average ranking	Final Ranking
Professionalism and ethical behaviour	4	10	10	10	1,48	7	27
Teamwork & problem solving	3	9	4	8,5	2,16	9	26,5
Receptive learning	2	7	3	6	2,17	10	23
Competency	2	7	4	8,5	1,07	6	21,5
Technologically literate	2	7	2	3,5	1,82	8	18,5
Community engagement	1	4,5	3	6	0,79	4	14,5
Innovation	1	4,5	2	3,5	0,88	5	13
Communication	0	2	3	6	0,68	3	11
Knowledgeable about the specialties	0	2	1	1,5	0,50	2	5,5
Global citizenship	0	2	1	1,5	0,13	1	4,5

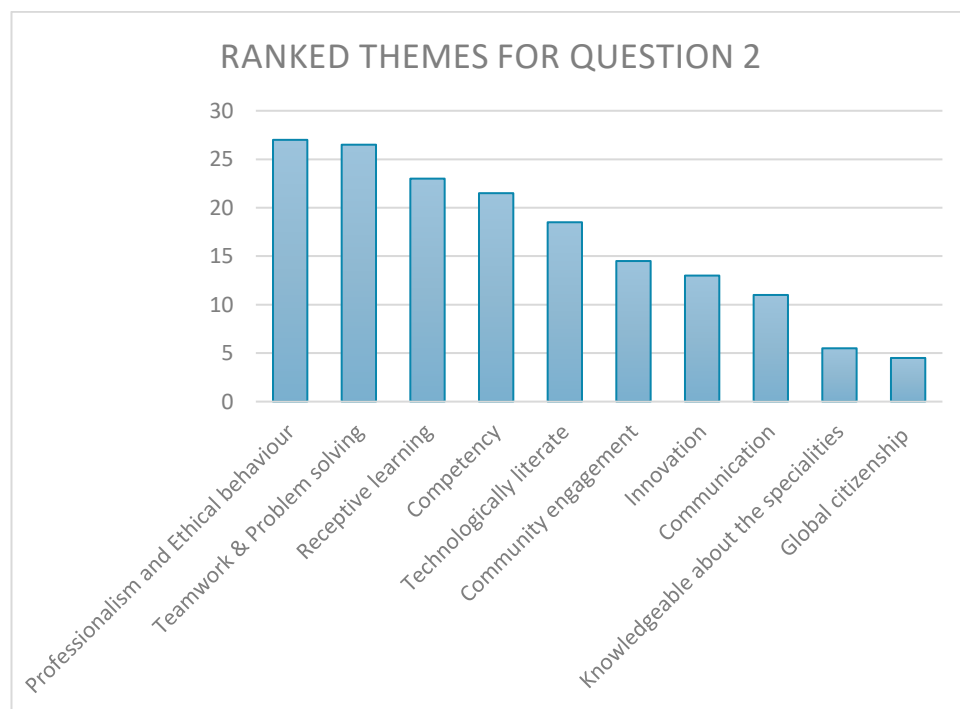


FIGURE 5.3 THEMES RELATED TO QUESTION 2 RANKED IN ORDER OF IMPORTANCE
[COMPILED BY THE RESEARCHER, PERKINS 2020]

5.5 SUMMARY

The three nominal group interviews conducted together with the statements generated from these meetings provided the researcher with an understanding of the role clinical simulation may play in the training and assessment of the pre-specialised clinical technology student. Furthermore, the specific graduate attributes these students need to be taught before starting with WIL in their respective fields of speciality were also addressed. Question 1 presented to the nominal group participants provided answers to research questions 1 and 2. Specific themes, e.g., using clinical simulation to provide a foundation for the training and enhancement of students' practical and clinical skills, helped answer the aforementioned research questions. Clinical simulation may also further provide an additional means of assessing students' newly acquired, practical, clinical and people skills. Question 2 presented to the nominal group participants provided answers to research question 3, mainly referring to the graduate attributes academics considered important students needed to be trained in. Being professional and displaying ethical behaviour ranked as the most important graduate attribute participants felt students should be educated in.

5.6 CONCLUSION

In this chapter, the data collected through the nominal group interviews were presented. Themes were identified from the statements as a response to the questions asked to the participants. The statements and themes indicated that clinical simulation might play a very positive role in the training and assessing pre-specialised clinical technology students in specific clinical areas and important graduate attributes related to these students' training.

CHAPTER 6: A SUSTAINABLE CLINICAL SIMULATION FRAMEWORK FOR PRE-SPECIALISATION CLINICAL TECHNOLOGY TRAINING IN SOUTH AFRICA

6.1 INTRODUCTION

The previous two chapters focussed and presented the results of the focus group and nominal group interviews. In this chapter, Chapter 6, these results, together with the literature review, are used to discuss the development of a conceptual, clinical simulation framework to enhance the current clinical technology practical training programme.

The discussion reflects the importance of clinical simulation, and the role simulation may play in training clinical technology students. The role of clinical simulation as part of clinical technology student training is described by focusing on the expectations of such a framework, the technical and non-technical skills, biomedical apparatus, specialised procedures, and graduate attributes that should make out the core of the proposed framework.

In addition to the clinical simulation framework's content, as mentioned above, the chapter discusses the possible methods used to incorporate such a clinical simulation framework into the current clinical technology curriculum. The chapter concludes with the proposed clinical simulation framework. Figure 6.1 provides an outline of the topics discussed in this chapter.

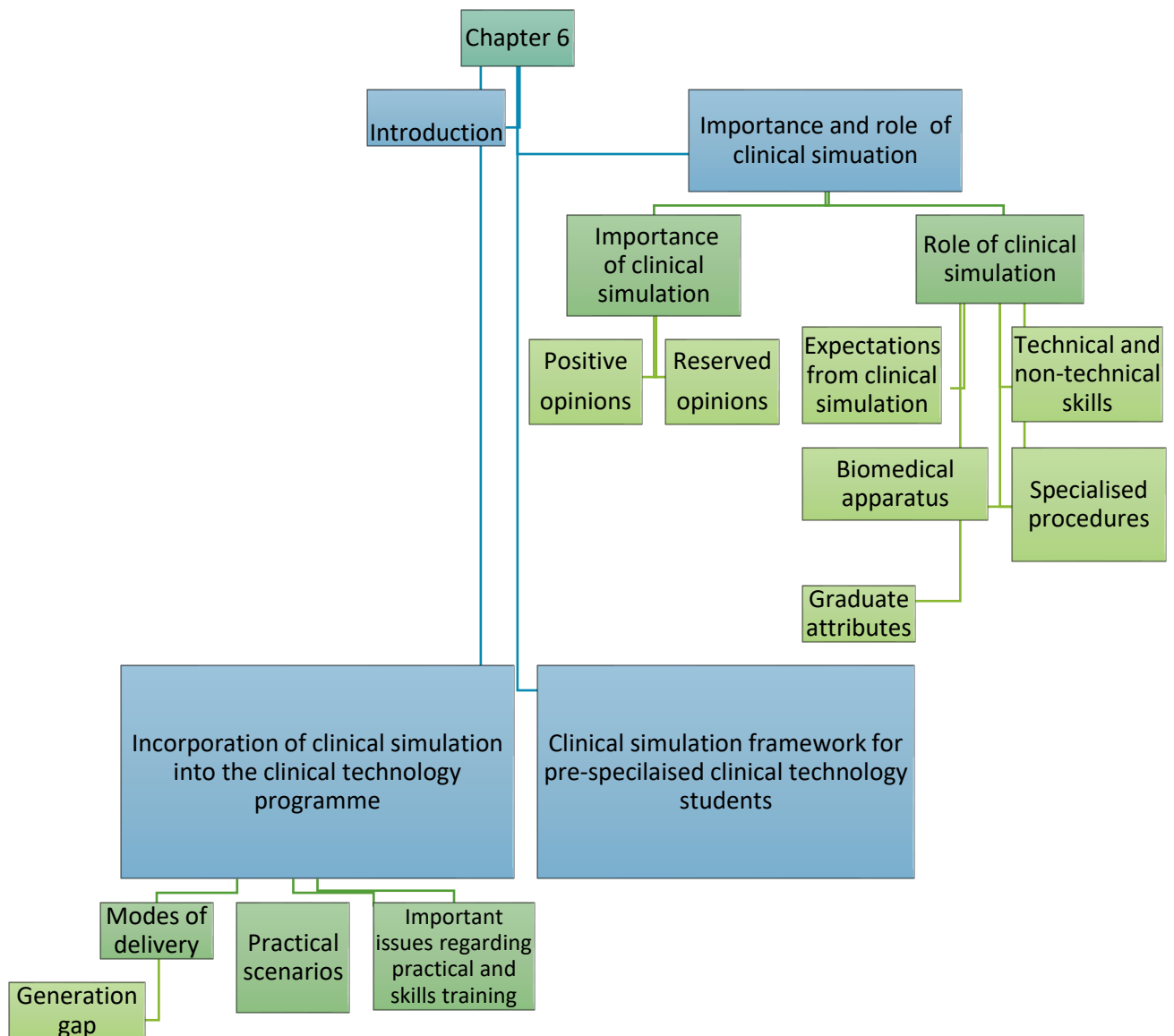


FIGURE 6.1 OUTLINE FOR TOPICS DISCUSSED IN CHAPTER 6
[COMPILED BY THE RESEARCHER, PERKINS 2020]

6.2 THE IMPORTANCE AND ROLE OF CLINICAL SIMULATION IN THE TRAINING OF PRE-SPECIALISED CLINICAL TECHNOLOGY STUDENTS

The possible use of clinical simulation in clinical technology students' training is for reasons of simplicity divided into two main segments: "*Importance of clinical simulation*" and "*The role of clinical simulation*" as displayed in Figure 6.2:

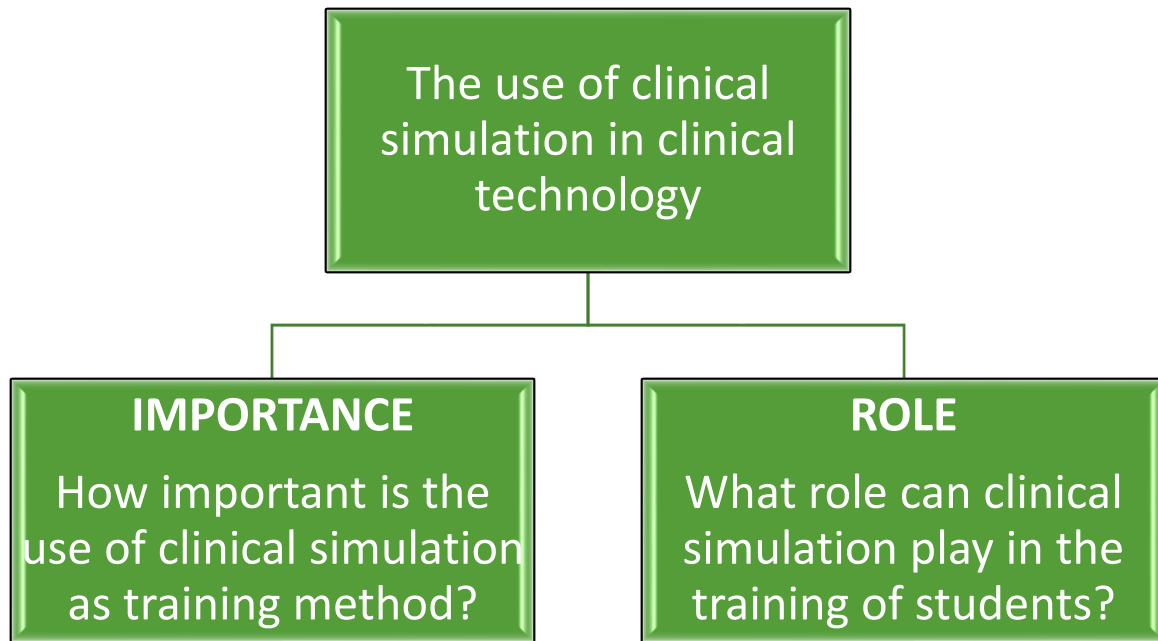


FIGURE 6.2 TWO MAIN SEGMENTS REGARDING THE USE OF CLINICAL SIMULATION IN CLINICAL TECHNOLOGY

[COMPILED BY THE RESEARCHER, PERKINS 2020]

The following section describes the importance of clinical simulation as part of healthcare students' training by combining the literature and reporting the results from Chapter 4.

6.2.1 THE IMPORTANCE OF CLINICAL SIMULATION IN THE TRAINING OF PRE-SPECIALISED CLINICAL TECHNOLOGY STUDENTS

Focus group area 1 (Section 4.4.2.1) described the importance of clinical simulation by reporting on the focus group participants' personal opinions. The importance of clinical simulation was identified as the only major theme from this focus group area. The theme: "*Importance of clinical simulation*" was further categorised into two categories. Firstly, participants who responded positively towards clinical simulation and secondly, participants who indicated a reserved opinion on the topic (Figure 4.4). The next section focuses on the participants who responded positively.

6.2.1.1 POSITIVE RESPONSE TOWARDS CLINICAL SIMULATION

International research indicated the importance of clinical simulation, specifically in healthcare students' training (Passiment *et al.*, 2011). Students exposed to clinical simulation during training demonstrated increased confidence and the ability to practice skills independently (Rozansky, 2012). Local research provided evidence that healthcare students lack specific skills such as professionalism, communication, leadership and clinical reasoning and that the use of alternative and innovative methods are needed to teach healthcare students these skills (Van Vuuren, 2017). Research within clinical technology as a singular healthcare entity is lacking. However, because clinical technology falls within the same healthcare section as other HAP's such as radiography and physiotherapy, who are also directly involved with patient care and treatment, the conclusion may be made that the lack of the mentioned skills in clinical technology students would be similar as the results presented in the Van Vuuren review. Scientific research continuously provides evidence that simulation as an alternative or supplemental training method improves students' performance and their ability to work as a team. Qualitative research conducted among nursing students to investigate the impact of simulation-based training to prepare these nursing students for clinical placement yielded positive results. The focus groups conducted among these nursing students indicated that students had more self-confidence, improved clinical skills, and clinical judgment due to simulation-based training (Hustad *et al.*, 2019). Research conducted in institutions with limited simulation resources also indicated the positive transfer of non-technical skills in students when simulation-based education was implemented as part of the training program (Coggins *et al.*, 2017). The resultant effect was that issues students are struggling with are being addressed using simulation-based training (Griswold *et al.*, 2012). The skills mentioned in research that undergraduate students were struggling with are very similar to the hard and soft skills mentioned by the focus and nominal group participant's clinical students were lacking. The research shows that clinical simulation may have a positive impact if used as a training tool for clinical technology students. A statement from one of the focus group participants not only asked the question of why clinical simulation is not currently part of clinical technology student training but also emphasized the importance of establishing a clinical simulation programme:

- “You know, I was very sceptical in the beginning in England when they introduced it, and it worked so well, and I always thought, why didn't we use it in South Africa, why don't we have a system like that, so it's. To me, it's a very nice thing to hear that. This

might be on the charts for it, but yeah I, I'm all for it, and I think it's if it's been done correctly. It will be a very good thing. No doubt about it." [W63] (Section 4.4.2.4).

The focus group participants were all qualified clinical technologists working in the healthcare environment and functioning as unit supervisors and trainers for the clinical technology students placed in their WIL units. Working closely with these students, the WIL supervisors can assess the abilities and the lack of specific skills of these students. The above-mentioned was confirmed from the focus group data especially referring to Theme 1 as presented in Chapter 4 (Section 4.4.2.2). Participants felt that students needed to be trained in both clinical and non-technical skills through simulation. These non-technical skills included people skills, patient movement and transport, patient awareness, communication, emotional maturity and infection control. In addition, focus group participants mentioned that simulation would be useful to train students in the basic practical and clinical skills as quoted below.

- *"I would say for basic practical and clinical skills. It is very important, I think, for students, because in the first and second years there is nothing that they know about working with patients as such."* [F1].
- *"Um, I think simulation, helps and exposure is very important...."* [F31].

The majority of the participants from both focus groups responded positively towards the importance of clinical simulation as a training method. Positive opinions, as reported in Chapter 4 (Section 4.4.2.1), ranged from being *"very important"*, *"helpful"*, *"vital"*, and *"beneficial"*.

6.2.1.2 RESERVED RESPONSE IN THE USE OF CLINICAL SIMULATION

Before a clinical simulation framework can be introduced into the curriculum, the proverbial *"elephant in the room"* needs to be addressed. The reserved opinion towards using clinical simulation within clinical technology, as reported in Chapter 4 (Section 4.4.2.1), is not new within curriculum development. However, it is understandable. The National Health Service (NHS) in the United Kingdom (UK) reports the unwillingness to use clinical simulation may be attributed to cost, reluctance to adopt new teaching methods and scepticism (National Health Service, 2012). Similar results as presented from the UK research surfaced from a South African survey on simulation-based education. The barriers the South African survey exposed included financial constraints, a lack of trained educators, shortage of simulation equipment and non-dedicated simulation time (Swart *et al.*, 2019). One of the barriers mentioned from the

Swart survey may result in the delayed rollout of a simulation-based program at CUT, with special reference to the lack of simulation trained educators. Reluctance to replace clinical experience with simulation has been experienced in other healthcare professions such as nursing. This being said, the benefit of introducing clinical simulation as a means to provide students with practical experience before they enter WIL should be emphasised (Harder, 2015). The purpose of the simulation framework for pre-specialisation students in clinical technology is not to replace clinical hours but rather to prepare these students for placements in a clinical environment. This was also emphasized by one of the focus group members:

- “.....and then the practical part, we will do in the specialised units.....” [W21]
- “I do feel simulation should not replace your practical exposure and your simulation, the approach needs to be changed to be to be on the same level as the clin techs it, and it needs to be most realistic scenario possible that it can be, then I think it will work.” [F52].

The reserved opinion from some participants in the focus groups is comparable with the NHS report, specifically referring to participants from focus group 1 who voiced fears regarding simulation costs and referring to simulation as “*something difficult to do*” [W17]. As expressed by some of the focus group participants, concerns related to the cost of simulation are an honest and valid concern and, as described in Chapter 2, is recognised as one of the possible pitfalls related to clinical simulation (Krishnan *et al.*, 2017). The current financial difficulties in the South African tertiary institution may contribute to institutions' reluctance to invest in simulation. The viability of certain South African tertiary institutions is under threat especially due to higher student intakes and higher funding demands. These demands need to be met to ensure that the students social and educational needs are addressed. (Paterson, 2021). The high cost of simulation is usually linked to high-fidelity manikins. However, simulation can still be efficient and successful using lower-fidelity manikins and standardised patients, which are less costly (So *et al.*, 2019). The clinical technology program currently uses an inter-program collaboration agreement with the Radiology program, where resources and venues are shared between the two programs. The collaboration helps reduce the procurement costs of simulation equipment. However, with the outbreak of COVID-19, the sharing of equipment and venues are minimised significantly.

The reserved opinions can be possibly explained and covered under the same “*blanket reason*”, namely the profession’s unfamiliarity with clinical simulation. The reason being that clinical

simulation, in general, has not been used extensively in the training of clinical technology students in South Africa. Therefore, not all lecturers and WIL supervisors may be knowledgeable about the extent clinical simulation may be used, especially within specific specialities, as the statements from the focus group participants confirmed the above-mentioned.

“It’s very small in South Africa, in Europe, and Americans it’s a very big system, we’re not used to it.” [W5].

“I always thought why didn’t we use it in South Africa, why don’t we have a system like that?” [W63]

“I don’t know really what the extent of the simulation, can be?” [F51].

“We’re still in a learning curve with the simulation program running for the first, and second years” [F55].

However, as stated in Chapter 3 Section 3.3.2.2 certain participants from the focus group members demonstrated various levels of knowledge regarding clinical simulation.

The intended implementation of a clinical simulation training programme is also directed toward training pre-specialised students and not students already busy training in their respective fields of speciality. Clinical simulation as a means of training clinical technology students at CUT has not formally been introduced and incorporated into the institution’s curriculum and is still in its *“infancy”* (CUT, 2019) (CUT, 2020a). The unfamiliarity in using clinical simulation in combination with the correct and proper use of such a clinical simulation programme may explain one participant’s contradictory statement advocating the importance of clinical simulation and stating that this type of training demonstrated limited advantages. As mentioned above as well as in Chapter 4 Section 4.4.2.1, the reluctance towards implementing clinical simulation in curriculums has been experienced in other healthcare professions. It was therefore expected that some participants would be hesitant towards the use of clinical simulation. This hesitancy can be addressed, and research conducted on the topic promotes that trainers should be trained to familiarise themselves with clinical simulation and the correct use of simulation as a training method Labuschagne *et al.*, 2014). Therefore, both WIL supervisors and tertiary institution lecturers should be encouraged to enrol for short or online courses on the use of simulation in training.

6.2.2 THE ROLE OF CLINICAL SIMULATION

Focus group area 3 (Section 4.4.2.3) investigated the role clinical simulation could play in the training and assessment of pre-specialisation students. As with focus group area 1, the participants agreed that using clinical simulation might result in a beneficial outcome for students. The majority of the focus group participants, which mainly represent WIL supervisors and lectures, responded optimistically towards the role of clinical simulation in training pre-specialised clinical technology students and presented in Chapter 4. The proposed role of clinical simulation in clinical technology will be discussed in the following sections.

6.2.2.1 EXPECTATIONS FROM A CLINICAL SIMULATION PROGRAMME WITHIN CLINICAL TECHNOLOGY

The singular theme that surfaced from focus group area 3 (Section 4.4.2.3) revealed what focus group participants expected from a clinical simulation training programme and are listed below:

- Better patient interaction
- Confidence
- Insight to specialities
- Being able to bridge the knowledge gap
- Graduate attributes
- Assessment of students

i) *Patient interaction*

Focus group participants voiced that they would expect students to understand better how to interact with patients on multiple levels. Participants required that students should be able to assess patients, be compassionate towards patients, be aware of the patient's legal rights and medicolegal aspects related to the patient's treatment. Using clinical simulation to help students obtain the necessary skills regarding patient interaction has been published. A study conducted in 2017 involving undergraduate nursing students evaluated the impact of using standardised patients (SPs) to train undergraduate nursing students in physical assessment, clinical judgement and self-efficacy. The study results revealed that using standardised patients or even fellow students was equally useful in teaching students patient interaction skills (Mueller, 2017). Research also demonstrated that students accept simulation as a training modality. With patient safety becoming increasingly emphasised across all healthcare levels, simulation has proved to be an effective means to train healthcare professionals to focus on patient safety

(Escudero *et al.*, 2019). In addition to patient safety, simulation-based training has also proved to be successful in providing communication skills and assessing healthcare students' communication skills (Agago *et al.*, 2021). Upon entering into WIL, the 3RD year clinical technology student is exposed to patients from their first day in the clinical environment. Even though they may not work with patients without supervision, the student may often be required to collect patients from the ward or assist with transporting patients to the theatre or high care. Students may be requested to monitor a patient's vital signs or take down a patient history, and due to this close interaction with patients at an early stage in the clinical technologist's career, it is imperative to ensure that these students know how to interact effectively and safely with patients. Therefore, simulation may be used to train and prepare these students in a variety of soft skills and assess their level of competency, as Agago *et al.* (2021) suggested.

Various simulation methods have proved successful in teaching students how to interact with a patient through simulation. The use of both standardised and simulated patients has shown to be useful in simulation (MacLean *et al.*, 2017; Zhang *et al.*, 2019). Care must be taken to distinguish between standardised patients and simulated patients. Standardised patients usually refer to a person with his/her own medical history. This is a person required to portray a patient with a specific condition for educational purposes. For example, a standardised patient may be a real patient with a particular disease.

On the other hand, a simulated patient is a healthy person instructed to portray specific signs and symptoms of an illness and simulate a patient (Beigzadeh *et al.*, 2016). As discussed in Chapter 2 Section 2.7.3, standardised patients or care actors are ideally suited to act in a situation where a student needs to take down a patient's history, conduct a physical exam on a patient, or evaluate a student's ability to communicate effectively (Datta *et al.*, 2012). One focus group participant from focus group 2 mentioned that using patient actors during a simulation exercise may add to specific scenarios' realism and contribute to the clinical technology students' training. Some of the other focus groups participants agreed with this statement.

“.... I think the interesting thing that I experienced was maybe to transition from this simulation to really experience this is with, with some of the medical students were they in the training they actually have a real people, and they actually drama students, and they trained to react a certain way when you do something or say something. And it was just quite interesting to me.”

Maybe that's also to get that patient contact, not just being a dummy or simulator. I think that's something one can also maybe look into with regard to giving them exposure to handling physical people rather than just dummy." [F39].

Participants that agreed with the statement mentioned above:

"And as number 3 now said, drama students that would help a lot for them to actually have other people because practising on your friend in class is always fun and games and they love, and they don't really take it seriously if they can have someone they don't know to practice on that will help a lot." [F40].

"I like the suggestion that was made when they do the mock simulations that they actually use drama students. Maybe you guys can set up something with the University, and drama students can come in." [F43].

Recent research indicated a 44% decrease in anxiety in medical students exposed to compassionate training by using actors in a simulated environment (Heath, 2019). Therefore, simulation can be effectively used to transfer ethical knowledge and identify possible gaps within the student's understanding of healthcare-related ethics to improve the student's skills and ensure patient safety (Pinar & Peksoy, 2016). The research, therefore, suggests that simulation could effectively be used within clinical technology. Clinical technologists mainly function in specialised healthcare areas where ethical issues are experienced regularly. The importance of simulation implementation is captured in the following quote by Dr Kim Baily: *"The organisation of simulation-based training and its implementation in the curriculum are crucial for the learning outcomes and for students' experiences of the transfer of knowledge to clinical practice."* (Baily, 2020).

ii) Student confidence

Another aspect the focus group participants voiced as one of the expectations they would like clinical simulation to assist students with is confidence. Participants from both focus groups indicated that students are overwhelmed when they enter specific clinical environments for the first time, e.g. theatre and intensive care. Literature dictates that students exposed to learning through simulation were better prepared and confident to function in clinical settings, especially in intimidating environments such as intensive care (Kapucu, 2017).

iii) Insight into the clinical technology specialities

Exposing clinical technology students to the seven different specialities is an important part of the tertiary institution's task in assisting students to decide in which particular speciality they would like to specialise. Students may be exposed to a variety of methods within different specialities. Firstly, through theoretical subjects where the subject content is structured in such a manner that one or two key biomedical apparatus and procedures related to the specific specialities are included in the curriculum. Examples of such subjects include Clinical Technology Practise (CTP) and Clinical Technology Instrumentation CTI (CUT, 2020a). Secondly, students are tasked to “*shadow*” the seven specialities for one or two days during the winter recess, depending on the specific speciality requirement. These shadow visits are the most effective means of exposing students to different specialities because students can physically see and experience specialities first-hand. Not all the specialities are necessarily available within a specific tertiary institution's geographical region, which means that students may only be exposed to five or six of the seven specialities. Certain specialities may only expose students to a limited extend, especially specialities such as Perfusion (theatre) and Critical Care (intensive care units), where access to the clinical environment is controlled either due to infection control measures or limited space. In some cases, guest speakers are invited by CUT to come and address the students on specific specialities where it might be difficult to provide physical access to these students in the unit. Considering this, it is not difficult to understand why focus group participants expressed their third expectation that students should be introduced to the different specialities using simulation to gain better insight into the specialities. It is also important to mention that clinical simulation should not replace the unit visits or “*shadowing*” but rather be used to augment the students' knowledge on the specialities to assist them in making an informed decision. Specifically regarding which speciality they would like to pursue, as one of the participants confirmed:

“With simulating and unit visits, we could give them a more balanced way of making an informed decision than with just viewing in the units....” [W3].

Due to the outbreak of COVID-19, students' shadow visits to the hospitals have been reduced significantly. However, even in this instance, the simulation unit may prove beneficial in providing students with the required information on each of the seven clinical technology specialities.

Experts such as Urhie from Western Virginia University School of Medicine also confirms that if students are exposed to different skills used in other healthcare areas using simulation, students will be comfortable with the work related to the various specialities, and this might assist students with their choice of speciality (Urhie, 2018).

iv) Bridging the knowledge gap

Focus group participants expressed their concerns that students demonstrated an inability to leap from a purely theoretical environment to a clinical environment since the two areas are so different. As reported in research and discussed in Chapter 2 (Section 2.7.4; Section 2.9), clinical simulation advantages indicate that simulation enhances knowledge and helps transfer knowledge from theory to practical (World Health Organization, 2018). Specific research investigating the use of low-fidelity manikins to assist undergraduate nursing students in linking theory and practice demonstrated a positive response regarding the use of simulation. The nursing students indicated that the simulation training was valuable to prepare them for their clinical work (Wall *et al.*, 2014). However, caution should be taken; it is important to acknowledge that simulation has some disadvantages and simulation research should be reviewed in the correct context, especially regarding bridging the knowledge gap (Lamé & Dixon-Woods, 2020). The proposed strategy for the clinical technology program is to add simulation as a supplementary training method and not as the sole means for training students.

v) Graduate attributes

Being able to communicate, act ethically and being professional is only a few of the graduate attributes expected from a clinical technologist. One of the study's research questions was to investigate the graduate attributes 3RD and 4TH-year clinical students lack as WIL students. The question arose from advisory board meetings that are regularly conducted with the different WIL units and supervisors. In these meetings, information is shared between CUT and the WIL units responsible for training the clinical technology students. WIL supervisors increasingly complained about the conduct of students placed in their units. Therefore, it was decided to include this research question to better understand the current problems, with specific reference to graduate attributes students have during their WIL learning and how this problem may be addressed. It was clear from the information gathered that the WIL supervisors expected CUT to ensure that students know how to conduct themselves when entering the healthcare environment and how to interact with patients. The possible solution would be to train these graduate attributes through simulation to the pre-specialisation clinical technology student.

Focus group participants agreed that students need to be introduced and exposed to graduate attributes. By exposing students repeatedly to simulation, sessions proved to reinforce and learn the specific non-technical skills or graduate attributes such as leadership and professionalism (Chen *et al.*, 2016).

CUT has identified ten specific graduate attributes, as discussed in Chapter 2 (Section 2.5). However, the essence of a CUT graduate is captured in the following statement: “*CUT graduates should be skilled, innovative, socially responsible, technologically savvy and astute, focused and competent.*” (CUT, 2020c). The HPCSA also has set out its understanding regarding the graduate attributes undergraduate clinical technology students should be skilled in. Together with the CUT’s graduate attributes, the graduate attributes documented by the HPCSA were also mentioned in Chapter 2 (Section 2.5).

It is essential to develop a curriculum using graduate attributes as a guide to ensure that students are trained in technical skills and, equally important non-technical skills (Laidlaw *et al.*, 2009). Through the analysis of the data (specific graduate attributes essential for clinical technology students researched through the nominal group interviews are discussed in Section 6.2.2.5), and the review of the literature, a comparison could be made between the training institutions, the lecturer’s perception and the industry’s professional requirements for a clinical technologist. Fortunately, one institution’s graduate attributes do not have to be ranked above another. Students enrolled through CUT are exposed to this institution’s graduate attributes through various institutional programmes with particular reference to the 1ST and 2ND-year students. In addition, the 3RD and 4TH-year students are exposed to the HPCSA graduate attributes during their WIL training. The role of simulation in the pre-specialised clinical technology program would be to help the transition of these students into WIL and to ensure that they demonstrate the basic graduate attributes required by the HPCSA before moving into their 3RD year of study.

vi) Clinical simulation as an assessment tool

Assessment of students is one of the well-known methods to confirm if students achieved the set learner outcomes (Vincent-Lambert & Bogossian, 2017). Focus group participants agreed that simulation should be used as a means of assessment. The detailed use of simulation as an assessment tool was discussed in Chapter 2 (Section 2.7.5). It is important to keep in mind that assessments should be set up according to the student’s ability level (Boulet, 2008). Research indicated that simulation might be used in a variety of ways of assessing health professional

students on the condition that students should have had previous exposure to simulation training and simulators. An extensive review of research conducted in simulation confirmed that standardised patients, part-task trainers and patient simulators could effectively be used in assessing students (Ryall *et al.*, 2016). Using simulation as a means of assessment was also one of the important themes identified from the nominal group interviews as described in Chapter 5. Participants from the nominal groups suggested that simulation as an assessment tool can be used to assess specific skills and techniques: “*Student assessment: Clinical simulation may provide an additional and standardised means of assessing students on specific clinical and practical skills.*” (Section 5.4.1.1).

From the nominal groups’ meetings, the role of clinical simulation was also discussed. From these meetings, fifteen themes were identified between the three nominal groups. Comparing the expectations voiced by the focus group participants regarding the role clinical simulation may play with the themes that emerged from the nominal groups, definite overlapping comparisons were made. Conforming themes are indicated by similar colours and displayed in Table 6.1:

TABLE 6.1 COMPARISON BETWEEN FOCUS GROUP DISCUSSIONS AND NOMINAL GROUP INTERVIEWS
REGARDING THE ROLE OF CLINICAL SIMULATION ³

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Focus Group Discussion: Expectations for clinical simulation	Nominal group interviews: Themes regarding the role of clinical simulation
Better patient interaction	Peer-assisted learning and work-integrated learning
Confidence	Practical and clinical skills
Insight to specialities	Practical scenarios
Being able to bridge the knowledge gap	Resources
Graduate attributes	Student assessment
Assessment of students	Introduction to biomedical apparatus
	Exposure to clinical technology specialities
	Student confidence
	Student equity
	Safe learning environment
	Expanding on knowledge
	People skills
	Integration of knowledge
	Graduate attributes
	Programme requirement

Most of the focus group participants agreed that clinical simulation would play a role in training and assessing pre-specialisation clinical technology students. Accordingly, the proposal is for students in the clinical technology programme to be assessed on a formative evaluation basis. Literature indicates that undergraduate students assessed on a formative basis demonstrated adequate clinical competence (Arrogante *et al.*, 2021). Although Arrogante *et al.* (2021) also recommend that a combination of formative and summative evaluations are followed, the formative evaluation strategy demonstrated that learning outcomes might be tailored. The formative assessment method also falls well within how the practical component of the specific subject content is currently assessed in the 1ST and 2ND-year clinical technology students. Therefore, no adjustments to the current assessment models would need to be submitted to the assessment and graduation unit.

³ Similar themes are indicated in similar colours.

Regarding the simulation equipment used to assess students, task trainers may be used to assess students in specific clinical or technical skills, e.g. airway management, whereas assessment of soft skills is best done through an SP approach (Chavda *et al.*, 2020). Even though clinical simulation may only play a limited role, participants expressed clear expectations of what they expect from a clinical simulation programme. As with the practical and clinical skills discussed later in this Chapter, the absence of specifically required traits in the pre-specialised student was easily identified and was mentioned by the participants. Some of the expectations voiced by the participants overlapped with practical skills, especially social skills. WIL supervisors indicated that students should be trained in “*how to work with people*” and communication. It was also evident that a clinical simulation programme may be used to expose the students to different specialities and assist students in integrating theoretical knowledge with practical skills. This could result in more experienced and confident pre-specialised clinical technology students.

The next section will discuss the technical and non-technical skills the focus group and nominal group participants thought necessary pre-specialisation clinical technology students should be exposed to.

6.2.2.2 TECHNICAL AND NON-TECHNICAL SKILLS

From the responses and conversation, it was fairly evident that the WIL supervisors, without difficulty, identified the technical and non-technical skills students currently lack. The WIL supervisors are involved with the students daily and work very closely together with these students. Therefore, it will be easy for WIL supervisors to pick-up on a student’s practical ability and skill level. Most of the technical and non-technical skills participants mentioned students lack were basic skills proficiency.

Non-technical skills:

Non-technical skills refer to a student’s ability to be socially interactive on a professional level, communicate and reason on a rational level, reflecting on the student’s ability to make intellectually sound decisions (Griffin *et al.*, 2020). Graduate attributes fall well within the definition of non-technical skills. The HPCSA has set out a specific set of “*core competencies*” essential for undergraduate students in clinical associated healthcare training in South Africa and include the following:

- Professional
- Communicator
- Collaborator
- Leader and manager
- Health advocate
- Scholar (HPCSA, 2014).

In light of the competencies mentioned above, the participants strongly agreed that students should be taught how to work with people and be able to communicate effectively. The non-technical skills can be divided into three main categories: social skills, cognitive skills, and personal resource factors, as displayed in Figure 4.7. The three groups are defined and displayed in Table 6.2:

TABLE 6.2 NON-TECHNICAL SKILLS CATEGORIES

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (GRIFFIN *ET AL.*, 2020)]

Non-technical skills category	Definition
Social skills	Being able to communicate, take leadership when required and work as part of a team.
Cognitive skills	Making sound decisions with good situational awareness.
Personal resource factors	Being able to manage stress and fatigue without non-technical and technical skills being influenced negatively.

The literature, as well as the focus group and nominal group participants, identified the following non-technical skills pre-specialisation clinical technology students should be exposed to:

i) *Communication*

Being able to communicate effectively is an important part of being a healthcare professional. A healthcare worker needs to communicate with their patients and their relatives and other healthcare workers (Subramanian & Sathanandan, 2016). Literature dictates that health professionals with the required communication skills are more efficient in working with patients with specific problems, resulting in reduced medical errors and costs. Healthcare professionals with good communication skills can effectively communicate over cultural boundaries (Al-Sheikh & Iqbal, 2020). Adequate communication also leads to more accurate diagnosis and patient compliance (Damm *et al.*, 2015). In addition to healthcare professionals

communicating effectively with patients, it is also important for healthcare professionals to have good interprofessional collaboration and communication. The before-mentioned leads to added patient safety, patient satisfaction and efficiency (Morley & Cashell, 2017). Al-Sheikh & Iqbal (2020) proposes a five-step process to effectively incorporate communication skills training into a curriculum. The five steps are listed below (Al-Sheikh & Iqbal, 2020):

- Step 1 - Analyze communication gaps in health professionals.
- Step 2 - Make communication skills an integral part of national as well as institutional curriculum competencies.
- Step 3 - Launch structured training of communication skills.
- Step 4 - Evaluate communication skills as part of the licensure examination.
- Step 5 - Evaluate and upgrade the communication skills training curriculum at par with international standards.

South African research on communication indicated that both language and culture are important within the South African healthcare setting. Revisiting the current curriculums on an institutional level, especially regarding the multiple language and cultural environments, may provide better communication between healthcare professionals and patients (Matthews & Van Wyk, 2018). The local research partially addresses Step 1 and Step 2 of the proposed five-step plan. Implementing the training of communication for students initiates Step 3. Step 4 would need to be addressed and implemented on a professional board level. Finally, once the communication training curriculum has been established Step 5 could be implemented and evaluated.

The benefit of training student's in communications skills using simulation lends itself to three important aspects (Bagnasco *et al.*, 2014):

- Simulation provides a safe environment for the student to make mistakes and practise in.
- Simulation provides an ethical environment because no real patients are involved.
- Simulation provides a controlled environment where the instructor controls the simulation's outcome guided by the student's actions.

Computer simulation is one of the methods that may be used for teaching communication skills to students. Through virtual reality, various realistic scenarios can be developed and used to

expose students to the possible real-life encounters they may experience in a healthcare environment, e.g. intercultural communication and interprofessional communication (Kron *et al.*, 2017). Currently, the clinical technology department has a dedicated computer laboratory with controlled internet access, and this makes the above-mentioned a feasible option for the program. In addition, a variety of free online virtual reality medical simulators are available, reducing the cost of buying expensive software licenses and the need for lecturers to be skilled in software programming to run these simulations.

Another well-known simulation method to allow students to learn communication skills is via role-playing, especially peer-assisted role play. This method has proved to be as effective as other simulation modalities in training the students in the required communication skills (Gelís *et al.*, 2020).

Being able to report and document essential patient information and patient parameters is vital for any healthcare provider. Therefore, it is not strange that this was one of the requirements mentioned by the focus group participant's clinical technology students should be skilled in. From the literature and focus group discussions, it is clear that simulation may play an influential role in training clinical technology students to be good communicators.

ii) *Emotional maturity*

Emotional maturity is defined as a person's ability to manage their emotions under any type of circumstance. Some of the key characteristics of an emotionally mature person include taking responsibility and owning your mistakes (Lamothe, 2020).

Clinical functionality can be affected by a person's inability to manage emotion successfully, especially regarding effective communication, sound decision-making, functioning in a team, and good leadership (Carvalho-Filho *et al.*, 2018).

Discussions from the focus groups indicated that students entering into WIL should demonstrate emotional maturity, especially during high-stressed situations. The nominal group members also highlighted the before-mentioned with the following statements as listed in Table 5.12:

- *"Responsible and accountable."*
- *"Cope with stress and a stressful environment."*

➤ “*Professionalism & conflict management.*”

As an integral part of a simulation, debriefing has demonstrated that students learn how to handle and manage their emotions (Carvalho-Filho *et al.*, 2018). Further research indicated that students could be exposed to situations that trigger a possible emotional response by using simple simulated scenarios and contribute to the development of their emotional maturity (Meska *et al.*, 2020). As discussed in Chapter 2 (Section 2.6.4.1), debriefing is an essential part of simulation and ensures that learning is successful (Zigmond *et al.*, 2011a). For debriefing to be successful, it is suggested that the debriefing of healthcare students after a simulation exercise are done using Decker’s suggested guidelines. The guidelines consist of five essential criteria that stimulate reflective thinking and include the following (Decker *et al.*, 2013):

- Debriefing should be conducted by a person trained in debriefing.
- The session should be conducted in an environment that promotes communication, confidentiality and trust.
- Debriefing should be handled by a person who observed the simulation exercise.
- Debriefing should take place along the lines of a structured framework.
- Debriefing should focus on both the objectives and outcomes set out at the beginning of the simulation exercise.

Fanning and Gaba (2007) suggest the necessity of debriefing are to be driven by the learning objectives, target population and simulation modality. Ensuring an effective and correct debriefing session demonstrated better team performance, together with improved behavioural and technical skills of those learners who attended both the simulation and debriefing session (Abulebda *et al.*, 2020).

Technical skills:

Practical and clinical skills (technical skills) were among the most important themes emerging from the nominal group interviews' data, with a final ranking value of 40, as summarised in Chapter 5, Table 5.7. No less than five statements from the three nominal groups expressed opinions from the members that clinical simulation would provide students with the opportunity to obtain, practise and revise technical skills (Section 5.4). Technical skills were also one of the major themes identified from the focus group discussions (Section 4.4.2.2). Simulation, combined with other training modalities, especially in undergraduate students, has

proved to be quite helpful and successful in teaching students basic technical skills (Vogel & Harendza, 2016).

Clinical technologists as healthcare workers are part of the daily diagnostic and treatment procedures of patients. To assist medical doctors with the diagnosis and treatment of patients, clinical technologists require certain clinical skills. Both focus group and nominal group interviews identified the required skills, as reported in Chapters 4 and 5. Therefore, being competent in clinical skills is an essential requirement for clinical technologists (Favarato *et al.*, 2019).

Simulation provides specific educational advantages for students learning skills, as described by Castanelli (2009):

- Learning is focused on the student.
- Training can focus on specific skills or complete procedures.
- Simulation allows for revision.
- Students can learn from their mistakes.
- Students can be assessed to evaluate the competency of students.

The focus group members emphasised clinical technology students' ability to perform basic skills such as general patient monitoring and vital signs monitoring. The next sections describe how simulation could be used to train students in basic skills and patient monitoring, as mentioned by the focus and nominal group participants.

i) *Anthropometric measurement*

One of the key messages derived from the focus groups meetings was that students should be taught basic skills. Being able to weigh and measure a patient's height may sound like an elementary skill, but it might result in incorrect medical equipment settings and patient treatment if not done correctly. Anthropometric measurement can be easily taught in a simulated environment through demonstration and simulated patients (Srinivasan *et al.*, 2017).

Students can even be exposed, for example, to an obese patient through simulation by having a simulated patient wearing an obesity simulation suit. Research regarding this obesity

simulation suit has shown that it sensitised students to communication and the needs of an obese patient (Herrmann-Werner *et al.*, 2019).

ii) *Use of an acoustic stethoscope*

Any healthcare professional required to measure a patient's blood pressure non-invasively must be able to use an acoustic stethoscope. Especially healthcare workers working in Cardiology or Pulmonology should also use an acoustic stethoscope effectively to listen and report on heart and lungs sounds (Ward & Wattier, 2011). Simulation can be used to improve both basic and advanced skills regarding patient auscultation (Fadellelmoula, 2018).

A variety of different simulation auscultation task trainers and high-fidelity manikins are available to teach students both heart and lung sounds. An example of an auscultation task trainer includes the Harvey cardiopulmonary patient simulator and an example of a high-fidelity manikin, the SimMan Essential or 3G (Ward & Wattier, 2011).

A cost-effective stethoscope simulator using Bluetooth technology and recorded cardiopulmonary sounds from real patients proved to be a valid means of teaching students the important skill of using a stethoscope in a safe environment (Fadellelmoula, 2018).

iii) *Respiratory support and airway management*

Respiratory support and airway management, e.g. use of a simple facemask, bag valve mask or intubation as part of basic life support and resuscitation of a patient, are some of the skills a clinical technologist should be able to perform. Certain specialities in clinical technology such as cardiovascular perfusion and critical care are also responsible for transferring and transporting critically ill patients, for example, from the theatre to the ward or from one hospital to another (HPCSA, 2020).

Simulation has proved that airway management techniques can be trained to students effectively (Komasawa & Berg, 2017). Both task trainers and high fidelity simulators in combination with demonstration videos and airway management guidelines may be used to train students in the required airway management skills (Yang *et al.*, 2016).

iv) *Blood pressure measurement*

One of the clinical skills indicated by the focus group participants, as reported in Chapter 4, as an essential skill pre-specialised clinical technology students should be able to perform when entering into the clinical environment was the ability to measure blood pressure accurately. Research on the use of simulation to train preregistered nursing students in the technique of blood pressure measurements indicated that students demonstrated more confidence, technical ability and increased knowledge related to the subject (Gordon *et al.*, 2013). Another survey that was done with nursing students regarding blood pressure measurement via simulation in a skills laboratory indicated that the nursing students felt they were adequately trained and prepared to enter the clinical environment after the simulated training (Kingston & Murphy, 2010). Blood pressure can be taught via simulation either by using simulated patients or task trainers, e.g. blood pressure training arms or a high fidelity manikin such as a Harvey cardiopulmonary patient simulator or SimMan 3G / Essential (Laerdal, 2020).

v) *Electrocardiogram*

Interpretation of a patient's ECG is essential. However, placing the electrodes in the correct anatomical positions may even be more important. Incorrect placement of ECG electrodes may lead to an incorrect diagnosis (Oli, 2015). An ECG electrode misplacement simulator utilised as a web-based application proved to be beneficial in assisting students in the training of ECG electrode placement (Bond *et al.*, 2011).

vi) *Vital signs*

Vital signs are an important reference to a patient's vitality. The ability to measure and monitor vital signs such as pulse rate, respiration, oxygen saturation, and body temperature is important for any healthcare provider (Suwa, 2015). Vital signs are defined as the following: "Vital signs are an objective measurement for the essential physiological functions of a living organism." (Sapra *et al.*, 2019). Vital signs include the measurement of a patient's temperature, pulse rate, blood pressure and respiratory rate and are usually the first parameters measured to evaluate a patient's health status (Sapra *et al.*, 2019). Using a simulation-based programme to teach students the skills to monitor vital signs ended up with students having a better understanding of the patient's vital signs and monitoring the patient (Tokunaga *et al.*, 2010).

Research comparing students being trained in vital signs through clinical simulation vs students trained on the traditional method without using clinical simulation indicated a significant gain

of knowledge and the ability to measure vital signs in patients when trained via clinical simulation (Eyikara & Baykara, 2018).

vii) *Patient movement and transport*

Receiving a patient from the ward in a wheelchair for a lung-function and having to transfer that patient from the wheelchair to a body plethysmograph or “body box” as it is more commonly known is just one of the many possible patient movement scenarios a clinical technologist may face daily. In addition to the before-mentioned clinical technologists in specific specialities such as critical care and cardiovascular perfusion may be required to assist with the movement of patients from theatre to intensive care or from the intensive care unit to the X-Ray department.

Various scenarios can be set-up in a simulation laboratory to teach students the essence of transferring a patient from one surface to another and assist with developing the students’ clinical reasoning ability (Baird *et al.*, 2015). In the case of the critically ill patient that needs to be transported from one clinical environment to another, simulation has proved to be beneficial on more than one level, especially regarding teaching students to be part of an interprofessional team and to ensure that every piece of equipment used during the transfer of the patient has been prepared and checked properly before the transfer (Patel & Copeman, 2019).

viii) *Basic life support*

Participants also indicated that a student should be confident in basic life support and clearly understand their role within an emergency. Simulation and basic life support are synonymous with each other, as discussed in Chapter 2. Using simulation-based training to teach students basic life support resulted in better knowledge and skills with resultant increased confidence in resuscitation (Daniel & Daniel, 2020). Simulation is useful in training students the required basic life support skills, but it also proved to play an essential part in maintaining these important skills (Sullivan *et al.*, 2019). One of the basic simulation tools that may be used to train students in basic life support is the Resusci Anne™ manikin (Rosen, 2008).

ix) *Infection control*

As healthcare workers, clinical technologists work in a clinical environment in direct contact with patients. Clinical technology students need to understand their role regarding infection

control. Simulation has proved itself as a means of educating healthcare workers in a variety of different clinical areas. Infection control is one area where simulation-based education may be used to train students (Barsuk *et al.*, 2009). Recent research agrees that the integration of simulation and the use of additional educational methods in training novice healthcare workers, especially regarding infection control, is beneficial (Haimour *et al.*, 2020). With the emergence of COVID-19, the use of simulation to train students in the use of Personal Protective Equipment (PPE) and infection control became even more prominent, and simulation has great potential to address the serious infection control issues associated with such a global pandemic (Dieckmann *et al.*, 2020).

The simulation modalities suggested by literature to train students and healthcare worker in infection control and the proper use of PPE's are listed below:

- Demonstration using videos.
- In-class demonstrations.
- E-learning (computer simulation).
- Skills training.
- Peer-to-peer learning with feedback during the training (Dieckmann *et al.*, 2020).

Computer simulation has proved to be one of the modalities that can be utilised successfully in training healthcare workers in the correct donning and doffing of PPE's (Hung *et al.*, 2015). High-fidelity simulation may be used to train healthcare workers and evaluate healthcare workers' competencies, especially in highly contagious diseases such as Ebola and COVID-19 (Abualenain & Al-Alawi, 2018). The outbreak of the COVID-19 had both a negative and a positive impact on the use of simulation. Students had to be divided into smaller groups, which resulted in innovative time management to ensure that all the students spend enough time in the simulation laboratory. However, the smaller groups led to better interaction between lecturer and student. The COVID-19 outbreak also proved to be a stimulus in training the students in the correct use of PPE's and infection control.

However, pre-specialisation students need to start at the basics, and proper hand hygiene has proved to be an effective means of infection control and, due to the before-mentioned, should be an educational priority for any healthcare student and part of each simulation session.

(Mathur, 2011). Hand hygiene is more than just handwashing, and the WHO refers to proper hand hygiene as the “*Five moments for hand hygiene*” and are listed below:

- Before touching a patient.
- Before clean/aseptic procedures.
- After exposure to body fluid or the risk thereof.
- After touching a patient.
- After touching the patients surrounding (Salmon *et al.*, 2015).

Using a simulated virtual reality environment may help healthcare students understand and be aware of the “five moments” hand hygiene concept (Bertrand *et al.*, 2010).

6.2.2.3 BIOMEDICAL APPARATUS

The participants’ consensus indicated that pre-specialisation students should be exposed to biomedical apparatus to a certain extent. The reason is that equipment is often used in collaboration with a practical or clinical skill, e.g. measuring a patient’s blood pressure. A student will not accurately measure a patient’s blood pressure if the student is not at least familiar with a blood pressure device. Participants also felt the exposure to equipment would provide the students with an insight into what different types of equipment are used in the different specialities. The WHO recommends the use of real equipment when training students through simulation. The reason is that the use of real equipment will add to the simulation’s realism and enhance the student’s psychomotor skills and increase their confidence when using similar equipment in the future (World Health Organization, 2018).

Biomedical apparatus forms an integral part of the clinical technologist scope of practice. The HPCSA has recently documented important aspects regarding the application of apparatus for procedures that fall within the clinical technologist’s scope of practice (HPCSA, 2020). These applications are listed below:

- Ensure patient safety.
- Prepare and calibrate equipment for medical procedures.
- Perform general quality control procedures.
- Implements infection prevention and control.
- Prepare, educate/facilitate and instruct patients for procedures.

- Perform investigative, therapeutic or organ supportive procedures on patients.
- Assess and validate the results.
- Collect and calculate test data in preparation for / and interpretation of reports.
- Calculate dosage for the administration of certain medicines for related interventional procedures.
- Calculate and provide the appropriate apparatus for procedures in collaboration with healthcare professionals.
- Oversee maintenance and functionality of the equipment for associated procedures.

From focus group area 2, the second theme identified from this focus area referred to the biomedical apparatus focus group participants suggested should be included in a clinical simulation programme. Within this theme, two categories were recognized:

- Generic equipment
- Specialisation specific equipment

The generic equipment referred to equipment generic to clinical technology that is used across the majority of specialities. Specialisation specific equipment referred to basic equipment specifically used within a specific speciality. One of the reasons why specialisation specific equipment was suggested was that it might help introduce students to different clinical technology specialities.

“I think it could be important for them to just be exposed to the different equipment related to each category.” [W3].

i) Generic equipment

The generic equipment mentioned by the focus group participants are listed below:

- Blood gas machine
- ECG machine
- Intra-venous equipment
- Defibrillator
- Blood pressure apparatus
- Vital signs monitor
- Basic respiratory equipment
- Suction apparatus

The clinical technologist's scope of practice has recently been re-evaluated and adjusted. The overlapping equipment used within the different specialities as described by the newly approved scope of practice are listed below (HPCSA, 2020):

- ECG machine
- Spirometry or peak flow measuring equipment
- Coagulation measuring equipment
- Respiratory monitoring and support equipment
- Non-invasive blood pressure measurement equipment
- Temperature measuring equipment
- Doppler
- Blood gas machine
- Oximetry measuring equipment
- Invasive blood pressure measuring equipment
- Patient monitoring equipment
- Defibrillators and AED
- Sonar machines
- Rotablation equipment
- Infusion devices
- Pacemakers
- Intra-aortic balloon pump
- ECMO machines

ii) Specialisation specific equipment

All seven different specialities in clinical technology were represented between the two focus groups. The participants were asked to provide information regarding the generic equipment they felt students should be trained in and which specific equipment in their respective specialities they would like students to be exposed to.

Two of the specialities, namely reproductive biology and neurophysiology, indicated that equipment within these specialities is too specialised and that no equipment from these specialities can be included in a clinical simulation programme.

- *“From the reproductive side. I don’t think there’s any apparatus that you can really use to train the students before they actually go to the unit” [W16].*

and

- *“Regarding simulation, I don’t really have any options here. Because as you know that the simulation doesn’t really give you brain activity or nerves to work with, so that is a bit difficult. I usually do all that training in the unit myself. And so regarding that, I don’t have any anything in their first few years that they can really learn. Regarding this speciality” [F13].*

Each of the remaining five specialities indicated at least one or two specialisation-specific apparatuses that should be included in a clinical simulation programme. The equipment is listed below:

- Spirometry equipment
- Coagulation measurement equipment
- Sonar machine
- Dialysis machine
- Basic ventilator

Biomedical apparatus equipment suggested by the focus group participants compared to the apparatus related to the scope of practice of clinical technologist is demonstrated in Table 6.3.

TABLE 6.3 BIOMEDICAL APPARATUS COMPARISON TABLE

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (HPCSA, 2020)]

Biomedical apparatus	Cardiology	Cardio-vascular Perfusion	Critical Care	Nephrology	Neuro-physiology	Pulmonology	Reproductive Biology	Generic equipment	Speciality equipment
Anthropometric equipment	X	X	X	X	X	X	X		
ECG machine	X	X	X	X	X	X	X	X	
Spirometry or peak flow measuring equipment	X		X	X		X			X
Coagulation measuring equipment	X	X	X	X	X	X	X		X
Respiratory monitoring and support equipment	X	X	X	X	X	X	X	X	
Non-invasive blood pressure measurement equipment	X	X	X	X	X	X	X	X	
Temperature measuring equipment	X	X	X	X	X	X	X		
Doppler	X	X	X	X					
Blood gas machine	X	X	X	X	X	X		X	
Oximetry measuring equipment	X	X	X	X	X	X		X	
Invasive pressure measuring equipment	X	X	X		X	X		X	
Patient monitoring equipment	X	X	X	X		X		X	
Defibrillator and AED	X	X	X	X				X	
Sonar machines	X		X						X
Rotablation equipment	X	X	X						
Drug administration and infusion devices	X	X	X		X			X	
Pacemaker	X	X							
Intra-aortic balloon pump	X	X	X						
ECMO devices		X	X						
Cell saver		X	X	X					
Dialysis equipment			X	X					X
Mechanical ventilator			X			X			X
EEG related equipment			X		X				
Bronchoscope			X			X			
Suction apparatus			X					X	

From the table above, a proposed equipment list students should be exposed to during their pre-specialisation phase as clinical technology students can be categorized into two main groups (Figure 6.3):

Group 1 - Equipment that the focus group participants suggested and fell within the clinical technologist's scope of practice highlighted in **Purple**.

Group 2 - Equipment that falls within the scope of practice but was not suggested/recommended by the focus group participants highlighted in **Red**.

The two main groups can further be divided into four sub-groups:

Subcategory 1: Equipment used in procedures in all seven clinical technology specialities but not mentioned by the focus group participants highlighted in **Blue**.

Subcategory 2: Equipment used in all seven clinical technology specialities and mentioned by the focus group participants highlighted in **Green**.

Subcategory 3: Equipment used in certain specialities and mentioned by the focus group participants highlighted in **Yellow**.

Subcategory 4: Equipment used in certain specialities and not mentioned/recommended by the focus group participants highlighted in **Orange**.

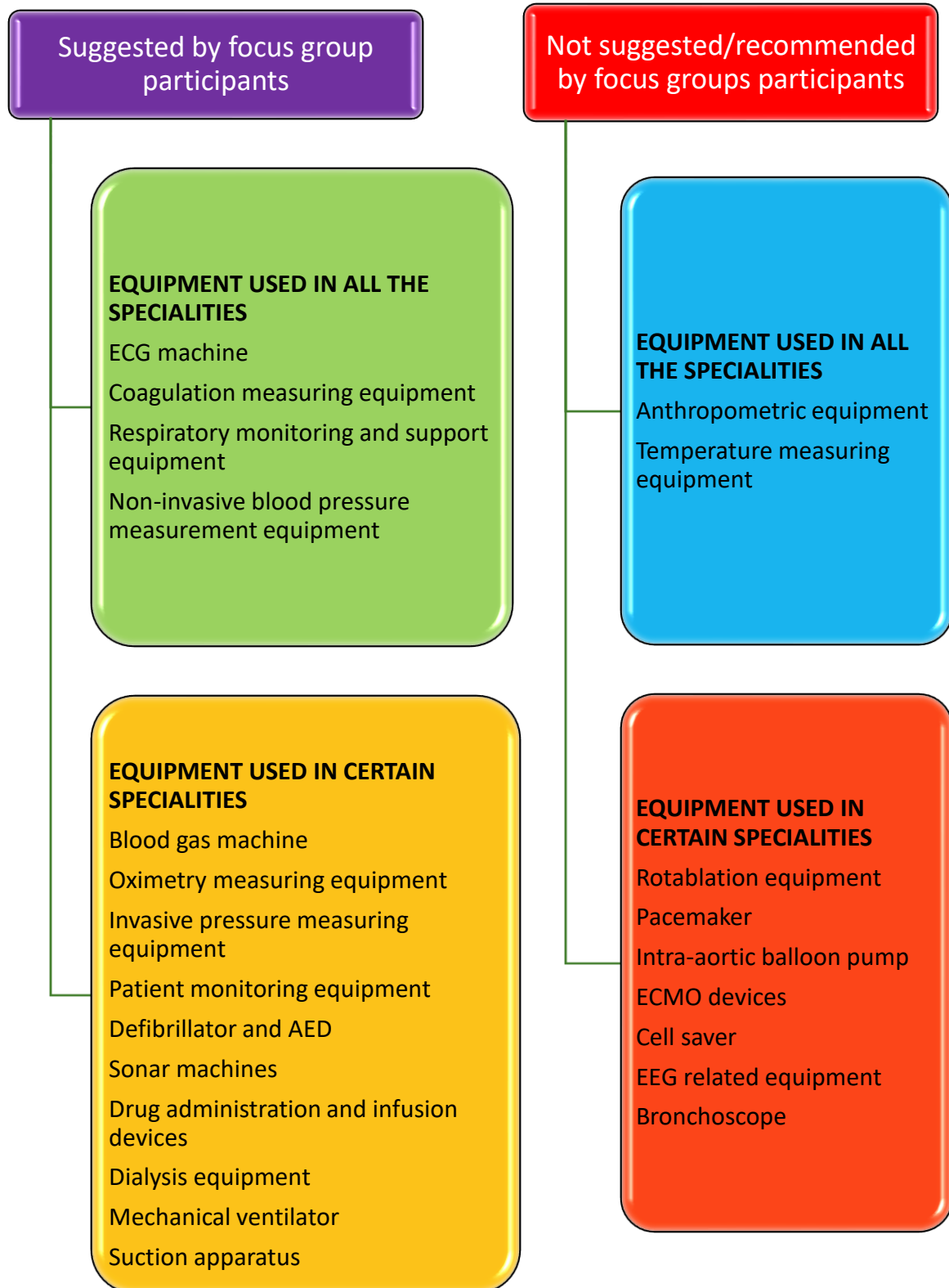


FIGURE 6.3 PROPOSED EQUIPMENT CATEGORIES
[COMPILED BY THE RESEARCHER, PERKINS 2020]

The equipment proposed in general by the focus group participants compared well with the clinical technology scope of practice as approved by the HPCSA. The area of concern falls within subcategory 1. The equipment categorised in this sub-group is related to basic procedures that fall into the scope of practice of all seven clinical technology specialities but were not mentioned by any of the focus groups. Therefore, it would be recommended that students be exposed to equipment from this category since focus group participants made it clear that a simulation programme's focus should be on the basic apparatus and skills.

- *“So I think with regards to basic biomedical apparatus, I think it's also important for the students to really know the basics as well....”* [F15].
- *“So, as previously mentioned, it's as simple things they actually have to start doing and the skills they build on that because you can't start with a specialized machine if you don't know your basics, actually.”* [W23].

Participants also strongly advocated that clinical technologists should not be trained to be equipment operators and that the focus in a simulation training programme should be on skills and not necessarily equipment.

- *“..... I think it's more important for teaching people skills....”* [W15].
- *“So I think the importance is more the skills than the equipment.”* [W22].
- *“But the main thing again is to teach them skills, not equipment.”* [W25].

The statements mentioned above also relate to the Fourth Industrial Revolution (4IR). Experts warn that caution should be taken if considered to eliminate the human element and replace them with artificial intelligence (AI). As with many healthcare providers, clinical technologists can use their clinical expertise to pick-up on physiological signs and symptoms to make an accurate diagnosis that an AI device might have missed. Over relying on technology and equipment for the sake of quality control should be avoided (Mahomed, 2018).

From the information gathered from the focus groups participants and literature, the equipment identified as the generic equipment and presented in Chapter 4 Fig 4.9 from the focus group analyses should form the basis of the equipment that should be included in a simulation laboratory for pre-specialisation clinical technology students. Specialisation specific equipment will be implemented secondarily to ensure that introducing the students to the

various clinical technology specialities is also met. Currently, the simulation unit at CUT is equipped with both generic and specialisation equipment.

6.2.2.4 SPECIALISED PROCEDURES

The specialised procedures deemed important by the focus group participants related to the technical and non-technical skills and the biomedical apparatus they felt were important students should be trained in. Specialised procedures were identified as the third theme in focus group area 2 and were reported in Chapter 4.

As with the biomedical apparatus, specialised procedures were categorized into generic and speciality specific procedures. The generic procedures mentioned in the focus group discussions were:

- Basic patient monitor set-up.
- Conduct and monitor arterial blood gas (ABG).
- Draw blood from a patient.
- Provide basic respiratory support to a patient.
- Conduct a basic 3-lead and 12-lead ECG.
- Set up an intravenous infusion set.

The other procedures that emerged from the focus group discussions were categorised per speciality and are summarised in Table 6.4:

TABLE 6.4 SPECIALISED PROCEDURES PER CLINICAL TECHNOLOGY SPECIALITY
[COMPILED BY THE RESEARCHER, PERKINS 2020]

Pulmonology	Critical Care	Cardiology	Reproductive Biology	Neurophysiology	Nephrology	Cardio-vascular perfusion
Spirometry	Set-up invasive pressure monitoring	Placement of ECG electrodes	None	Placement of EEG electrodes	Respiratory airway suctioning of a patient	Coagulation test
	Patient intubation	Set-up invasive pressure monitoring			Basic X-ray interpretation	
	Set-up of a ventilator	Hemodynamic monitoring				
	Basic ventilation interpretation					
	Draw blood from an A-line					

The teaching of specialised procedures to healthcare students may be achieved through simulation. For example, part-task trainers are especially well suited to train students in procedures such as phlebotomy, intravenous/arterial access and airway management. At the same time, computer-based and virtual reality simulations may be used for training students to set up a vital signs monitor and/or basic ventilation (Al-Elq, 2010).

Presently, in the CUT simulation laboratory, vital signs monitors are used for demonstration and allow students to practice setting up and monitoring the vital signs of a “patient”. The patient is represented by a high fidelity manikin SimMan™ Essential. Through various venous and arterial components and supplies, students are provided with the opportunity to learn the working, set-up and calibration of venous and arterial lines. The addition of a simple self-made system allows the student to practise the draw of an arterial blood gas with simulated blood. With the use of specific airway part-task trainers’ as mentioned in Al-Elq’s (2010) research, clinical technology students are taught the correct manner to perform airway management, e.g. securing an airway, correct use of a bag valve mask and intubation. The use of an upper-body manikin provides students with the opportunity to practice the placement of 3-lead and 12-lead ECG electrodes.

6.2.2.5 GRADUATE ATTRIBUTES

The University of Edinburgh provides an extensive definition and explanation for the term graduate attribute:

“What it means to be a graduate of a higher education institution not only in terms of a student skills level and ability but also in terms of attitude and approach.” (The University of Edinburgh, 2020). The method graduate attributes are acquired by students is more than just through a simple lecture about the topic and is confirmed by the following statement: *“Graduate attributes are not simply taught but developed through meaningful experiences and the processes of learning and reflection.”* (The University of Edinburgh, 2020).

The use of simulation has proved its ability to train and reinforce graduate attributes, especially non-technical skills such as leadership, teamwork, professionalism and decision making (Chen *et al.*, 2016). Nominal group members were asked to identify the graduate attributes they felt important pre-specialised clinical technology students should be trained in. Ten important themes related to graduate attributes were identified from the three nominal group interviews and are listed below:

- Professionalism and ethical behaviour – A person should have a professional work ethic be responsible, and act ethically.
- Teamwork and problem-solving – The graduate should be able to work as a functional team member with good critical thinking skills to resolve problems effectively.
- Receptive learning – Students should engage in learning independently with the pursuit of being a lifelong learner.
- Competency – Competent as a clinical technologist within their respective speciality.
- Technologically literate – The ability to use technology accurate and effective within the profession of clinical technology.
- Community engagement – Being sensitive toward the community and understanding the diversity within each society and community.
- Innovation – To be innovative and identify and pursue entrepreneurship opportunities.
- Communication – A clinical technologist should be able to communicate professionally with patients and other healthcare professionals.
- Knowledge about specialities – Students should have a good understanding of each speciality in clinical technology.
- Global citizenship - Being a good citizen and leader within a society country and ultimately globally.

Comparing the graduate attributes from the HPCSA and CUT with the graduate attributes identified from the nominal group interviews revealed both differences and similarities between the three groups and are demonstrated in Table 6.5.

TABLE 6.5 GRADUATE ATTRIBUTE COMPARISON BETWEEN THE HPCSA, CUT AND NOMINAL GROUP DISCUSSIONS⁴

[COMPILED BY THE RESEARCHER, PERKINS 2020]

HPCSA	CUT	Nominal Group Discussions
Communicator	Sustainable development	Professionalism and ethical behaviour
Collaborator	Community engagement	Teamwork and problem-solving
Leader & Manager	Entrepreneurship	Receptive learning
Health Advocate	Innovation and problem solving	Competency
Scholar	Technologically literate	Technologically literate
Professional	Numerate	Community engagement
	Communication	Innovation
	Technical and conceptual competence	Communication
	Teamwork	Knowledge about specialities
	Citizenship and Global Leadership	Global citizenship

Differences between the graduate attributes described by CUT and the graduate attributes mentioned by the nominal group discussions may be contributed that graduated attributes from CUT are generic, involving all the learning programmes offered by CUT, where graduate attributes from the nominal groups mainly focussed on clinical technology. However, more similarities than differences between the two before-mentioned groups were recorded with a 60% comparison between the two groups. The graduate attributes identified from the themes from the nominal group discussions compared well with both the graduate attributes listed by the HPCSA with an 80% comparison between the two groups. Therefore, the proposed strategy would be to align the graduate attributes pre-specialisation clinical technology students are exposed to, to the graduate attributes prescribed by the HPCSA from their first year of studying clinical technology. Therefore, maximum effort should be put in to instil the graduate attributes of both the CUT and HPCSA in clinical technology students from their 1st to 4th year of study. However, the maximum benefit of the HPCSA graduate attributes should only come to the forefront once the student reaches his/her 4th year of study.

⁴ Similar graduated attributes are illustrated with similar colours. Differences between the three groups are not highlighted.

6.3 INCORPORATION OF CLINICAL SIMULATION INTO THE CURRENT PRE-SPECIALISATION PHASE OFF THE CURRICULUM OF CLINICAL TECHNOLOGY AT CUT AS SUSTAINABLE TEACHING, LEARNING AND ASSESSMENT TOOL

To incorporate a clinical simulation programme as part of pre-specialised clinical technology students' training, it is important to understand where and how the programme can be included in the current curriculum. One of the themes (Theme 5) that were identified from Focus group area 2, Chapter 4, Section 4.4.2.2 was “*Modes of delivery*”. The question was put to the focus group participants through what mode of delivery they thought clinical simulation should be delivered to the students. This was one of the questions that the focus group participants found difficult to answer. In contrast to some of the other topics participants discussed in great detail, the mode of delivery seemed to be a topic the focus group members were not too familiar with. This can be explained because most of the WIL trainers and supervisors are, first and foremost, clinical technologists and are not necessarily acquainted with the educational term. However, certain important concepts related to the theme did emerge from the discussions.

6.3.1 GENERATIONAL GAP

A specific category recognized from Theme 5 was that WIL supervisors were well aware that they were dealing with a new generation of students and that the teaching methods should be altered accordingly. One of the statements from Focus group 2 emphasized this fact.

- “...., the overall teaching method is also changing. So we need to look at the generation we are working with. Currently, we are all experiencing problems with the current generation....” [F35].

Participants agreed that lecturers and WIL supervisors need to be aware of the fact that the new generation of students learns differently. A few important points on the possible teaching methods for this new generation of students emerged from this discussion.

6.3.1.1 KNOWLEDGE RETENTION

One of the aspects discussed on this topic was that it is important that students be taught the basic skills and should be able to revert to these skills and knowledge. This enabled the students to use the previous skills and knowledge as a stepping stone to progress to more advanced skills and was sub-categorised as “*knowledge retention*” under the category Teaching methods in Chapter 4 (Section 4.4.2.2). Simulation has proved to be an effective means to ensure the retention of specialised skills (Moazed, 2013). Research has also indicated that “*knowledge*

retention” is better achieved through multi-simulator sessions than a single simulation (Bassily-Marcus *et al.*, 2010). More recent research advocates that using the correct simulation modality is also essential to ensure better knowledge retention in students (Arcoraci *et al.*, 2019).

6.3.1.2 MENTORSHIP

Mentoring and mentorship as a teaching method are not new within the educational realm, and it was not surprising that the concept was mentioned as one of the possible teaching methods. It is important to differentiate between true mentorship and supervision because mentorship does not involve evaluation, whereas supervision usually incorporates some sort of compulsory evaluation. Mentorship is also voluntary, whereas a supervisor is an appointed position (Arnesson & Albinsson, 2017). Recent research indicated that using a dedicated mentorship programme with traditional mentorship and peer-mentorship helped improve mentees’ practical skills (Fard *et al.*, 2020). Because the 3RD and 4TH-year students are not on campus but busy with training in the WIL units, these year groups cannot act as peer mentors for the pre-specialisation students. However, the 2ND year students may be used as mentors for the 1ST year students, especially in the simulation environment. Local research agrees and proved that peer-mentorship helps facilitate novice students transition into clinical learning (Mlaba & Emmamally, 2019). By combining mentorship, clinical simulation, and clinical experience, student confidence towards moving from the university to the clinical environment may be enhanced (Dalgaty *et al.*, 2017).

6.3.1.3 DEMONSTRATION

Introducing students to skills through demonstration was another method suggested by the focus group participants to teach students. Using videos as a demonstration method has been indicated by research to be an effective method in teaching clinical skills, especially in junior students (Padmavathi *et al.*, 2019). One of the participants mentioned videos as a cost-effective teaching method and allows the students to revise specific skills by reviewing the video to refresh their memories. This would especially be effective if the video were freely available on a digital platform such as a website. Demonstration as a teaching method in combination with the correct technology can successfully be used especially by incorporating Peyton’s 4-step approach to teach specific skills and is discussed below in Section 6.3.1.6.

6.3.1.4 INTEGRATION OF KNOWLEDGE

Focus group participants mentioned that students should be able to integrate theoretical knowledge into practical experience. A known method of integrating theory with practice is through active learning. With active learning like simulation, the focus is placed on the development of skills. As mentioned above, a demonstration helps students be more engaged in learning through observation and discussions (Wrenn & Wrenn, 2009). Practical scenarios are discussed later in the Chapter (Section 6.3.2). However, practical scenarios are one way to assist with knowledge integration (Harrington & Simon, 2020).

6.3.1.5 REPETITION

Repetition of clinical skills is a teaching method that suits clinical simulation well. In research, it has been mentioned that clinical simulation lends itself towards providing the student with the opportunity to revisit the clinical simulation lab to practice and re-practice learned skills. Repetition forms part of a simulation session's core and helps students retain the knowledge gained during a specific session (Jones *et al.*, 2015). However, students' ability to reflect on sessions using debriefing and then repeat the simulation session has also proved beneficial to students' knowledge and confidence (Gharibi & Arulappan, 2020). Repetition also falls well within the Behaviourist learning theory described in Chapter 2 (Erlam *et al.*, 2017). Repetition should be focused on a deliberate practice methodology where the practice is focused on dedicated areas with specific outcomes (Perkins, 2007). In the clinical technology programme, students can practice the skills they lack expertise in under partial supervision. The students are allowed to practise the skills without the supervisor standing next to them. However, the supervisor is available should the students struggle or require additional assistance.

6.3.1.6 TECHNOLOGY

The use of technology, specifically computers and computer-based programmes, is synonymous with medical simulation. Using technology will benefit the newer generation student as one of the focus group participants mentioned:

- “So we need to understand that they love technology, they love their phones, they love the internet, they love music. So we need to incorporate our training by using these tools.” [F43].

The participant's statement is confirmed by research on the topic that indicated virtual reality and simulation used to produce realistic clinical cases would improve knowledge, skills and communication in students (Moran *et al.*, 2018).

On evaluating the teaching methods suggested by the focus group participants and considering that most of these participants are not formal educators, their suggested methods did not fall short by any means. Comparing the participants' suggested methods with Peyton's 4-steps approach to teach skills, many similarities are noted. Peyton's 4-steps are listed below:

- Demonstration - Demonstration of skill by the teacher at normal speed without commentary.
- Discussion - Demonstration of skill by the teacher whilst providing explanation and discussing with students.
- Comprehension - Demonstration of skill by the teacher, with instructions and explanation provided by students.
- Execution - Demonstration of skill by the student, with commentary and instructions from other students (Münster *et al.*, 2016).

The four-step method has been adapted by Khan (2020) specifically to accommodate an online format by demonstrating clinical skills on simulated patients and manikins utilizing videos posted on an easily accessible platform, e.g. YouTube.

- 1) Demonstration: Demonstration of skill with video, at normal speed without commentary.
- 2) Discussion: Discussion of skill with the teacher, augmented with multiple short video clips.
- 3) Comprehension: Narration of skill by students, with help from other students.
- 4) Consolidation: Q&A and clinical contextualisation (Khan, 2020).

The adapted method doesn't just make use of technology that appeals to the new generation student and incorporated peer-assisted learning and revision by making the video available on an easily accessible internet platform.

6.3.2 PRACTICAL SCENARIOS

Another theme that emerged from both the focus group discussions and the three nominal group interviews were practical scenarios and the use of practical scenarios as a part of a simulation programme (Section 4.4.2.2 and Section 5.4.1.1). Practical scenarios as part of the medical simulation are defined as follows: “A simulation scenario is an artificial representation of a real-world event to achieve educational goals through experiential learning.” (Harrington & Simon, 2020).

Based on the discussion’s participants indicated that practical scenarios had the potential to contribute to the pre-specialisation clinical technology students’ training.

- “Yes, so I think *particles scenarios is very important.....*” [W28].

However, two important aspects were raised by the focus group participants regarding practical scenarios:

- 1 Practical scenarios should be as realistic as possible.
 - 2 Practical scenarios were not to replace unit visits.
- “*It must be a very stressful environment to simulate the real world like in theatre or anything that goes wrong with our patients, it’s for them to understand, and they need to know how to react to it.*” [F50].
 - “*I do feel simulation should not replace your practical exposure and your simulation, the approach needs to be changed to be to be on the same level as the clin techs it, and it needs to be most realistic scenario possible that it can be, then I think it will work.*” [F52].

Heigel (2017) agrees that practical scenarios, especially high-fidelity scenarios, should be as authentic as possible to prepare students for the clinical environment they will be working in. The focus group participants discussed the practical scenario theme along two lines, firstly the importance of practical scenarios as mentioned above and secondly, how practical scenarios may be used as a training tool. From the discussions, the following facets regarding the use of practical scenarios could be listed:

- Knowledge gain.
- Knowledge retention.
- Exposure to specialities.
- People skills.

- Management of stress.

The nominal group participants felt that practical scenarios would provide the students with the opportunity to be exposed to “*real life*” within a safe environment with the possibility to expose students to multiple scenarios (Section 5.4.1).

As discussed in Chapter 2 (Section 2.7.3), both live and virtual simulations lend itself to the creation of realistic, practical scenarios. Practical scenarios provide lecturers with an additional teaching tool to train students in specific clinical topics (Pettersson *et al.*, 2017). Using a practical scenario is a valid teaching tool because it promotes learning and critical thinking (Abuzaid & Elshami, 2016).

Nickson and co-workers (2020) suggest that the following questions should be asked to create realistic, practical scenarios:

- Is the scenario aligned with the objectives?
- Is it feasible?
- Is it appropriately challenging?
- Is it physically and psychologically safe (Nickson *et al.*, 2020)?

Practical scenarios are designed for the following reasons:

- Assessment.
- Education.
- Identification and bridging gaps within the knowledge of students.
- Integration of knowledge.

As mentioned above, practical scenarios may be used as a means of assessment; however, research advocates that when practical scenarios are to be used for assessment purposes, it should be set up in such a manner that students will perform well. In contrast to its use as an assessment tool, practical scenarios used for training purposes should be set up so that it is challenging to promote growth in the students (Harrington & Simon, 2020). The statement above relates well to “*Zone of Proximal Development*”, defined by Vygotsky as the difference between what skills a student can perform on his/her own versus the skills students can perform with the assistance of an experienced partner or lecturer (Fletcher, 2018). Understanding which skills learners are capable and comfortable in performing will assist the educator in setting up

simulations in such a manner that they challenge the students so that learning and development may occur. Kurt agrees that tasks should be challenging to keep the student's interest. However, assessments should cover a range of the student's abilities (Kurt, 2020).

6.3.3 IMPORTANT ISSUES REGARDING PRACTICAL AND SKILLS TRAINING

From focus group area 4, as discussed in Chapter 4 (Section 4.4.2.4), important issues regarding the practical and skills training were identified by the focus group members, namely:

- The application of theoretical knowledge in practice.
- Knowledge of basic skills.
- A practical training or simulation programme should be goal-directed.
- A simulation programme should be integrated into the current clinical technology curriculum.

6.3.3.1 APPLICATION OF KNOWLEDGE

One of the focus group participants commented: *"Students are book smart and not street smart. So they perhaps know theory from the book, but they don't know how to apply it..."* [F24]. Nominal group discussions also identified the application of knowledge as a priority statement: *"Allows the student to test theory and apply in a clinical setting."* from nominal group 3 as demonstrated in Chapter 5, Table 5.4. Clinical technologists are specialists and professionals in their own right and need to be experienced and skilled to perform their tasks with precision. Students seem to gain experience in practical skills on their own time and ability as mentioned by one of the focus group members from focus group 1 *"And, I also think, students who are very practically inclined, pick up the skills quickly in the beginning. And those are more theoretically inclined take a little bit longer..."* [W22]. The before-mentioned may be linked to 21ST-century children not being able to demonstrate critical thinking skills. Halton (2019) states that adults have to deal with complicated situations in real life and even more so for the person working as a healthcare provider. Therefore, lecturers need to be encouraged not just to ask *"how"* or *"why"* to students but also should encourage students to solve problems and defend their solutions and choices (Halton, 2019). One of the methods used to promote critical thinking is scaffolding, a teaching technique and process, where students are exposed to prompts, supports and modelling that assist the students in completing complex tasks (Browne *et al.*, 2009). Davis *et al.* (2017) suggest that scaffolding in simulation is generally seen as an information organisation. This information may result from prior knowledge the student

possessed or information lecturers shared to which new information may be anchored (Davis *et al.*, 2017).

As discussed in Chapter 2 (Section 2.7.4), one of the known advantages of clinical simulation is the transference of classroom knowledge to real-life situations (Al-Elq, 2010). Simulation has demonstrated that knowledge retention is better after applying the knowledge in a practical simulated environment (Botma, 2014). By integrating simulation into a healthcare curriculum, the resultant effect may be better-exposed students and experienced healthcare professionals (Eyikara & Baykara, 2017).

6.3.3.2 KNOWLEDGE OF BASIC SKILLS

Emphasis was placed by both focus group discussions that students should be trained in basic skills. Basic skills emerged as a category from Theme 1, namely Clinical skills and Theme 2 from focus group area 4, as presented in Chapter 4 (Section 4.4.2.4). Students' basic skills development during their university phase was also identified by the nominal group 2 and was ranked as one of the “*top five*” statements from this group's discussion (Chapter 5, Table 5.3). Therefore, the conclusion can be made that clinical technologist student knowledge and experience in basic skills are seen in a very important light by WIL supervisors and lecturers. Literature dictates that basic skills are best taught to students utilizing low-fidelity simulation and task trainers (Naylor & Torres, 2019).

Basic skills as mentioned by the focus group participants and discussed earlier in this chapter, Chapter 6 (Section 6.2.2.2; Technical skills) included anthropometric measurement, the use of a stethoscope, respiratory and airway management, blood pressure measurement, ECG, vital signs, patient movement and transport, basic life support and infection control. In addition, basic healthcare skills have been proven to be easily taught to students through simulation (Srinivasan *et al.*, 2017). Currently, students are taught through demonstration of the required basic skills. These demonstrations may either be by the lecturer or a video. Part-task trainers are then mainly used to allow students to practise the basic skills, and in some cases, SPs are also used primarily for skills such as anthropometric and blood pressure measurements.

6.3.3.3 GOAL-DIRECTED SIMULATION

Focus group participants felt that a training programme involving the training of practical and clinical skills to clinical technology students should be goal-directed. Measurable objectives are mentioned by literature as one of the key criteria regarding successful simulation development (Lioce *et al.*, 2013). Simulation is goal-directed in its totality and if broken down into specific simulation modalities (Motola *et al.*, 2013). The literature agrees with the focus group participants' suggestion of a goal-directed programme with well-defined outcomes and educational goals (Jones *et al.*, 2015). The clinical technology programme currently has a well-structured curriculum, especially regarding practical subjects. Therefore, it is unnecessary to revise the curriculum but rather re-evaluate aspects such as practical training that are offered to the pre-specialised clinical technology students. In addition to the revision of the practical training, staff members need to be trained accordingly in simulation. Currently, only one staff member in the clinical technology programme is trained in simulation, and this staff member needs to initiate the initial implementation of the proposed simulation framework.

6.3.4 INTEGRATION OF A SIMULATION PROGRAMME INTO A CURRICULUM

Focus group members from both focus group discussions indicated that a clinical simulation programme should be integrated into the current curriculum. One focus group participant suggested that the programme be incorporated as a separate subject, whereas another participant proposed that a simulation programme be incorporated as an additional module to the current subjects.

A variety of different simulation-based training strategies exists and are described by the literature as follows:

- Deliberate practice – This type of training strategy usually consists of specific detailed outcomes and is used to enhance students' performance and skill development using focused and repetitive practice sessions and detailed feedback on their performance.
- Simulation-based mastery learning – This training strategy encourages the student to develop specific skills, very similar to the concept of the student becoming the “*master*”.
- Just-in-time training – as described by the term, this type of strategy implemented just before the student is required to perform the required procedure on a patient. It does not

necessarily refer to newly acquired skills but can also be effectively used to refresh previously learned skills.

- Low-dose, high-frequency training – This strategy is known for its short and well-targeted training sessions. It is especially useful in the work environment to ensure a required level of performance and competency (Sullivan *et al.*, 2019).

The proposed clinical simulation framework for the pre-specialisation student at CUT will make use of a “*deliberate practise strategy*.”

As described in Chapter 2 (Section 2.7.4), for a successful simulation programme, the programme must be integrated into a current curriculum (Motola *et al.*, 2013). Motola *et al.* (2013) further advocate that the integration of a simulation programme should take place in four phases, namely:

1. Planning phase: This is an important phase of the implementation of a clinical simulation programme and is recognised by identifying specific outcomes, the availability of resources, mode of delivery, development of simulation-based content and how the programme will be logistically and financially supported.
2. Implementation phase: With this phase, the simulation-based programme are implemented, and any possible issues are identified and rectified.
3. Evaluation phase: Once the programme has been implemented, the programme must be evaluated to assess if both learners and instructors are satisfied with the outcomes.
4. Revision phase: Based on the results from the evaluation phase, revisions can be done during this phase to optimise the programme (Motola *et al.*, 2013).

From the four steps mentioned above, the current proposed clinical simulation framework is in its planning phase. Focus group and nominal group discussions, specific outcomes, content, and modes of delivery have been identified from the literature. The set-up of a simulation laboratory with particular reference to the resources needed and space required are discussed in the next section.

6.3.5 SIMULATION RESOURCES

Resources or supplies required for a simulation laboratory can be divided into two segments, namely “*hardware*” and “*supplies*”. Therefore, it is essential to secure funding and set up a

comprehensive budget to procure resources needed within a simulation laboratory. In addition to funding, partnerships with companies that might usually dispose of expired medical items may be arranged to reallocate those items scheduled for disposal to the simulation laboratory (Lazzara *et al.*, 2014).

Focus group participants expressed their concerns regarding the possible costs related to simulation, especially regarding equipment. A variety of methods do exist to minimise the cost related to the set-up and maintenance of a simulation laboratory. Using low fidelity simulators, *in-situ* training, and standardised patients are simulation methods less costly and more sustainable (So *et al.*, 2019).

An initial budget for the establishment of a simulation laboratory may be quite extensive, and careful consideration should be taken to include the following possible expenses:

- Designing and building of new venue or renovation of a current venue.
- Equipment (general medical, simulation specific equipment and props).
- Information technology, audio and digital equipment and software.
- Medical supplies (Rothgeb, 2008).

Costs related to a simulation laboratory can mainly be divided into three categories and are illustrated in Figure 6.4:

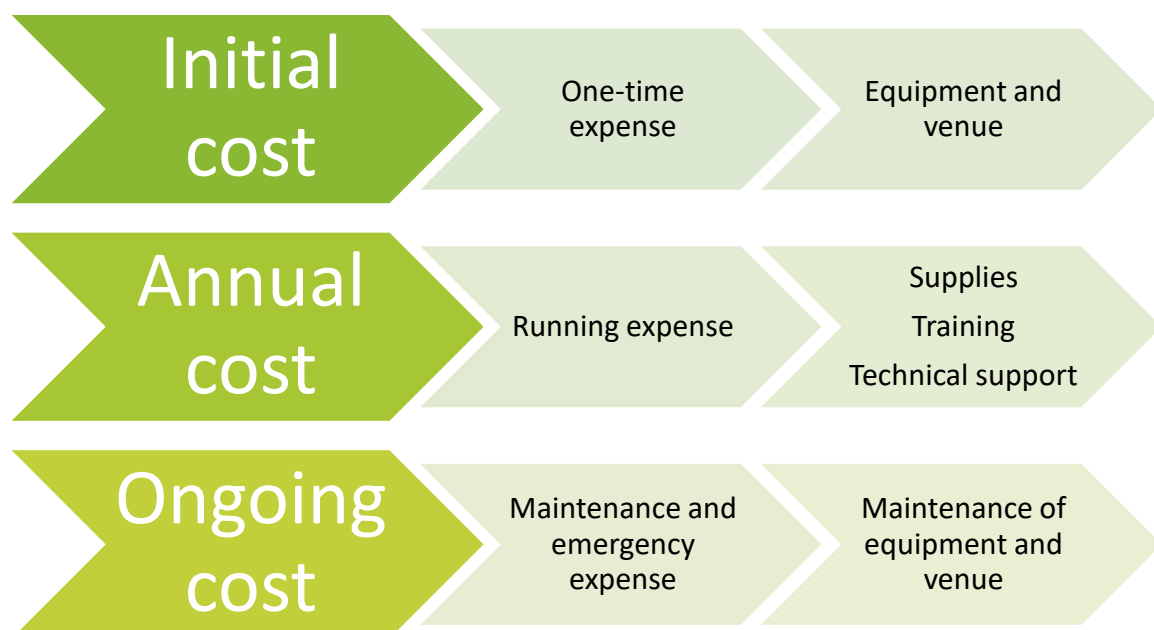


FIGURE 6.4 SIMULATION LABORATORY COST CATEGORIES

[COMPILED BY THE RESEARCHER, PERKINS 2020 WITH DATA FROM (GREENWALT & BRZYCKI, 2007)]

General equipment requirements for a simulation laboratory are very similar to the equipment found in various clinical settings. Equipment includes but is not limited to hospital beds, intravenous equipment, wheelchairs and medical monitors (Labuschagne, 2012). The current equipment available for simulation training at CUT includes various medical apparatus (mechanical ventilator, vital signs monitors, digital blood pressure monitors, a dialysis machine and an ECG machine), task trainers and one high fidelity manikin (SimMan™ Essential). The programme also has access to Department of Higher Education and Training (DHET) funds that may be used to procure the necessary equipment. As discussed in Chapter 4, focus group members have indicated the importance of exposing clinical technology students to basic and specialised medical apparatus. Establishing a clinical simulation framework for pre-specialisation clinical technology students must consider this list.

Medical simulators are complex, and a variety of different types and models are available. A simulation programme creator will need to evaluate the required curriculum outcomes, obtain simulators that fall within the allocated budget, and produce the desired knowledge and skill acquisition. The different types of simulators and their respective use within the simulation environment were discussed in Chapter 2, Table 2.6.

A vital component of a simulation laboratory is the physical venue where the simulation is conducted. Careful planning should go into the design and building of a simulation laboratory. A key factor to the initial set-up of a simulation laboratory is the Faculty's buy-in (Healthy Simulation, 2020).

A simulation laboratory would ideally consist of various rooms, each one with a different function. The simulation room's primary purpose is to mimic different hospital locations, e.g. intensive care units, the theatre or a maternity ward. The type of simulation room depends on the purpose of the simulation and the desired outcome of the simulation. For example, if the room's purpose would be for a medical student to examine a patient, the room will essentially resemble a typical exam room and the equipment associated with such a space (Healthy Simulation, 2020).

Larger simulation centres also use control and observation rooms, especially where high-fidelity manikins need to be manipulated, and simulation scenarios are run without instructor interference (Labuschagne, 2012). Another vital area essential to any simulation laboratory is a storage room and space. In these areas or rooms, expensive equipment, manikins, and other supplies may safely be stored (Baily, 2019).

6.4 SIMULATION FRAMEWORK

The purpose of the proposed clinical simulation framework for pre-specialisation clinical technology students is to be sustainable and complement the current clinical technology curriculum currently offered by CUT (Motola *et al.*, 2013). The reasons for implementing the before-mentioned simulation framework compares well with the reasons described by the literature:

- Teaching student procedural skills.
- Teaching and assessment of the student's communication skills.
- Training students to be part and be contributing members of a healthcare team.
- Familiarizing students with sound clinical decision making (Felix & Simon, 2019).

By using the cognitive load theory, as described in Chapter 2, the proposed clinical simulation framework was designed implementing the following concepts:

- Provide learners with the opportunity to come up with as many possible answers to a problem.
- Set specific simulations up to reduce the extraneous cognitive load ensuring maximum learning opportunity.
- Using a step-wise approach in teaching students, starting with simple skills before attempting more complex skills and procedures.
- Starting with low fidelity simulation, the end goal is for a student to successfully negotiate a high fidelity simulation scenario (Reedy, 2015).

For the simulation programme to be sustainable, Lazzara recommends simple techniques that can be used to promote the buy-in from the students and the personnel (Lazzara *et al.*, 2014). However, it is important to train staff and lecturers in the use of simulation to further ensure the programme's sustainability (Labuschagne *et al.*, 2014). Lecturers may be trained via either

short or online courses in the use of simulation in health education as currently presented by institutions such as the University of the Free State's Clinical Simulation and Skills Unit.

Currently, the pre-specialisation clinical technology students' practical component is incorporated into two subjects, the first-year subjects CTP115 and CTI125 and the second-year subject CTP206 (CUT, 2019). Practical sessions are held with the students to expose and train the students in technical skills such as measuring non-invasive blood pressure. Measurement of blood pressure was one of the technical skills focus group participants felt an important skill to teach students. As discussed, blood pressure was only one of many technical and non-technical skills mentioned by the focus group participants. By incorporating these skills and required procedures in a formal simulation programme, students will be able to be trained in the skills and be assessed to ensure competency (Weller *et al.*, 2012).

Considering previous and current literature and the data collected from the focus group and nominal group discussions, the following simulation framework is proposed for inclusion into the existing clinical technology curriculum to train pre-specialisation clinical technology students.

The proposed simulation framework for pre-specialization clinical technology students are presented in Table 6.6, according to the following four levels:

1. Instructional medium – Textbook, lectures, computer-based simulation.
2. Simulation modality – Computer-based simulation, simulated patient (SP) simulated clinical immersion or procedural simulation.
3. Instructional method – Self-instruction (self-directed learning) or instructor-based learning.
4. Presentation – Feedback, fidelity, type of simulator, scenario (Chiniara *et al.*, 2013).

The required skills in the proposed framework are presented in order from importance and difficulty level, starting with the most basic skills such as infection control and progressing to more advanced skills, e.g. hemodialysis. It is important to keep in mind that the simulation framework is focused on the 1ST and 2ND year pre-specialisation students within the clinical technology program. The framework was further developed, referring to instructional medium and simulation modality, mainly by employing Gagne's nine events of instruction (Cheung, 2016). By using three known qualitative research methods, namely literature review, focus

group and nominal group meetings, all the information and data were triangulated to develop the simulation framework for pre-specialisation clinical technology students.

TABLE 6.6 PROPOSED CLINICAL SIMULATION FRAMEWORK

[COMPILED BY THE RESEARCHER, PERKINS 2020]

Required skill	Level 1 Instructional medium	Level 2 Simulation modality	Level 3 Instructional method	Level 4 Presentation
Infection control	Lectures	Procedural	Instructor-based learning	Low-fidelity
Communication	Lectures & video	Simulated patient	Self-directed learning	Low-fidelity
Anthropometric measurement	Lectures & instructor demonstration	Simulated patient	Self-directed learning	Low-fidelity
Measuring pulse rate	Lectures & instructor demonstration	Simulated patient & simulation manikin	Instructor-based learning	Low-fidelity
Measuring respiratory rate	Lectures & instructor demonstration	Procedural simulation	Instructor-based learning	Low-fidelity
Basic respiratory support	Lectures & instructor demonstration	Procedural simulation	Instructor-based learning	Low-fidelity
Patient movement and transport	Lectures, instructor demonstration & video	Simulated clinical immersion	Instructor-based learning	High-fidelity practical scenario
Communication and graduate attributes	Lectures	Simulated patient	Self-directed learning	Low-fidelity
Blood pressure measurement	Lectures & video	Simulated patient	Instructor-based learning	Low-fidelity
Use of a stethoscope	Lectures & instructor demonstration	Procedural simulation	Instructor-based learning	Low-fidelity
Measuring oxygen saturation	Lectures & instructor demonstration	Procedural simulation	Instructor-based learning	Low-fidelity

Required skill (cont.)	Level 1 Instructional Medium (cont.)	Level 2 Simulation modality (cont.)	Level 3 Instructional method (cont.)	Level 4 Presentation (cont.)
Intra-venous set-up	Lectures & instructor demonstration	Procedural simulation	Instructor-based learning	Low-fidelity
Set-up of an intra-venous pressure line	Lectures & instructor demonstration	Procedural simulation	Instructor-based learning	Low-fidelity task trainer
ECG measurement	Lectures & instructor demonstration	Procedural simulation	Instructor-based learning	Low-fidelity task trainer
Blood gas analysis	Lectures	Computer-based simulation	Self-directed learning	Low-fidelity
Basic respiratory support	Lectures & instructor demonstration	Procedural simulation	Instructor-based learning	Low-fidelity task trainer
Mechanical ventilation	Lectures & instructor demonstration	Computer-based simulation	Instructor-based learning	Low-fidelity
Infection control (advanced)	Lectures	Simulated clinical immersion	Instructor-based learning	High-fidelity simulation manikin
Communication	Lectures & Video	Simulated patient	Self-directed learning	Practical scenario
Blood pressure measurement	Lectures, video & instructor demonstration	Simulated patient	Instructor-based learning	Low-fidelity
Vital signs measurement	Lectures & instructor demonstration	Simulated clinical immersion	Instructor-based learning	High fidelity simulation manikin
Airway management	Lectures & instructor demonstration	Procedural simulation	Instructor-based learning	Low fidelity task trainer
Respiratory support	Lectures & instructor demonstration	Procedural simulation	Instructor-based learning	Low fidelity task trainer

Required skill (cont.)	Level 1 Instructional Medium (cont.)	Level 2 Simulation modality (cont.)	Level 3 Instructional method (cont.)	Level 4 Presentation (cont.)
Intubation	Lectures, video & instructor demonstration	Procedural simulation	Instructor-based learning	High fidelity simulation manikin
Defibrillation	Lectures & instructor demonstration	Computer-based simulation	Instructor-based learning	Low-fidelity Virtual reality
X-Ray	Lectures	Simulated patient	Instructor-based learning	Practical scenario
ECG measurement	Lectures & instructor demonstration	Procedural simulation	Instructor-based learning	Low fidelity task trainer
Hemodialysis	Lectures & instructor demonstration	Computer-based simulation	Instructor-based learning	Virtual reality
Spirometry	Lectures & instructor demonstration	Simulated patient	Instructor-based learning	Practical scenario
Basic Life Support	Lectures & instructor demonstration	Simulated clinical immersion	Instructor-based learning	High fidelity, simulation manikin

6.5 CONCLUSION

Chapter 6 provided insight into the specific requirements for developing a sustainable clinical simulation programme for pre-specialisation clinical technology students. The clinical simulation programme requirements were gathered through a literature review, focus group interviews, and nominal group interviews.

Various facets were evaluated, including the importance and role of clinical simulation, the technical skills, biomedical apparatus and specialised procedures that should be included in a clinical simulation programme for clinical technology students. The non-technical skills and specific graduate attributes necessary for a clinical technology student to become a professional healthcare worker were discussed in addition to the before-mentioned. The resultant outcome

from the evaluation of different facets led to developing a detailed clinical simulation framework that may be used in the training of pre-specialization clinical technology students. In the next chapter, Chapter 7, this research study's conclusion, recommendation, and limitations are discussed.

CHAPTER 7: CONCLUSION, RECOMMENDATIONS AND LIMITATIONS OF THE STUDY

7.1 INTRODUCTION

The researcher did an in-depth study to acquire information to develop a sustainable simulation framework for pre-specialisation clinical technology students. The framework aims to provide additional training methods to augment clinical technology students' current training.

This study aimed to develop a sustainable clinical simulation framework for clinical technology students in the pre-specialisation phase. A clinical simulation framework with general and specific outcomes for students would help students obtain specific skills and be exposed to certain apparatus and procedures. The proposed skills and graduate attributes a clinical technologist student require should be incorporated as part of a clinical simulation framework. The chapter aims to provide a short overview of the study and present comments and a few final remarks. The chapter starts with an overview of the study, followed by the conclusion, limitations related to the study, recommendations, the study's contribution, and a conclusive remark.

7.2 OVERVIEW OF THE STUDY

Currently, no formal clinical simulation programme exists at CUT, and with the findings of this research, such a programme may be established and incorporated as part of the current curriculum. The motive for incorporating a clinical simulation programme lies within various current problems healthcare students experience when entering the WIL environment. Students not experienced in certain basic skills feel stressed, anxious, and confident to enter into WIL (Jamshidi *et al.*, 2016). In addition to students being exposed to basic skills through simulation, patient safety and satisfaction are also addressed (Kuo *et al.*, 2020).

Clinical technology is an established healthcare profession within South Africa, directly and indirectly, responsible for the health and wellbeing of a variety of patients (SAQA, 2015). It is important to ensure that students gain experience in the appropriate and relevant skills associated with the profession and the disease profiles that fall within the clinical technologist's scope of practice.

For students to gain experience in a specific skill set, students need to practice the required skill. Compromising on patient safety and wellbeing is not negotiable and clinical simulation proved to be an acceptable alternative for students to acquire the necessary experience (Lateef, 2010). The lack of clinical placement opportunities and positions is a recognised challenge globally, and clinical technology is not excluded from this problem and will need to use alternative methods such as clinical simulation to address this problem (Weller *et al.*, 2012). A clinical simulation programme may include basic procedures and one or two specific skills related to the seven specialities in clinical technology (Motola *et al.*, 2013).

To obtain guidance and information to develop a clinical simulation framework for clinical technology students, the researcher made use of three known qualitative data collection methods:

- Literature review.
- Focus group discussions.
- Nominal group interviews.

Due to the outbreak of COVID-19 and the associated restriction on movement and gatherings, the focus group and nominal group interviews could not be conducted face-to-face, and the research protocol was amended to facilitate these meetings online. Meetings were held via the Microsoft® Teams application, and two focus groups and three nominal groups were conducted. To achieve the research objectives set out for the study, the researcher approached the tertiary institution's personnel and WIL supervisors and lecturers to provide answers to the research questions.

The required information for the study was gathered by asking three research questions. The three research questions' answers were derived from the literature and data collected from the focus, and nominal group interviews incorporated as part of the study methods and analysed to achieve the study outcome. Chapter 1 provided an outline for the research questions, and the following subsections Point, 7.2.1 to Point 7.2.3 provides a review of the three research questions, the main findings and outcomes for each research question.

7.2.1 RESEARCH QUESTION 1

Question 1:

- “How can clinical simulation can be used to enhance the practical training programme of clinical technologists at CUT?”

Objective pursued:

- Develop a conceptual, clinical simulation framework to enhance the practical training programme of clinical technology at CUT. This objective was achieved with the literature review, focus group interviews, and nominal group interviews.

To develop a clinical simulation framework, it is important to understand how simulation can be used as an additional training method. The purpose of research question 1 was to better understand the role and importance of clinical simulation in clinical technology students’ training. Chapter 2 provided a comprehensive understanding of the clinical technology healthcare professional and the profession (Section 2.2 and Section 2.4). Due to clinical technology being simulation naïve, it was essential to understand how simulation is currently used in other professions and, specifically, other healthcare professions (Section 2.7.2 and Section 2.8). From the focus group discussions, the importance of clinical simulation and the possible role clinical simulation may play in clinical technology emerged from the data and were reported in Chapter 4 (Section 4.4.2.1 and Section 4.4.2.2). The clinical simulation’s possible role was further confirmed from the nominal group discussions in Chapter 5 (Section 5.4.1).

7.2.2 RESEARCH QUESTION 2

Question 2:

- “How can clinical simulation be incorporated into the current pre-specialisation phase off the curriculum of clinical technology as sustainable teaching, learning, and assessment tool?”

Objective pursued:

- Provide guidelines on how clinical simulation can be incorporated in the pre-specialisation phase of the current clinical technology curriculum. This objective was achieved by using Focus Group interviews and Nominal Group interviews.

Clinical simulation is used as a training method. To use clinical simulation correctly and optimally, it is important to understand how students learn. Chapter 2 (Section 2.6) provided insight into the learning theories and, more specifically, which learning theories specifically lend themselves to simulation (Section 2.6.19). Clinical simulation as a training and assessment method has proven to be successful. Chapter 2 (Section 2.7.4 and Section 2.7.5) provided evidence of this specific role of clinical simulation, which also emerged from the nominal group discussions (Section 5.4.1.1). Focus group discussions provided further insight into how simulation may be delivered to students (Section 4.4.2.2). Special reference to the skills and practical simulation scenarios from both the focus group and nominal group interviews were made to be incorporated into a current training programme (Section 4.4.2.2 and Section 5.4).

7.2.3 RESEARCH QUESTION 3

Question 3:

- *“What specific procedures, generic and specific, clinical skills and graduate attributes should be included in a practical training programme for clinical technologists during the first two years of study to ensure the delivery of competent and skilled students to WIL units?”*

Objective pursued:

- Determine what specific procedures, both generic and specific, together with clinical skills (including graduate attributes) should be included as part of the practical simulation training programme for clinical technologists during the first two years of study to provide/deliver a competent and skilled student entering the WIL unit. This objective was achieved with Focus Group interviews.

The scope of practice of the different clinical technology specialities provided a base answer to this research question (Section 2.4). However, the focus groups and nominal group discussions yielded vast amounts of information to form a conclusive answer to what specific skills, procedures, and graduate attributes should be included in a clinical simulation framework that falls in the clinical technologist’s scope of practice.

- i) **Skills:** From the focus group discussions, the skills that the group members mentioned were divided into non-technical and technical skills, with detailed information on the specific skills as reported in Chapter 4 (Section 4.4.2.2).
- ii) **Equipment:** The focus group discussion provided additional insight into the question of which medical equipment pre-specialisation clinical technology students should be trained in (Section 4.4.2.2). A summary of the equipment is provided in Figures 4.9 and 4.10.
- iii) **Specialised procedures:** As with the skills and equipment focus, group members provided detailed data on the required specialised procedures (Section 4.4.2.2 and Figure 4.11.)
- iv) **Graduate attributes:** Literature, as discussed in Chapter 2, revealed the importance of graduate attributes but also how the tertiary institution CUT and managing professional body HPCSA defines and describe graduate attributes (Section 2.5). The nominal groups delivered detailed answers to establish which graduate attributes personnel from various tertiary institutions find important as part of the clinical technology student's knowledge base to integrate successfully into WIL (Section 5.4.2).

7.3 CONCLUSION

The use of clinical simulation in clinical technology students' training lacks in South Africa, and the researcher identified this gap. The vast majority of healthcare professions have fully or partially incorporated simulation into their training programs and curriculums. As healthcare providers, clinical technologists are responsible and involved in the diagnostic and therapeutic treatment of patients and have not yet included clinical simulation formally into their training programme. The reason might be that no formal clinical simulation framework currently exists.

Clinical technology is not excluded from the many similar problems and issues other healthcare professions experience with their students' clinical training. Through the analyses of focus group and nominal group interviews, the researcher has proved that clinical simulation can play an important role in addressing many of the problems currently experienced in clinical technology students' training. Training of healthcare students requires that a student must be exposed to real-life patients and other healthcare professionals. Patients' safety is imperative, and patients cannot be used as a singular entity and test ground to train students. Literature

indicated that junior students find initial integration into healthcare intimidating. The researcher compiled a comprehensive list of skills, equipment, and procedures that a clinical technology student should be trained in before entering WIL from the data generated by the focus group members. Incorporating these requirements into a clinical simulation framework will provide the educators with the tools to build on the students' knowledge and confidence to successfully integrate into WIL. The researcher further provided guidelines derived from the literature (Chapter 2) and the focus group's data on how clinical simulation can be incorporated into a current curriculum successfully.

As a professional and carer responsible for patients' wellbeing, clinical technologists are required to act in such a manner to manage patients safely and promote their profession as a fundamental part of the healthcare system in South Africa. Theoretical knowledge and the ability to perform specialised skills confidently are essential in a clinical technology student's training. The combined information from the literature (Chapter 2) and data from the nominal groups helped the researcher compile a list of graduate attributes both the industry and personnel find essential for a clinical technology student to merge into his/her professional persona. The aforementioned will help the student function and communicate successfully as an experienced individual and as part of a complex healthcare team.

Triangulating the data from the literature, focus group, and nominal group meetings helped the researcher develop a clinical simulation framework to incorporate simulation training in the pre-specialised clinical technology training programme to train better-prepared students for WIL.

7.4 LIMITATIONS OF THE STUDY

The researcher recognised some limitations in the study. The clinical technology profession's unfamiliarity with clinical simulation yielded some uninformed responses, especially from focus group members in certain clinical technology specialities.

The study mainly focused on establishing a framework for pre-specialisation students but could have been extended to include students currently specialising within their respective fields.

7.5 CONTRIBUTION OF THE RESEARCH

The research could make a valuable contribution to the future training of clinical technology students at tertiary institutions in South Africa. The study laid the foundation for the implementation of clinical simulation into the curriculum of clinical technology. This opens the door for future research to further enhance clinical technology students' theoretical and practical training.

The resultant effect of implementing the framework into the current curriculum will lead to better patient safety. In addition to their contribution to patient healthcare, students could be better prepared to proceed with their further studies as clinical technology specialists. Clinical technologists will be able to increase their contribution to the current healthcare system on a professional level.

This study's findings allowed for the development of an additional accredited method to assess students' theoretical and practical knowledge and perform student competency evaluation.

The study's overall purpose was to develop a sustainable clinical simulation framework that can be implemented into the current clinical technology curriculum in South Africa. The study results lead to the first clinical simulation framework for pre-specialisation clinical technology students in South Africa.

7.6 RECOMMENDATIONS

For the developed clinical simulation framework to contribute to its full potential, the researcher takes the liberty to make the following recommendations.

- The study's findings be made available for use by clinical technology training institutions in South Africa and Africa to incorporate into their training programmes.
- Establish an inter-institutional simulation committee to promote the incorporation of simulation as an additional teaching tool in the training programmes of the three institutions in South Africa involved with clinical technology training.
- The study's findings be submitted to the Faculty of Health and Environmental Sciences Management at CUT for consideration and possible approval to be implemented into the current pre-specialisation clinical technology curriculum.
- The forming of an official interdepartmental simulation committee.

- The creation of an integrated CUT Faculty of Health and Environmental Sciences simulation unit.
- Training of lecturers in the use of simulation as a training and assessment method is recommended.
- Establish a dedicated simulation budget to maintain the current simulation equipment and develop the Faculty of Health and Environmental sciences' future simulation training capabilities.
- Further research related to the development of this framework and the practical training of clinical technology students. Implementation scrutinization and adjustment of the proposed simulation programme to ensure maximum benefit.
- Supplementary investigation and research on the role of simulation in the specialising clinical technology student.
- Publishing the results and future findings emerging from this research through accredited higher education and clinical journals.
- Presenting the results of the study at national and international conferences.

The researcher believes that this research made a significant contribution to the future training of pre-specialisation clinical technology students in South Africa.

7.7 CONCLUSIVE REMARK

The use of clinical simulation as an additional means of training pre-specialised clinical technology students will benefit most students, the WIL trainers and supervisors, and the profession. Clinical simulation is not an all-inclusive answer to solve the training problems within clinical technology but might prove to be a useful tool to address the vast majority of the difficulties both students and trainers currently experience.

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Appendix: A1

LETTER OF INVITATION TO PARTICIPATE IN AN ONLINE NOMINAL GROUP INTERVIEW

Dear Colleague

This is a letter to request you to participate in a doctoral research study:

A sustainable clinical simulation framework for pre-specialisation clinical technology training in South Africa.

The purpose of the nominal group interview is to investigate the possibility of implementing a clinical simulation program into the current curriculum for pre-specialisation clinical technology students. The nominal group interview is a small group discussion and will take approximately 125 minutes to complete. The meeting will take place via an online meeting platform, e.g. Zoom. A meeting weblink/ meeting identification number and/or password will be sent too willing participants via e-mail at least 48-hours before the meeting. Information is gathered by asking participants to list suggestions or ideas and then to partake in the prioritisation of the context of the list via an electronic index card document sent to willing participants at least 48-hours before the meeting. This process will result in a set of prioritised ideas that will be representative of the group as a whole. The following steps will take place during the nominal group interview:

Introduction by the facilitator (5 mins)

Stage 1 – Individual responses (20 mins)

- Participants will be presented with a question.
- Each participant will be requested to write down his/her ideas to the question(s) posed on an A4 paper.

- Each participant will have a turn to state one of their ideas at a time, and this will continue till every participant has stated all of the ideas and suggestions that were written down.

Stage 2 – Clarification and consolidation of responses (15 min)

- All the ideas and suggestions will be, numbered and clarified, similar ideas will be consolidated and shared to the group via the facilitators' computer screen.

Stage 3– Ranking responses (20 min) – This process will be directed by the facilitator, and each participant will be requested to complete an electronic index card (ranking card) they received via e-mail.

- Participants will choose the “*most important*” five (5) ideas.
- Participants will then be requested to rank the five (5) ideas from “*most important*” to “*least important*”.
- By taking everyone's ranking order, the top five (5) ideas/suggestions will be determined.

The above process will be repeated for each one of the two questions posed to the participants of the nominal groups.

I would like to request you to take part in the nominal group interview. Please note that by taking part in the nominal group interview, you voluntarily agree to participate in the research study. You will remain anonymous, and your data will always be treated confidentially. You may withdraw from this study at any given moment during the completion of the nominal group interview with no penalty or loss of benefits. Should you be willing to participate, you will not be held responsible for any decisions or conclusions made from the study. Kindly note that the results of the study may be published. You will not receive any remuneration, and there will be no costs payable by the participant. Data, transcriptions and recordings collected from this nominal group interview will be kept for a period of five years after completion of this study. Documents, data, transcriptions and recordings will be stored digitally in a locked cabinet in

the researcher office. Upon completion of the five-year storage period, all documentation, data, transcriptions and recordings will be destroyed in the appropriate manner.

Please fill in the accompanying consent form and return it to me electronically or hand it personally to me. The investigators may stop the study or remove you from the study if you do not conform to the set ground rules; this can be done without your consent.

BENEFITS TO TAKING PART IN THE STUDY?

It is reasonable to expect the following benefits from this research:

The information found in this study may lead to the development of a simulation program that could be included in the current curriculum of BSc. Health Sciences students in Clinical Technology. A simulation program will prepare these students in specific practical and clinical procedures and expose these students to specific biomedical apparatus and procedures they might encounter in their 3RD and 4TH years of study.

Thank you for your consideration of this initiative. I am looking forward to hearing from you and hope to meet you personally in future.



Yours sincerely

Mr J.J. Perkins

Faculty of Health and Environmental Sciences

Central University of Technology

Bloemfontein, South Africa

E-mail: jperkins@cut.ac.za

Office Number: (051) 507 3863

Mobile Number: 082 253 2448

HSREC number: UFS-HSD2020/0165/2104

REC number: REC2020/08/003

Promotor: Dr L Botes

lbotes@cut.ac.za

Co-Promotor: Prof. M.J. Labuschagne

LabuschagneMJ@ufs.ac.za

Appendix: A2

FORM OF CONSENT: NOMINAL GROUP INTERVIEWS

Date _____

Hereby I, the undersigned, consent to participate in a nominal group interview, which is scheduled to take place via an online meeting application on _____, time _____, meeting web link/meeting identification number, _____.

My full particulars are as follows:

Surname:

Full names:

Telephone number:

E-mail address:

Signature

I wish to assure you that the information will be treated in a highly confidential manner and that there will be no reference to any names. Thank you in advance for your kind cooperation. Please take note that the results coming from this research will be published.

Yours faithfully



Mr J.J. Perkins

Lecturer Clinical Technology

Department of Health Sciences

Central University of technology

Bloemfontein, South Africa

HSREC number: UFS-HSD2020/0165/2104

REC number: REC2020/08/003

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Appendix: A3

Nominal Group Guide

PREPARATORY TASKS

The Meeting Room:

The meeting will take place via an online meeting platform, e.g. Zoom. The online meeting should be opened for participants to access at least ten minutes before the scheduled time of the meeting.

Facilitation

The facilitator should ensure that all the participants are connected. Request participants to switch on their audio and video functions to ensure that the application is functioning correctly and that connectivity has been established. Ensure that each participant received the electronic index card document via e-mail. Kindly request participants to close any other computer programs except the electronic index document, which is a Word document and their e-mail service, the last-mentioned applications may be “*minimised*”.

Opening Statement

Facilitator’s welcome, introduction and instructions to participants:

Welcome, and thank you for volunteering to take part in this nominal group. You have been asked to participate as your point of view is important.

I would like to thank each of you for attending this meeting to identify ways of the making use of simulation as a training and assessment tool for pre-specialisation clinical technology students.

I am very happy to have each of you with us today. Our objective is an important one. At the conclusion of this meeting, we will have mapped a potential strategy for implementing simulation as part of the current curriculum for clinical technology students.

In our meeting, it is important that each of us fully participate. Indeed, success will depend on our equal and full participation. Each of us is here as an important group resource. There are no status differences between us in this particular meeting. Our success depends on every member fully sharing the insight from his or her own work experience perspective. I appreciate, therefore, the willingness of every one of you to fully share your ideas and work intensely during the next 90 minutes we are together.

The ideas which you generate in this meeting will become the basis for using simulations as a training and assessment tool for clinical technology students.

CONDUCTING THE SESSION

Step 1: Silent Generation of Ideas in Writing

Facilitator present participants with the first question by means of screen sharing:

☐ Present the questions or problem to the group of participants by means of screen sharing-and then verbally read the questions to the group.

The following two questions will be posed to each nominal group.

- 1) “In your opinion, what role can simulation play in the training and assessment of pre-specialisation clinical technology students?”
- 2) “Which graduate attributes would you have a student clinical technologists be trained in?”

☐ Facilitator requests each member to take five minutes to list their ideas in response to each question by describing their ideas in a brief phrase or a few words on an A4 paper.

☐ The facilitator must kindly remind the participants to work independently. During this period of independent thinking, kindly request participants not to talk to each other, or interrupt other

participants thought process. This is an opportunity for each participant to prepare his or her contributions to the meeting. The facilitator will indicate the end of the five minutes where after the facilitator will allow the participants to share their ideas and discuss it in the group.

Step 2: Round-Robin Recording of Ideas

For the second step, the facilitator should request the participants to share their ideas one at a time with the rest of the group. The facilitator should record the ideas and make it visible to the entire group by means of screen sharing. The facilitator must make use of the “*round-robin*” method of recording by going around the table and asking for one idea from one participant at a time. The facilitator must capture the ideas of the group members on his/her computer until all the ideas from all the participants have been recorded. After the entire list is captured, the facilitator will provide the opportunity to members to discuss, clarify and dispute the ideas. Should two or more of the group members have presented the same idea, this idea may be consolidated as one idea or suggestion. Consolidation of ideas is only allowed if the emphasis of the two ideas is the same.

The facilitator should take note of the following important aspects during Step 2:

1. Number and record each idea on his/her computer.
2. Allow a person to “*pass*” if they have no new ideas (but allow them to re-enter later if they wish).
3. Record ideas as rapidly as possible.
4. Record ideas in the exact words of the group member.
5. Make the entire list of ideas visible to the entire group by means of screen sharing.
6. Allow only a listing of ideas, not a discussion or debate.

Step 3: Serial Discussion

The facilitator will allow the participants to discuss each idea for the purpose of clarification. The facilitator should explain to the participants that the purpose of the discussion is to clarify

the meaning of each item recorded as well as providing the opportunity for each member to express their understanding of the logic behind the idea and the relative importance of the idea. Participants should be encouraged to feel free to express varying points of view or to disagree. The facilitator should ensure that each recorded item receives the opportunity for equal attention by the group. The facilitator must also remind the originator of an idea not to feel obliged to clarify or explain any of his/her ideas. However, other members of the group may fill that role.

Step 4: Preliminary Vote

☐ Step 4a

After completion of the discussion of the entire list of ideas and clarification of the meaning of each idea, and discussion on the areas of agreement and disagreement the facilitator should at this point request the participant's judgment on the most important ideas on the list. The facilitator should ensure that each participant clearly understands how to complete the electronic index card document. Before-mentioned can be achieved by means of a demonstration.

Ranking of the tabled ideas is accomplished by the following:

- Take five index cards (electronic index card document provided to each participant) and request the participants to select the five most important items from the list of items.
- By examining the facilitator's screen, the participant should identify the item they feel is very important and record this item on one of the electronic index cards with its corresponding allocated number in the upper left-hand corner of the index card titled "*Identifying number*".
- This process must be repeated for each one of the five most important items.
- On completion, each participant should have five index cards with a different idea or suggestion wrote on the card under the "*Idea description*" section of the electronic index card accompanied with its identifying number in the top left corner of the card.
- The facilitator should ensure each participant understand this process and address any questions the participants might have.

☐ Step 4b

- Once each participant has finished his/her selection, the facilitator must request the participants to review their electronic index cards.
- Looking at their set of five (5) cards, the participant should decide which card is the most important in other words which card is more important than the other four (4) cards?
- Once each participant has made their selection of which card is the most important the facilitator should request the member to type the number five (5) in the lower right-hand corner of the card under the “*Ranking*” section of the electronic index card. The participant should look at the remaining four cards and make a decision on which of the remaining cards is the least important, the number one (1) should be filled in the “*Ranking*” section located in the lower right-hand corner of the electronic index card.
- The process is repeated with the remaining three cards with the number “4” filled in the lower right-hand corner for the second most important card.
- The less important card of the remaining two cards should now be selected with the number two (2) filled in the lower-right hand corner.
- The last remaining card will receive the number three (3) in the lower-right-hand corner.
- The completed electronic index cards should then be e-mailed back via the e-mail address indicated on the bottom of the index card document on request of the facilitator. The electronic index card documents must be returned via e-mail before the closure of the meeting.

□ Step 4c

The remaining parts of Step 4 are as follows:

- Once the index cards are received back from the participants, a detailed count of the scores for each one of the round-robin ideas will be made.
- The facilitator sums the scores for each of the ideas to identify those ideas which are most highly rated by the group as a whole.

This guide was adapted from the Nominal Group Technique: A user’s guide (Dunham, 2006).

Appendix: A4

Electronic Index Card Document

Question:

Index Card 1

Identifying Number

Idea Description:

Ranking:

Index Card 2

Identifying Number

Idea Description:

Ranking:

Index Card 3

Identifying Number

Idea Description:

Ranking:

Index Card 4

Identifying Number

Idea Description:

Ranking:

Index Card 5

Identifying Number

Idea Description:

Ranking:

Appendix: B1

REQUEST TO PARTICIPATE IN AN ONLINE FOCUS GROUP INTERVIEW

Date: _____

Time: _____

Venue: Online

Dear Colleague

This is a letter to request you to participate in a doctoral research project entitled:

A sustainable clinical simulation framework for pre-specialisation clinical technology training in South Africa.

The purpose of the focus group interview is to investigate the possibility of implementing a clinical simulation program into the curriculum for pre-specialisation clinical technology students.

I would like to request you to take part in the focus group interview. The focus group interview will take a maximum of 120 minutes and will take place via the online meeting platform Zoom and include the completion of a short demographic questionnaire. A meeting identification number and/or password together with the demographic questionnaire will be sent to willing participants via e-mail 24-hours before the meeting. Please note that by taking part in the focus group interview, you voluntarily agree to participate in the research study. You will remain anonymous, and your data will be treated confidentially at all times. You may withdraw from this study at any given moment during the completion of the focus group discussion. Should you be willing to participate, you will not be held responsible for any decisions or conclusions made from the study. Kindly note that the results of the study may be published. You will not receive any remuneration, and there will be no costs payable by the participant. Should you be willing to participate, please fill in the accompanying consent form and return it to me electronically or hand it personally to me.

Thank you very much for your consideration of this initiative, and I am looking forward to hearing from you.

Yours sincerely



Mr J.J. Perkins

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REC number: REC2020/08/003

Promotor: Dr L Botes

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Co-Promotor: Prof. M.J. Labuschagne

LabuschagneMJ@ufs.ac.za

Please e-mail the electronic card documents for both Question 1 and 2 to jperkins@cut.ac.za before the closure of the meeting.

Appendix: B2

FORM OF CONSENT: FOCUS GROUP INTERVIEW

Date _____

Hereby I, the undersigned, consent to participate in a focus group interview, which is scheduled to take place online on _____

Meeting weblink/meeting identification number via **Microsoft Teams.**

My full particulars are as follows:

Surname:

Full names:

Telephone number:

E-mail address:

Signature

I wish to assure you that the information will be treated in a highly confidential manner and that there will be no reference to any names. Thank you in advance for your kind cooperation.

Please take note that the results coming from this research will be published.

Mr J.J. Perkins

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Appendix: B3

Focus Group Guide

Facilitator's welcome, introduction and instructions to participants: (The facilitator must ensure that all the participants are connected and that all the participant's audio and video functions are switched "ON" and functioning correctly.)

Welcome, and thank you for volunteering to take part in this focus group. You have been asked to participate as your point of view is important. I realise you are busy, and I appreciate your time.

Introduction:

This focus group discussion is designed to assess your current thoughts and feelings about the development of a sustainable, practical clinical simulation training model for pre-specialisation clinical technology training in South Africa. The focus group discussion will take no more than two hours.

May I record the discussion to facilitate its recollection? (if yes, start the recording function of the meeting application.)

Anonymity:

Despite being recorded; I would like to assure you that the discussion will be anonymous. The recordings will be kept safely in a locked facility until they are transcribed word for word, then they will be destroyed. The transcribed notes of the focus group will contain no information that would allow individual subjects to be linked to specific statements. You should try to answer and comment as accurately and truthfully as possible. The other focus group participants and I would appreciate it if you would refrain from discussing the comments of other group members outside the focus group. If there are any questions or discussions that you do not wish to answer or participate in, you do not have to do so; however, please try to answer and be as involved as possible.

Ground rules:

- The most important rule is that only one person speaks at a time. There may be a temptation to jump in when someone is talking, but please wait until they have finished.
- There are no right or wrong answers.
- You do not have to speak in any particular order. However, for the sake of functionality, the facilitator may direct the conversation by requesting each participant by name to engage in the discussion.
- When you do have something to say, please do so. There are many of you in the group, and it is important that I obtain the views of each of you.
- You do not have to agree with the views of other people in the group.
- Does anyone have any questions?
- Okay, let's begin.

Warm-up

- First, I'd like everyone to introduce themselves. Can you tell us your name?

Introductory question

I am just going to give you a couple of minutes to think about your experience of training students in specific practical and clinical skills and what your personal opinion is regarding the use of a clinical simulation program as part of the preparation and training of pre-specialisation clinical technology students?

Guiding questions

- **What is your personal opinion regarding the use of a clinical simulation program as part of the preparation and training of pre-specialisation clinical technology students?**
 - What are the basic practical and or clinical skills that you consider as essential/important for a student clinical technologist to be trained in before he/she starts their work-integrated learning? E.g. Taking a patient's vital signs, use of a blood gas machine.

- What specialised biomedical apparatus would you recommend pre-specialisation clinical technology students should be exposed to?
- Which specialised procedures would you recommend pre-specialisation clinical technology students should be exposed or trained in? E.g. draw of blood gas, set-up of an intravenous infusion.
- Is exposure to practical scenarios to the pre-specialisation clinical technology student important? Motivate your answer.
- What are the best modes of delivery to training students the mentioned skills?
- **In your opinion, what role can simulation play in the training and assessment of pre-specialisation clinical technology students?**

Concluding question

- Of all the things we've discussed today, what would you say are the most important issues you would like to express about the practical and skills training of pre-specialisation clinical technologists?

Conclusion

- Thank you for participating. This has been a very successful discussion.
- Your opinions will be a valuable asset to the study.
- We hope you have found the discussion interesting.
- If there is anything you are unhappy with or wish to complain about, please contact the researcher or speak to me later.
- I would like to remind you that any comments featuring in this report will be anonymous.
- Before the conclusion of the online meeting, please ensure to return your completed questionnaires via e-mail to the designated e-mail address at the bottom of the questionnaire.
- Please, write your report based on the results of the focus

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This focus group guide was adapted from: Guidelines for conducting a focus group (Eliot & Associates, 2005).

Appendix: B4

Focus Group Demographic Questionnaire

Please answer the following questions in the spaces provided, circle or tick the most appropriate options.

1. Age: _____

2. Are you: (please tick as necessary) ☐ Male ☐ Female

3. What is your highest qualification within Clinical Technology?

- ☐ National Diploma in Clinical Technology
- ☐ Baccalaureus Technologiae Degree in Clinical Technology
- ☐ Magister Technologiae or Master's Degree in Health Sciences (Clinical Technology)
- ☐ Doctor Technologiae or PHD Degree in Health Sciences (Clinical Technology)
- ☐ Other

4. In which speciality within Clinical Technology did you qualify? (If specialised in more than one please tick all the specialities you are specialised in.)

- ☐ Cardiology
- ☐ Perfusion
- ☐ Neuro Physiology
- ☐ Critical Care
- ☐ Nephrology
- ☐ Pulmonology
- ☐ Reproductive Biology

5. Are you currently working in a Work Integrated Learning unit responsible for the training of clinical technology students?

- ☐ Yes ☐ No

How many students do you take into your unit to be trained?

- ☐ 1 – 2 Students/year ☐ 3– 4 Students/year
☐ > 4 Students/year

How many students have been trained in your unit in the last five years?

- ☐ 2 Students ☐ 3 - 6 Students
☐ > 6 Students

6. Experience in Health Care as a Clinical Technologist:

- ☐ <1 Year ☐ 1-2 Years
☐ 3-5 Years ☐ 6-10 Years
☐ >10 Years

Thank you for taking the time to complete this questionnaire. Please return the completed questionnaire to jperkins@cut.ac.za.

Appendix: C1

Focus Group Interviews: Phase II – Transcript for the Western Cape focus group discussions held online via Microsoft Teams on 28 August 2020 at 13:00

Person Speaking	Paragraph Number	Transcription of words
Facilitator	W1	Okay, I think I'm going to start with the first question. I think what I'm going to do is I'm going to read the overall question, and then break it down. Then I'm going to go one by one, and just please give your honest opinion, and honest input, we would greatly appreciate it. So question number one is: 'What is your personal opinion regarding the use of a clinical simulation program as part of the preparation, and training of pre-specialisation clinical technology students?' So the first part is, we're looking for what are the basic practical, and or clinical skills that you would consider as essential for these students to be trained in before they actually start their work-integrated learning? Do you need a little bit of time or can we start? I think all of you work every day with students, and so forth. So I think let's start. If you don't have anything to say, but you would rather let me come back to you, please tell me. Number 1, inputs on that question please you will see it on your screen as well?
1		Okay, so I think it's very important, I think, just personally speaking from a pulmonology perspective we deal with a lot of patient interaction, so I think if they are taught, I think the basics around lung function testing different type of tests we perform. I think basic information like your normal spirogram and lung function testing. I think having a bit of that knowledge, helps a lot when it comes to the third, and fourth years. Yes, I think for now that's all I can think about.
Facilitator		Thank you very much. Number 2?
2		Just give me a pass there for a moment, please.
Facilitator		Okay, I'll come back to you. Thank you, Number 3?
3		Also come back to me, please.
Facilitator		I'm too quick, it seems. Number 4?

4	W2	I think it's quite vital that we actually have this as a background in training for the students, especially in the times we went through currently. To give them more practical experience when there are no cases actually, and assist them to be more comfortable during a case as well.
Facilitator		Okay, great, Number 5?
5	W3	I have to answer this on three levels because we're talking about pre-specialisation students here. So, if we're talking about the whole group before they've even thought about where they're specialising, I think it could be important for them to just be exposed to the different equipment related to each category. You know I wouldn't expect them to be able to operate it or understand it all but just to be able to see what each category entails because I think a lot of times they might be exposed to one or two procedures or devices, and not everything that it entails. So that's on one level. On another level. I think it's quite difficult to formulate a list of general equipment that would need to be included for them to undergo as simulation before specialisation, and therefore be familiar with that equipment because it's so different across the categories. I mean the only things I can think of that might be universal across most of the categories would be an arterial blood gas, and perhaps an activated clotting time. But otherwise, the other equipment is very specialised, and so I don't think you'll find a long list that would be familiar to all. But then, on the last point, you know, if they are looking at different categories, they need help to make an informed decision. I sometimes think just seeing it in the field is not the same as simulating it. It's more valuable to see it if possible, in a scenario. I obviously don't quite relate to all the other categories but for example, simulating what the cath-lab techs would do during an angiogram or simulating what does it mean to go on bypass in perfusion - what does it entail? With simulating, and unit visits, we could give them a more balanced way of making an informed decision than with just viewing in the units, which can sometimes sort of being the glorified version, and not the actual nitty-gritty of what they are doing.
Facilitator		Okay, thank you very much. Number 6?
6	W4	So I would, mostly agree with Number 5 what she said. Now it's quite difficult before knowing what a person is going to specialise and to know what skills to properly invest in students. As most of the people only decide once they've heard back from the supervisor that will take them into the unit, and train them, and then only make the decision to go and join that unit. So I would say that probably a broad spectrum

Facilitator 7 Facilitator 7 Facilitator	W5	should be given to them so that they can simulate in a way like Number 5 voiced, going on to bypass or what is necessary to do angiogram or as Number 1 mentioned about what is a spirometry meter, and not just reading up on it, but actually having it may be in your hand or just seeing what it can do. Okay, thank you, Number 7? I think you're still on mute. Hi, can you hear? Yes, now I can hear you. Thank you. What I said is I think it's, I'm all for this type of simulation before they specialised, I mean there's a lot of knowledge that goes past students due to the fact that they have to learn many of the situations they will be in, in the work environment, and if you can teach students certain concepts before they reach the specialisation area. I think it's a very good idea. I have some training in America, and in Europe, and they use that extensively, even the American Society for CPR. If you do the CPR course in America these days, it's online. You do the whole course online before you go, and go for the practical, and do the exam than with the instructor. There are many such situations, especially in cardiology where you can teach, we can widen the knowledge of all the students so much more if you use technology if you use the simulation programs, rather than having somebody teaching them that. Because, you know, you are limited with the amount of time you have, and if you have a simulation program they can go in, and they can go back to the lecture that was given or just listen to it again. For me, I'm for it. I'm hundred per cent for a simulation program, and even if you go into the specialisation field, we at ***** use it. Even before COVID, you know, to have certain simulations that you can use in echo-cardiographs. We have a whole simulation lab in our department, and it helps the students a lot if you think, and if they can actually have it. It's very small in South Africa, in Europe, and Americans it's a very big system, we're not used to it. Okay, thank you. ***** ? ***** I think your microphone is still on mute. I still cannot hear I don't know if there's an issue with the connection, maybe? Can we continue to Number 8? [Inaudible] There's something wrong with the audio on my side I don't know if you can properly hear. If I can ask you if we still struggle, can you just please type what you are saying in the chat room, please? Okay, I'll continue back to Number 2 in the meantime Simulation is a good idea the question being, and this is where one of the later questions are about apparatus, and that type of thing, because

2	W6	we are all different categories, one has to look at, you can't supply all the equipment, even for basic tests, and that costs a lot of money, and expenses are going to be exorbitantly high. Another important thing that I feel is that because we all work with patients well, most of the categories work with patients, and these people should be taught some people skills as well that they can at least work decently, and properly, and correctly with patients, and that.
Facilitator		Okay, thank you very much. Number 3?
3	W7	I think the simulation is actually a very good idea because from the past experience we had when the students rotate through the different units in *****, some of the units they get exposed to do a lot of work, there's a lot of investigations that different departments do. We then always struggled to find people, for instance, in our field pulmonology because people don't want to specialise in pulmonology because what they can see in *****, is very limited. When you have a simulation where they can see all the tests the pulmonology department is doing, or what the people are doing in critical care then the students will be much better informed in that category, they actually want to specialise in. I mean the last few students we took on here at ***** hospital not one of them were interested in pulmonology, and now they enjoy it. So, I just think in that case simulation will help a lot that the students can really see what the category entails.
Facilitator		Good afternoon, can I ask you quickly to introduce yourself? Number 9?
9	W8	Hi everyone, this is Number 9 from *****, and *****, I'm the chief perfusionist there, and good to meet everyone. Can you hear me?
Facilitator		Yes, we can hear you. Thank you very much, sir. Did you have an answer to that question that we busy with, or would you like to come back to that at a later stage?
9	W9	Look, just to add with what everybody's been saying, I think, as well. It would be a benefit for the students, quite a lot if we had simulation. Because if you look at the hospital visits that we normally do. I mean, I think it's still been done like how we did it before. Those days, like one or two days, were never enough, to actually have an experience on what's happening with that speciality or category, that you're going to decide to choose. So if a simulation program is a new way to do things, I think it's going to benefit the students.

Facilitator		Thank you very much, sir. So I'm going to go to the second part of that question. 'What specialised biomedical apparatus would you recommend pre-specialisations clinical technology students should be exposed to?' So we're looking at the specialised biomedical apparatus. Okay, so I'm going to start, maybe I should start again with Number 1? Number 1. I think your mic is on mute.
1		It's a difficult question. Can you hear me?
Facilitator		Yes, we can hear you.
1	W10	As Number 2 said it is a broad topic in the sense of there is a lot of tests that is seen in each speciality, so it's going to be difficult to mention, I think the most important now I think we should probably just give a summary, and then later maybe give more opinion, but I think when it comes to pulmonology, spirometry is obviously the most important. I think diffusion, and plethysmography those are your main biomedical apparatus tests that are being performed. But what I do agree with what some of the people said that, and you should not just focus I think on one or two tests, because there are so many tests. So I think it's important that you do mention some other tests as well because some of the laboratories, mainly focus on certain tests, but the field lets say for example pulmonology is much broader than what they are exposed to, but I think for pulmonology, spirometry, diffusion, and plethysmography are probably the key biomedical apparatus tests that need to be dealt with in your second year.
Facilitator		Thank you very much. Number 3? The mic is still on mute.
3		Can you hear me now?
Facilitator		Yes, thank you.
3	W11	As Number 1 has said, you know, this is a quite a difficult question you know the two fields I am in like pulmonology, and critical care you know you use such a different scope of apparatus. If you think of critical care, what are you going to use, you know? And as Number 2 has mentioned it before you know the cost is going to be quite high, because if you want to simulate or show the apparatus to all, the students which we use in critical care or in pulmonology, I mean, this is going to cost millions of Rand, and we will have to sit together, and

Facilitator		just show the most important ones but then the student, only gets the idea that you know, this is all what pulmonology or what critical care is about. It is actually a much wider spectrum of investigations and tests the person will do. I mean in the critical care are you going to take a dialysis machine or are you going to take the ventilator, and that's my question? What, apparatus are you going to choose to represent, sort of, that category?
2	W12	Okay. Thank you, Number 2? Just adding onto what Number 3, and Number 1 has said cost-wise, I was just sitting here thinking now what one could do, and this goes back to what one of the previous gentlemen had spoken about, the visits at hospitals in *****, and the different units. Is that one asks each category for different procedures that are performed to make a video of sorts? That's going to be a cost-saver, and that can be used at the classes to show the students all tests, and it's basically a novel way of simulating everything in any case, and the cost would be much less in that regard. To put out millions of Rand, and this is not going to be possible for equipment. Back to critical care ventilators, and that, which type of ventilator do you take, a general ventilator, an oscillator, it becomes a hodgepodge of things in that, which I don't know, and don't see that it would be able to work easily?
Facilitator		Yeah. Thank you. Number 4?
4		Just give me a pass quickly. You can come back to me.
Facilitator		Okay. Not a problem. Number 5?
5	W13	So, I think it is obviously difficult because each category has so many different devices, and I mean, if I look at perfusion alone, we only really have three small devices that you could say are for 'testing': the ACT, the blood gas machine, and perhaps the little Hemocue machine. But the rest of our equipment is all related to support, so it's the heart-lung machine, the intra-aortic balloon pump, the ECMO machine, the cardiac ablation machine, and then cell-saving which is obviously processing shed blood, so it would be very difficult to try, and give you a list just speaking for perfusion. I'm sure all the other categories are similar, which is basically what people are implying. So I thought perhaps it might be more practical, and worthwhile to not think about necessarily just equipment or devices, that would be useful but perhaps skills that could be applied across all categories; you know like how to draw up drugs, how to put on the ECG stickers. What is ICU, and theatre infection prevention, and the correct behaviour? How do you put a litre of saline in a pressure bag, and

Facilitator 6	W14	pump it up? You know, things like that are all generic skills that could perhaps go across all the categories and are not necessarily devices where you might only have one or two that would go across all the categories. Okay, thank you very much. Number 6? I think we're going to have a lot of repeats of answers, but I do also think it's a little bit, not advised to buy all the equipment, especially because, like Number 5 said, we are giving support in some areas, and other areas are diagnoses, and others are treatment. I would also just add on Number 5's comment like general information taking, like how to answer the phone, how to phone out to request something from a doctor or make a request or an order from a doctor or order things from the pharmacy, small skills that you would think that someone has been taught, but actually, we do realise that this is not known anymore.
Facilitator 7	W15	Okay, great. Thank you, Number 7: Hello, can you hear? I must say I agree with Number 5, and I like what she said. I don't like the idea that we become a profession of working with, like, for the last thirty years was equipment, and that's all we can think of. We really not just into equipment we don't need to teach somebody how to use the equipment. The rep selling the equipment can also use that equipment, and he can teach the student, and the qualified to use the equipment. I think it's more important teaching people skills, and even in a specialised field, that you can definitely do with simulation. If I just look at cardiology most of the work, we do in the diagnostic field. Many of the skills you need to have in your daily practice is actually a skill; it's actual knowledge. The "<i>knobology</i>" of the equipment can change, three times a year. You know I always teach my students that this is how you analyse mitral stenosis. I don't teach them the "<i>knobology</i>", that I teach them when they stand next to me, and I think we lose the point of the profession. We, you know, we want to go forward with this high-tech electronics, and stuff, and we still 30 years back where we started with regards to the work we do on a daily basis with machines. We don't work with machines anymore. The anesthesiologist works with machines, almost all professions in the medical field work with machines, why do we keep talking about you know how to teach people how to use machines, you know, that's part, and parcel of what you do every day but you need to have a skill. I put an echo machine in somebody's hands he knows all the "<i>knobology</i>" like the rep. He can't analyse the patient! He can't diagnose the disease, and that should be the focus, and I can not one time see that that will be a problem in simulation because many of the fields you can get a lot of

Facilitator 8 Facilitator 8 Facilitator 8	W16	knowledge by teaching or having a simulation or online program where students can see exactly how the physiology and the pathophysiology of the disease works. And then when you go to the unit, you get taught how to use that specific machine, and that can change. Just this year, if I look at ECGs, my ECG equipment changed three times this year already. So, do I need to go back to the drawing board, and teach everyone how to use every machine, no that I do in five minutes? But I do teach them ECGs. I do teach them the correct way as Number 5 said, the correct way of doing the work. The “<i>knobology</i>” of equipment is really for me a secondary thing, you know, and that’s how I feel. I mean, simulation it shouldn’t be about the equipment. It should be about skills. You can get all the skills you need to do your work from simulation but many skills definitely, there’s many of them you can. And I think for me the focus point skills and knowledge. I cannot for one moment see why simulation or a simulation program cannot help ‘up’ the skills level of students as well as qualified people. That’s how I feel. Nothing there. Number 8? Hello? Now we can hear you. Thank you so much. Hi, my name is actually *****. I just used someone else details to log in for the meeting. Oh, I’m so sorry. Welcome Number 8 Thank you. From the reproductive side, I don’t think there’s any apparatus that you can really use to train the students before they actually go to the unit. We do work with microscopes inside the laboratory. But I don’t think it’s going to..... I don’t think they’re going to really learn anything from just working with a microscope in a simulation room, because the environment in the reproductive biology lab is completely different. And there are too many different microscopes we work with, different procedures, and all the equipment that we use. They will never be able to learn to work with all that equipment in a simulation room. So, what I would suggest if the students are interested in specialising in reproductive biology.... then I would suggest they go to a unit, spend a few days, say, for instance, a week in that unit, see what the embryologist actually does, what they work with, how they use the microscopes, how they use the equipment, all the consumables, and everything, and get a feel of the environment of how it works in the laboratory itself. And then I think from there they can play around with extra material that we have such

Facilitator 9 Facilitator 1 Facilitator	W17	as sperm, and eggs or embryos that we were going to discard anyway, they can play around with. See how they really feel about the actual field, and then make a decision from there. Okay, thank you very much. Then last but not least Number 9? Look, I'm not sure if I can add any more to what's been said, but I agree with the lady that spoke now, with regard to, you know, that the students should have longer visit days on each category than what they've been having before. That should be more than enough to make them decide if they really want to, you know, be involved in that specific you know profession. I mean if you're going to stay, maybe at least two weeks coming to observe cases, and, if I'm the perfusionist there, I'd be explaining stuff to you. So that you know, and you'll be able to see what's really happening in theatre, and in that way as well I can provide you with you know the skills that you need to have if you're going to be a perfusionist. And I think, you know, the more days, you have to explore and observe the better. I mean we'll give you a chance to actually decide if you really want to be in that profession or not. And with the simulation as much as they say it is expensive, it's something that's very difficult to do. I mean, we ourselves, you know, we struggled to get some simulation on some of our machines right for example, how to teach our own students. So we have to make up our own things. But yeah, I think, you know I think more days observing in that particular category would be enough for students to make a decision. There are only two or three days, and then you go on to the next profession, and then the next day was to go somewhere else and then by the third day, you have forgotten everything that happened four days ago. That's what I think. Thank you very much, sir, Okay, so our next part is more about which specialised procedures would you recommend in pre-specialisation? So we're looking at the basics what basics skills would you like them to do in a simulation program if you can choose? So I'm going to go down the list again. Number 1? Can you please repeat that? Okay, I'll repeat for you which specialised procedures, would you recommend pre-specialization? So we are looking at the pre-specialisation students but just specialised procedures. So, before they actually specialise, what would you like them, to know? Thank you, the question was just highlighted on your screen.

1	W18	This is a broad question, can you hear me? Yes, I think, again, it's a broad question, I think, looking at pulmonology, definitely doing blood gasses, and being able to interpret blood gasses. I think when it comes to critical care, there's a lot of stuff I think being able to do, and set up an A-line, insert an A-line, zeroing of an A-line. I think being able to intubate patients, and interpreting ventilation, different loops, and graphs of ventilation But, yes, I think it's difficult to say exactly what should be done, but I think we should probably get a list, and because there's a lot of stuff they will need to do. But I think, having the knowledge, and then definitely, do a bit of practical stuff for pulmonology definitely be able to do spirometry. And as Number 2 mentioned way earlier, they need to have people's skills they need to know how to perform the test they don't need to know exactly how to interpret everything but at least know a bit of basics, and what's going around in this specialisation of that field, and I think with critical care.... [inaudible]
Facilitator		That last part I missed a little bit, and I don't know if it's my mic or my computer. We seem to. I don't know, going out of sync or something I have no idea. If you would like to just repeat that last part let's just see if we can capture that, please. Okay seems to be a connection issue there now. We'll come back to Number 1, in a minute. Number 2?
2	W19	I think he was looking at basics; what basics one has to look at what is something which all categories are basically doing together. Spirometry, in lung-function pulmonology, e.g. a basic lung function. Once again, the patient, how to work with people is important firstly, and then basically monitor set-ups in critical care. In a lot, well quite a few categories that have monitoring, and that I would say, monitoring, and how to measure pulse is important. A little bit of CPR maybe because you could always have a patient collapsing on you while you're busy with procedures, and something like that maybe?
Facilitator		Okay, thank you, sir. Number 1 can we go back, and just please; it was just the last 10 seconds of your comment that I missed.
1		Can you hear me?
Facilitator		Yes, thank you.

1	W20	I am trying to remember the stuff they need to know. I think when it comes to critical care knowledge in the sense of being able to intubate patients to set-up A-lines, monitoring ventilation, and doing a spirometer. Again, they don't need to know exactly the interpretation and this type of stuff. I think they need to know about the basic of tests, being able to perform a diffusion, and knowing what Hb does to your diffusion, and indicating as to why you do it. And a BodyBox, why is it different than doing a Helium dilution test? So I think a bit of each test probably, it's a bit difficult to give a complete answer at the moment.
Facilitator		Thank you very much, sir. Number 3?
3		Can you hear me?
Facilitator		Yes, thank you.
3	W21	If I think of this, you know, my honest opinion, is that I think that on the second-year level, it is more important than at that stage that you must tell them what the type of investigations is or what is the type of treatments we are doing, and why we are doing it. And what information can you get from your investigations, or what is happening in the patient if you give him the treatment? And then how we do these investigations or how we treat them, that we can do on the third-year level when they come to the unit. But before they come to the unit rather tell them what is the difference or try to explain to them what is the different investigations we do or the different treatments we do, and why we do it. How the patient will gain from it, and then the practical part, we will do in the specialised units, that's my feeling.
Facilitator		Thank you very much, and Number 4, I see I missed coming back to you about the previously asked question. Do you want to give us comments on the previous question as well as this one? Number 4 is the microphone on mute? Number 4, I still cannot hear you. I'll get back to you I don't know if there's a connection issue there might be, and I'm going to continue to Number 5.
5	W22	So, I already kind of alluded to answering this question in my answers to the first two questions. But I think just to reiterate the importance of having students become familiar with skills. You know, a lot of the skills, although they may not use a specific one in a specific way, they would've learned it. A lot of the skills are generic, and cross over each

Facilitator		other, and I also think, students who are very practically inclined, pick up the skills quickly in the beginning. Those who are more theoretically inclined take a little bit longer, which at the end of the day, doesn't matter because, by the end of the year, they're in the same place. But I do just think it would help those who are more theoretically inclined, and not very adept, you know, practically, to have covered some of these skills already, e.g. know how to set up a transducer, how to hang up a drip set, how to read labels on fluid. I've had a student come to us before, and say, 'Here's some Balsol', and we responded, 'No, this is Saline', and they said, 'No but it says Adcock Ingram at the top'. You know, how to actually distinguish between fluids, where to put on ECG stickers etc. because those are generic things that may not be used routinely but at some point in the categories, you're going to use it some way or some variant of it. So I think the importance is more the skills than the equipment. But like I say the only thing I can think of in terms of equipment, procedures that would go universally across the categories would be the arterial blood gas. Okay, thank you. Can we try again Number 4?
4	W23	Yes, sorry, I had some connection issues on my side. I heard the last part of Number 5's comment on the blood gas, and I must agree with her, as I heard from the first two guys as well. It is specialised, and we have a diverse group of people that have to go into units at the end of the day to teach them something that will be universal in the end, for example, a blood gas, ECG's or a monitor that they would actually be able to set-up. But I think if you're looking at a blood gas, it's all coming back to your pathophysiology as well. So you actually have to be able to apply what you've learned, and I think that's the main thing that they'll be able to apply what they've learned in the background. So, as previously mentioned, it's the simple things they actually have to start doing, and the skills they build on that because you can't start with a specialised machine if you don't know your basics, actually. And I think we have to actually start identifying what's your basics in these matters.
Facilitator		Okay, thank you very much. Number 6?
6	W24	I think for the perfusion side ACT machine, and a blood gas machine would be the most important to know what we use, and how it can be used, and what results at the end of the day means.
Facilitator		Thank you. Number 7?
7		Hi, can you hear?

Facilitator		Yes, thank you.
7	W25	Yes, I do think there's a lot of pre-skills that we can teach students before they get to the specialised area. But the main thing again is to teach them skills, not equipment. I think in cardiology it's important. The previous speakers also mentioned blood gas and ACT. This is also important in cardiology, and it will be nice if they have the backup knowledge of how to do that, and it's something you can teach them early on in the simulation situation. Even how to draw blood, they must know, and another important thing is just to teach them sterile technique because, you know, it's, quite difficult to get the student in the specialised area, and they have no idea of how to be sterile, and how to work in a sterile environment. And I think that can be a good pre-specialised thing to teach them in the simulation situation, and then, I think it was ***** that previously said also subskills like answering a phone, and how to take a message. Because we work with patients, they phone us with medical problems. You need to know how to handle them. Even in situations, you could teach them some legal stuff via simulation, in the medical environment, this will be a good thing before they get to a specialised area to know some legal things. The sterile technique, blood pressure we need in all the categories, we need to know how to take blood pressure, even if you don't do it daily. I mean you're still a medical professional. If somebody asked what's the patients' blood pressure, and you don't know, I think it's not good. And you can do that in a simulation situation. CPR as I previously said in America, you do your basic CPR online, and then you go for your practical. That's all stuff that they can be taught in simulation. You can teach students in a simulation situation an ECG set-up on how to set-up your electrodes correctly. Set-up, a transducer, teach them how to do an A-line or venous line, Swan-Ganz, and all that stuff, there is numerous stuff you can teach the students in the pre-specialisation skill area where they can actually pick up on skills that will be necessary somewhere in the profession. As soon as they get into a specialised area, it makes it much easier for us if they already have a skill, in like I said, just a sterile technique. Yeah, that's more or less what I have to say about it.
Facilitator		Thank you, so I'm going to give ***** a chance again. Still nothing it still might be a connection issue. Okay, Number 8?
8		Hi?
Facilitator		Hello. We can hear you.

8	W26	Yes, um, unfortunately, in the reproductive field. Um, our job is very hands-on. There is nothing that we really can do. Our procedures are so specialised that the students will, unfortunately, only be able to learn it in the unit itself. I mean, out there in a simulation room you can't really teach a student how to do a semen analysis, for instance, that's only one part of our specialised procedures. Everything is practically based on your skill, also in the lab, but that the student can only learn over time, because it is very specialised, it's very sensitive the procedures because we work with everything, we work with all the gametes. It's all microscopic all clin techs have to work through a microscope all the time. So it's going to take the time to learn all these things. But unfortunately, it has to happen inside the unit, and that's the sad part of the reproductive field. You can't even really teach them how to communicate with patients because the type of patients that come here they are already so stressed, they are so sensitive about the whole reproductive issue that you can only learn with experience how to communicate with these type of patients. So, unfortunately, there are not any specialised procedures that they can be exposed to before they actually decide to specialise in reproductive biology. Like I said, with the previous question as well. These students will have to go, and spend a few days maximum a week, I would say in the reproductive laboratory, so they can be exposed to all these procedures, and get a little bit of background on what really happens in the reproductive field.
Facilitator		Okay, Thank you, ma'am. Number 9?
9	W27	Yep. Look, I'm not sure if things have changed, but I mean if I look back in our days. With this, I mean we're studying, we had that biomedical apparatus subject where you were actually introduced to things like syringe pumps, transducers, ECG's, and whatnot. All the stuff that the guys have mentioned now before, I mean, perhaps maybe we should look into like advancing that subject into something much more, you know, better how it's been done. Because, I mean if you're going to be trying to get the students to experience in all these kind of equipment beforehand, I mean, I don't know. I'm just saying that you had that before where the students, were introducing to those things, beforehand, and did practical in those things as well to actually pass, but maybe perhaps they should just look into advancing, you know, that subject, and to make it better. If that can help?
Facilitator		Thank you. Okay, the next part of our question is do you think the exposure to practical scenarios to the pre-specialisation clinical technology students is important, and please motivate your answer. So, Number 1 is always first on my list. Number 1 comments?

1	W28	Yes, so I think practical scenarios is very important, I think we need to remember the students that come from university, and has no hospital experience, and with critical care, and pulmonology, and I guess with each speciality there is always an emergency case, and you need to handle the pressure, and need to know what to do. And I think that comes down to having the proper knowledge with your physiology, anatomy, and pathophysiology. So, I think scenarios are important, but I think it's key to know your normal knowledge in the sense of the second year, and the first year, they need to know that, and then to interpret that with your scenario I think that will be good.
Facilitator		Thank you, Number 2?
2		Thanks. Sorry,
Facilitator		There we go. Thank you.
2	W29	So, this goes back to what I was saying earlier, that I think this is where videos of different procedures, would be very helpful. And also where Number 6 mentioned earlier that going to visit units in that hospital. Then we get better exposure to categories, in what to decide, and to better ways to decide which category they want to go to. I mean, I am not interested in neurophysiology or nephrology so I wouldn't be or will be interested in looking at the apparatus or are having to work with apparatus in neurophysiology. So I think videos of different procedures, different apparatus, and uses would be much better, and beneficial for the students.
Facilitator		Okay, thank you. Number 3? Do we have a connection problem?
3	W30	I agree with most of what Number 2 have said I don't have anything. Thanks.
Facilitator		Thank you. Number 4?
4	W31	I think on this topic; they said everything actually because practical scenarios is sometimes actually the best way to learn something and to make the essence of it stick forever. So I think that's quite important like they said, the videos scenario, and then you maybe have to see it 'live', go, and visit the unit self as well.
Facilitator		Number 3 something to add? Okay, I suppose not. Number 5?

5	W32	I think we're all answering along the same lines, but I think, obviously, practical exposure is important, and whilst I think videos will definitely help people, I think, to really get the true essence of a category, you do need to experience it. You do need to see it, and as Number 9, and I alluded to, not just for one or two days. So I think it might be helpful to have a compulsory session where people have to attend all of the categories, but perhaps at a later stage, they could choose two or three that they want to visit again, you know so that initially they have a general understanding of all of them; even if they didn't think they were interested in a particular category, they might realise only when they see it isn't actually what they thought. But then also to be able to see it again, because if you go, and you visit a category, you know, you might catch them on a day where everything is running smoothly, there're no glitches, and as I said before, you know, it's kind of a glorified version of what they're seeing - everything runs smoothly there are no problems the surgeons are all in a good mood, and music is playing in the theatre. Yet you go on another day, and the surgeon faints at the table because he didn't have breakfast, and equipment fails, and you've got to troubleshoot, and, you know, it gives you a much broader picture of what's going on. So I think videos are helpful, but I think being on site is important, and I think to avoid wasting time everyone should have a general exposure for whatever period, you know, CUT determines is valuable, but then they can come back to one or two or three categories to look at again in more depth.
Facilitator		Okay, thank you. Number 6?
6		I see Number 2 raised his hands. I don't know if he wants to ask something first?
Facilitator	W33	Number 2, you want to add something?
2		I am sticking to this video story and that. I don't have a problem visiting units, and that, but I'm going to go to a unit, and our experience is that students have gone to pulmonology in *****, and they don't do nearly half of what is done in other units. So you're not going to see much to get to decide if you want to do that or go do something else. And then you're not happy in that category, and so where the video is going to show you everything. I mean a department can take, and show you everything, and you can get all procedures done in that manner, and I feel this is very important, actually.
Facilitator		Hey, thank you very much. Number 7?

7	W34	Yes. Yeah, I agree with that I think it's especially in the pre-specialisation scenario, you can get a lot of knowledge to the students, with regards to what's happening. I agree with Number 5, and Number 2, and all those people that said, you can never have a real scenario on a video only when you are in the situation, but it gives the student an idea. I mean if they see what happens during an infarction, and resuscitation, and the defibrillation, and everything. Maybe it's not for them, and at that stage of their career or study career it's important to then see okay, I will not fit into this scenario, although they haven't experienced all the good, and bad of that specific speciality. I think it will be a very good thing to have them exposed to practical scenarios before they specialise just to see what's happening there. I mean, that can even be in all the categories even reproductive biology, and stuff like that, to see, you know, that's the environment you're going to work in. So I think that will be a very good place to start with these scenarios, practical scenarios, and to expose students to that.
Facilitator		Thank you Number 8?
8	W35	Um, yes I also agree with the videos, exposing them to videos more so because even though a lot of reproductive laboratories they all work in the lab basically. The work is based on the same principles, but we all do things differently in the lab, but if you make a video that you can show to the students, then they can at least be exposed to the basics of what happens on a day to day basis in the laboratory itself. I think that should be more than enough information on whether they actually want to go to the unit physically to get exposed practically to all these procedures, and spend some time there, and see how they feel about it.
Facilitator		Okay, thank you. Number 9?
9	W36	Look I pretty much agree with everyone I mean the videos are quite good to show your students, but I'll still stick to the hospital visits. And also for the visits to be much more days than just one or two days. But also, the only time I think that students will immediately decide, the example was made with Pulmo, and stuff, students, decide that you know, they're not going to do this thing, is simply because if they get to a place where a qualified works which are actually not happy at work right now and don't have the energy to show the students around, or what's happening in that unit. Obviously, the students are going to decide that, 'No this thing is boring', and stuff but I mean it doesn't matter which category you at if you get a nice

Facilitator		person to show you around. A person with some positive energy working in that category or whatever they doing, there's no way that you can just decide in two visits that stuff is boring. We usually as students you know, enjoy the visits or whatnot when I was doing it, I enjoyed a lot of the units because I had actually a nice person to show me around to give me like some proper energy in that profession, and that's just my take on it. Thank you.
6	W37	Thank you, sir. May I just add something quickly? Sorry, I don't know if this question, mostly as one mentioned, refers to what the broad spectrum in training needs to be, taking blood pressure or answering a phone or whatever? So to me, those things would be necessary to also be set out in the scenario so that you can teach a student, and see if you actually did something to get the knowledge to them in a way. I mean, obviously, it is important for everyone to go to the units, and everyone to see the video. But one must then just take into consideration when making a video there is a lot of legal modalities that need to take part, and I mean for every video that we need to send out or photo that we need to send out we need to get a surgeon's permission, we need to get hospital's permission, we need to get the patient's permission. So just taking that into consideration, that can make it very difficult for a unit to send a video out, but I mean if you have it once you can repeat the video, obviously.
Facilitator		Okay, thank you very much. Okay, the last part or rather the second last part of this question. Where am I now? Now, this is the last part I'm sorry: 'What are the best modes of delivery to train the students in the mentioned skills?' You will see the question there on your screens. So I'm very sorry I'm going to start again with you, Number 1, sorry but I've got a list to follow.
1	W38	No problem. I think with this question. I think it comes back to what Number 9 said. I think, sending students to unit visits, making sure they get enough time at each unit because I know from my experience, we were told, you only need one day at a specific speciality. And I mean, how can you get any knowledge from one day's experience? So, I think having a standardised unit and a set time, let's say four to five days per specialisation. And then looking at the question I think then it should include all three those examples, it should show you how to communicate with patients as has been said, how to answer the phone. It also should show you how to do normal blood pressure monitoring and ABG's. So I think it's actually, for me, I would say it's actually all three. But I think the most important is that units visits should be standardised four to five days for each specialisation. And again, as Number 9 said, it also depends

Facilitator 2	W39	on the supervisor you get on that day they need to make it interesting for you. And I think as Number 5 also said certain days are quiet, or other days are actually very busy, so then you need to know, communication skills let them do a bit of admin, and when it's busy let them know, and show them how to do a bit of basic of each speciality. Okay, thank you Number 2? Just looking at that little list of details, for example, blood gasses aren't done in quite a few categories at all, and they're not interested in it, e.g. neurophysiology, reproductive biology and nephrology. There's quite a few. So I don't see the reasoning for doing the ABG's, and that. Communication and that once again comes down to people skills, blood pressure, yes, it does have an effect on most categories. So once again, it boils down to videos, and that also in some regards, and that, so that they can see it to make the final decision.
Facilitator 3	W40	Okay, thank you. Number 3? Number 3 I think your mic is still on mute. Sorry. It's me and technology. The most important thing for me is that the students must be trained the basic skills. As all of you have repeated, is the communication, they must know what to do in an emergency, how to do basic resuscitation, what will be needed that the blood gas will be done during the resuscitation, and really, all the basic things at that stage of training. And that the students must understand why all the different investigations in all the different categories are being done because that will help them already a lot in their future decision they're going to take. 'I'm going to specialise in cardiology because I like the results they get when they do an echo'..... or if they like perfusion 'I like the treatment they do, and that for me that is the most important'..... that they know exactly around what the test is showing but they must just know the basic skills like this is how I'm going to resuscitate, and things like that.
Facilitator 4	W41	Okay. Thank you, Number 4? I think Number 3 actually sum it up quite nicely but if I can add maybe like he said the basic skills that you have to add. I don't know if this maybe is already done, I'm not on the ball with that but, is there may be a video that will introduce the students to what each category specialises in? Maybe, for instance, cardiology or perfusion. If they know that pulmonology actually consists of all the different stuff, but

Facilitator		you will only find maybe two of the seven types of tests only *****, and maybe the other five in *****. Before they actually go for their visits, they say: ‘Oh well, Pulmo is definitely not for me. I’m not going to go for that visit.’. You already limit your student visits to the hospital as well. So I think that also maybe something that’s of the topic now but we can maybe go into as well. Modes of delivery always come back to your skills because your skills are your basics, and your basic skills, as I said is you’re stepping stone that you have to start from. And I think that’s why it’s so important to make sure that’s actually in place.
5	W42	Okay, thank you. Number 5? So, I’m not sure about if I have interpreted the question properly, but I’m assuming that you’re saying, sort of what modes of delivery of training the students should be taken. Everyone knows that when you train someone in a skill, mentoring comes into it, but it’s basically ‘see one few times’, ‘do one with someone watching you’, a few times, and then when you feel confident, then you do it without someone watching over your shoulder. In terms of modes of delivery, I think it’s important that the students be able to see the skills, and in different scenarios. But I don’t think it’s appropriate for them, pre-specialisation, to train in a hospital because of all the hospital legalities etc. You know, they wouldn’t be allowed to touch the equipment or to use it, even a blood gas; I mean if they did it incorrectly, and, you know, clogged up the machine then they would be responsible. So I think it’s important that they see it, but then I think this whole simulation factor then comes into play, that then they go back on site to CUT, and they practice doing, for example, blood gasses, and, setting up transducers etc. etc. So that they’re familiar with it to a point when they specialise in their third year. Then, at this stage, they obviously then start doing the ‘see one’, ‘do one while being watched’, and then ‘do one’, without someone watching you, and then go on like that.
Facilitator		Okay, thank you. Number 6?
6	W43	So, I would just add then here, that reasoning needs to come in here somewhere as well because you can’t just show someone what to do, but they don’t know why we’re doing it, and then, to actually bring back what the result is like if your blood pressure is 140/100. What does that mean, why would the nurse or the doctor be worried about that or something like that? So that they can actually start interpreting things, and then having an action for the result?
Facilitator		Okay, Thank you. Number 7?

7	W44	All right, yes. Again, I think the question is the mode of delivery. So, I will just say that, I think, you know, having a website. If I look at this, the online stuff we have in cardiology is a website that students can go back to. Even if they start doing the specialisation, if I think of sterile technique, they can still go back to that video on the website, and then see how it's done. It's nothing to do about how you are going to teach your students in your unit; it's just the mode of delivery. I think it's always important you know some other skills. If you start with specialisation or even pre-specialisation you forget stuff, and to have something to just fall back on, and to see okay, but this is the stuff that you need if you want to for example put up an arterial line. It's just a refresher, and I think, the best mode of delivery for that is not to have, you know, like a video sent to all the students but to have a website. We have it in cardiology where you can actually just fall back, and you click on how to set up an arterial line, and you can just look at it again. It's maybe not what you do in your unit, as Number 5 said, that you must learn how to use that specific skill, and sometimes do it a few times. Just something to fall back on, you know if you want a blood gas or if you want to do an ECG it's very easy just to show people on a video, for example, this is where you put your electrodes. I mean it's not that the unit may have nitty-gritty stuff that they want to include in those ECGs but something to fall back on. And I think the best mode will be to have a website. A teaching website where people or students can go back to 'click' on that specific skill, get what they need, and then go back to the specialised unit later, and see how that specific unit is doing that skill. So this, I think it's the main thing, and the main reason for this is just to, to have a system where students can fall back on, and that's my answer.
Facilitator		Thank you very much. Number 8?
8	W45	Yes, I actually agree with, Number 7 on that one about having a website with the different procedures that you do, and maybe show, and exposed them how to do a little bit of skill on there. We don't have a website. As such, but I believe we can always keep it in mind to create a website like that because I think it would actually be very helpful. Simply for the fact also that all the work that we do is like I said microscopic so which means we will have to have cameras on our equipment to record what we actually do. But it can be done, and I think it would actually help a lot to expose the students to see the different procedures in that way so yes I think a website, would actually be a good idea.
Facilitator		Thank you, Number 9:

9	W46	Look, I'm not sure if I can add anything more I pretty much agree with everyone with what is brought forward, but also maybe perhaps the visit should not just only be about observing cases, but maybe, students should have like Q&A or assignments for each category. You know, with regards to what they actually observed when they go for the hospital visits, and stuff. I noticed, most of the time they would have like sort of like a questionnaire, asking them how was the visits, and how do they feel, what did they see or all those kind of things but very much a proper Q&A. Well proper assignments and visits might help them as well like Number 7 is saying, if you can go back on a website, and take a look at certain procedures, and stuff as well as from having to do an assignment have a Q&A that as well, that would actually make you go read up on stuff that you've seen on that particular day, and you know, take it from there. Thank you. Thank you. Okay. Please bear with us we are almost done. So as the second last question, the last one would be very quick. We would like to know, in your opinion, what role can simulation play in training, and assessment of pre-specialisation clinical technology students? And I think the better way might be to ask you just do think what a simulation program could actually be used for to train the students? So, I think it's better to ask 'Can it be used? Yes, or No, and why would you think that?' So Number 1?
Facilitator		
1	W47	Yes, I think it can be used, I think, for me personally I think it's important to do this. So if you get exposure as to what each specialisation has to offer you. I think during the first, and the second year it's a lot of theoretical work. But it's a different thing to at least experience what each speciality is offering. So I think simulation is a good idea, I think, if it's done correctly, it will help the student, and, again, coming back to what Number 7 said with emergencies, then you can see is this specialisation is for you or not. I think simulation for me yes the answer would be it is very important Thank you. Number 2?
Facilitator		
2	W48	I don't know. I don't understand what you want to assess the student with; you assess the student in their first or second year. I don't understand the question? Maybe I should ask Number 10 to explain a little bit better.
Facilitator		
10	W49	Say for instance that we are going to use a simulation program to train students, and if I may use this example of putting on ECG electrodes, should we only train them, how to do this, or should we actually

Facilitator		assess, and see if they can actually do is correct? So it's one thing to train the students, but should we use simulation as an assessment tool as well? I know for instance, in radiography that they use the assessments where they have a scenario, a simulation scenario where they teach students how to take an x-ray of a patient with a hip fracture, and then what they do is, later on in the year they use a manikin and a mobile x-ray machine. Assessors sit in the room they bring the student into that room, and then they see if a student can actually work with a patient, take the x-ray of that patient with the hip fracture, and a mark is then allocated, to indicate whether the student is competent or not. So I hope that explains the question a little bit better?
2	W50	Thank you Number 2 comments? Okay so I hear what Number 10 is saying with his scenario being a radiographer assessment, and that's one thing because all they do is taking x-rays and that when we start looking at clinical technology, we have to come to an agreement, which basic skills, are we going to require, which are going to be able to cover all different categories? In that, e.g. blood pressure yes, ECG electrodes, yes, are they placed correctly, yes! So that's where one is going to have to come into agreement, and on where are we are going to go? In other words, to assess yes, it is not useful to show them how to do a thing, and teaching them how to do a thing. Not only that, I mean they could place the ECG electrodes completely incorrect, and then we end up with rubbish, and so. Regarding assessment, we have to agree with, which procedures are going to be your basic tests for everybody to be able to do?
Facilitator		Okay, thank you. Number 3? Yes, I think it can help. I think we must just be very careful that we, teach a student for instance to do an ECG, and then assess them. Check them, and then at the end when they're qualified in reproductive biology, then they come back and say, but they can also charge for ECG because we must also be very careful to where we go and what we teach them that they don't come back, and then, the pulmonology students start doing things with nephrology or cardiology. And start asking money for it, you know, and then that is the other place where we must be very careful about what we teach the students. I think it's, as I said, it's important that they know the basic skills, the basic things, and, and then we will, in the third year, we will train them in the more specialised procedures, and assess them, but I think there is definitely a place for this type of training.
3	W51	

Facilitator		Thank you, Number 4?
4	W52	I think simulation can definitely help the students because they can actually assess your students, and see how they developed on a practical side as well, and you can actually start building confidence in the student itself to actually handle the machines or the scenario itself.
Facilitator		Okay, thank you. Number 5?
5	W53	So I think I would agree along the lines of what Number 2 was saying that there's definitely a place for training, and assessment, you know, of different skills, and perhaps 1,2 or 3 of the devices that would go across the board, but there have to be some agreements on what those skills are; we don't want to include a skill that only one category has. And so, basically, everyone's learning it, but technically it only applies to one category, you know that kind of thing. So, we'll just have to narrow it down, and agree as to which skills should be included.
Facilitator		Thank you, Number 6?
6	W54	I'm also between the yes, and the no it's like Number 2 said it's good that you actually see what we train the students in, but I understand what Number 3 is saying as well. You don't want to waste time, and learning something if they're not going to use it, and now, if you've learned it, and then start using it in other fields because our field has a lot, there's a lot of categories where you specialise in. Training, and simulation for first, and second years is very limited, and might be difficult to actually see were, and in what way you want to train the students in.
Facilitator		Okay, thank you, Number 7?
7	W55	Well, I am definitely for it. I think it's a very good thing. I worked in and taught in an environment where this type of system was used, and it worked very well. Again, I think we need to just remember that, you know, there's a difference between, like, let's take the example of ECGs everyone does. It's fine, teaching somebody a skill. But, you know, you need to understand like in cardiology many people in pulmonology do ECGs, everyone even in critical care but not every one of us can interpret the results. So it's not just about teaching them how to use the ECG machine. I mean the nurses also do ECG's, and there's a lot of procedures that's been done by other professions. I know that physiotherapists a starting doing ECG's in there learning

Facilitator 8	W56	program now, and so it's not about that it's just to 'up' your game with skills, and I think this program can work because the student can go back the whole time, and see, you know how to do this correctly. The knowledge around that, I mean, we can't just be the people doing the stuff, so you teach people how to use the machine. I mean there's a lot of other people that also use the same machine, you need to be able to interpret what you see. If you're a perfusionist. I mean, they can teach me ten times how to use the bypass system, but I still can't do it. I don't have the skill, and the knowledge to know all the things that can go wrong. So this is this program, in my opinion, how to teach somebody that skill, and that knowledge associated with it. It's just to give them the background knowledge of how to work in a sterile environment, how to do a correct ECG. I mean I can teach many people to do ECG, but they can't interpret the same way I do, or somebody in cardiology or whatever other professions. I think the main reason for this is not to teach somebody how to do somebody else's skill, you know, it's just to actually have a system where they can fall back on. So if in pulmonology I suddenly need to do an ECG, and I can't remember where the electrodes should go, I can go back to that video, and they can show me. I'm not going to take away anything from the guys in cardiology because they do it every day, and they actually have to interpret it, and that's where you need to 'up' your game, is in the knowledge, surrounding your profession. I mean, I can know everything about flying planes, but I still can't fly a plane, because I haven't done it, because I just play on a flight simulator the whole time. It doesn't tell me how to climb in the aeroplane, and fly it, because I can only play flight simulator, that's the same here, it teaches you some skills that you use. I mean, in an environment we work in, some stuff, e.g. if you look at sterile technique, you need to know this. You can just fall back on a video maybe, and say, okay, this is what I need to do. Or this is how you set-up the transducer set. The knowledge around that you pick up in your profession when you specialise, and that's for me I think it's a very good thing if they do this it's something to fall back on for the student. Okay, thank you very much. Number 8? Unfortunately, I don't think simulation will help for the first, and second-year students. It is not going to work for the reproductive field, because the procedures that we do are too specialised, and unless the university wants to invest in getting microscopes with camera sets on them so they can actually see what the students are seeing, and doing under the microscope. But then still I don't think that you have the knowledge to be able to assess those students, and that can only be done, unfortunately, by the embryologists that work in the sterile laboratory. It's one thing to teach the students a lot of theory, and show them videos, and create a website where they can look at skills and things. But I don't think anything, practical, can be

Facilitator		taught to them on-site at the university. Unfortunately, I think for the reproductive field the university will have to focus on the unit visits for the reproductive field, so the students can go, and spend time in the unit, spend sufficient days there for them to experience the environment, see how things are getting done. And I think that's the only way that they would really be able to decide if that is the field that they want to specialise into.
9	W57	Okay, thank you, Number 9? Look also my question is, or is this simulation program being introduced to assist the students to choose which category, they would want to be in the third year, or is it just like advanced biomedical apparatus subject that we had before we were introduced? But now it's going to be more of a kind of a simulation, if this is the case, then, and I mean I fully agree, you know, I'm with it. But if it's for the students to choose, I still stick to hospital visits, being more than one or two days. That's where they'll get to experience a bit more about each category, and they get to have like a one-on-one with a qualified, e.g. with newly qualified, and with the qualified who has more experience. You know, that's where they can actually you know get to understand the profession, much better. Simulation if it's for the biomedical apparatus subject as an advanced subject, I agree. But if it's for students to choose, I think hospital visits are still much more appropriate, you know. Thanks.
Facilitator		Thank you, so I have one last question for you, and then I promise I'll let you go if you don't want to add anything else, you don't have to. I would just like to know about everything that we've discussed today. What is the most important issue that you would like to focus on what do you want to take away from this?
1	W58	Well, um, I think it's mentioned a few times. Is getting together, let's say topics that we all can agree on. And it's used in more than one speciality, and I think when this simulation is going to happen, I think, there's a lot of work that will need to be put in place for this to be successful. And then again, as Number 9 said, unit visits I think also plays a big part when it comes to pre-specialisation.
Facilitator		Thank you. Number 2? Number 2 missing now? Number 3?
3		Can you hear me?
Facilitator		Thanks, I can hear you now.

3		Sorry, Number 2 was called to an emergency in the Peads ICU, so that's why he was not answering.
Facilitator		No problem, thank you.
3	W59	I think simulation can work very well, and especially if it can help the future students that they can choose the category which they think will be interesting. And that they will be informed very well of all the different categories, and what the investigations, and what the treatment is that is happening within each category, and so they will make an informed decision.
Facilitator		Thank you, Number 4?
4	W60	So I will add that, they actually use this to equip the students as best as possible to make an informed decision after their first two years, what will be the future about what they're actually going to specialise in. To make it best for them, and as easy as possible we know about a lot of students will often after a year realise this is not for me. So we can actually cut that may be out of the system as well. Thank you.
Facilitator		Thank you. Number 5?
5	W61	Just the fact that CUT is asking this question, it just means that you guys are committed to more than adequately preparing students before they go into their chosen categories. So I think, as everyone's been telling, is I think it's a fantastic idea just to help people to select the category, with a more holistic picture. But then also to add a new dynamic, which to me seems new in this forum, where they would be semi-prepared, you know, with a baseline skill that they would actually sort of already be familiar with, and we wouldn't have to start teaching them literally from scratch on day one, but that they would have some level of skills. I think that's very interesting, and an important thing that needs to be investigated and pursued.
Facilitator		Thank you Number 6.
6	W62	I think if this program starts to actually implement this. It will help the students a lot by coming into the workplace, and study together with that because then they can see how, and what is expected from them. And just for the people, that's training them, when they arrive in their third, and the fourth year then we will know that they actually

Facilitator 7	W63	have taught them, and we don't need to start from the beginning in a certain type of area. Thanks. Thank you. Number 7? You know, as I previously said I'm all for it, I worked in an environment in Europe, as well as an America. They extensively use this, and it worked so well. You know, there's so much more time spent on specialised training, and the nitty-gritty stuff many times, you can just ask the students just go back, and go watch that, and see that procedure, and get the background knowledge about it. You know, I was very sceptical in the beginning in England when they introduced it, it worked so well. I always thought why didn't we use it in South Africa, why don't we have a system like that? To me, it's a very nice thing to hear that this might be on the charts for us, but yeah I'm all for it. And I think if it's been done correctly, it will be a very good thing no doubt about it.
Facilitator 8	W64	Thank you very much, Number 8? I don't think simulation is really going to work for the reproductive field because there's just too much of intensity going around our procedures that we perform in the laboratory, what you maybe could do. If you really want to expose the first and the second-year students to the reproductive field. Just to give them an overview of what goes on in the reproductive laboratory. Maybe you can set-up some kind of workshop for them to attend, so people can actually show them what happens in the laboratory, because there is no basic skills or guidelines that we can really set out to say this is what you can really expose them to on that level, at the university. The only thing that they would, they should do basically is just go to a fertility unit, and go visit the laboratory to spend a few days, and experience everything because we do get a lot of high school students also that come. There's not a lot of people out there that actually knows what goes on in the reproductive field, and when students hear about this field, they are very intrigued. So, they will email, they will make contact with us, and they will ask actually can they come job-shadow with us for a few days? So we do allow school students also to come to job-shadow for a few days so they can see from start to finish what happens in the fertility unit. From where the patients actually start with the doctors because the laboratory is not really running on its own. Also, it goes along with what the doctors do with the patients as well there is stimulation, and all that, so it's all connected. So, the only way that they would really be exposed theoretically, and practically to everything that happens in the reproductive field is if they go do a unit, and visit for a few days. That's my recommendation.

Facilitator		Number 9?
9	W65	Look, I mean we're in the 21st century, so I'm all for simulation, it is the in-thing. I mean, right now we train students, and if we had proper appropriate simulation managers and machines to do it, I mean, we would be doing it in hospital. So if they can do it, I mean, in the first or second year. Again, I mean, for me, I still see it as just upgrading that biomedical apparatus subject that we had before because I mean like I said you are introduced to these kinds of equipment, and you are shown electrodes, and whatnot. So I mean if that's it, it can be introduced I mean it would be good for students. So I think.
Facilitator		Thank you very much, and I would like to thank each, and every one of you for your valuable time we know that you're very busy. Thank you for participating. We really appreciate it. Thank you for a very successful discussion, and I must say your opinions will be a valuable asset to the study; otherwise, it wouldn't be possible. Just a quick reminder there was a questionnaire that was sent to you, please remember to complete it, and just email it back to the researcher, please. And then that's it, thank you very much. Have a lovely weekend.
10		I just want to say thank you very much, and thank you, everyone, for participating. It was greatly appreciated, especially your time and effort. Thank you very much. Meeting concluded.

Appendix: C2

Focus Group Interview: Phase II - Transcript for the Free State, Northern Cape, and Gauteng focus group discussions held online via Microsoft Teams on 28 August 2020 at 15:00.

Person speaking	Paragraph Number	Transcription of Words
Facilitator		Thank you. Okay, so I'm going to give you a few minutes just to focus a little bit on your experiences. You have been dealing with students, and you have been dealing with the training of students. So there are a few questions. I think I'm going to read the first question, and then I'm going to give you a few minutes. It is an overall question with a smaller question that actually fits under it. So I'm going to just read it to you on your screen as well: 'What is your personal opinion regarding the use of a clinical simulation program as part of the preparation, and training of pre-specialization clinical technology students?' So the first part that we would like to focus on is what are the basic practical or clinical skills that you consider essential for the student clinical technologist to be trained in before they start their work-integrated learning? So I'm just going to give you a few minutes; otherwise, I'm going to bombard the first person and didn't give them a chance to answer or to think about it. So think about that part in the meantime, I'm going to go down the list. If you wish to add something as I said previously, please raise your hand. But I'm going to go down the list to give everyone a chance to add their view, please. I am just going to give you one or two minutes. [2min break] Thanks. Okay, I'm going to start with Number 6. Are you ready? Number 6 either your microphone is on mute because we can't hear you. Or there's some connection problem? Okay, there seems to be an issue there, Number 1?
1	F1	I would say for basic practical and clinical skills. It is very important, I think, for students, because in the first, and second years there is nothing that they know about working with patients as such. For that, I think that something about that must be brought in somewhere that, e.g. this is how you work with a patient, and then, obviously, taking the pulse of a patient, those vital signs we talked about here, blood pressure, and that kind of things, that is with regard to the first question.
Facilitator		Thank you. Number 2?
2	F2	Definitely a clinical skill, practical side if we expose the student a bit earlier as to what is actually the red line on a monitor for instance in theatre, arterial pressure, CVP, ECG. When they get into theatre that they're not totally

Facilitator		thrown out of: ‘What am I seeing?’, because we literally in their third year have to do these basic, basic things in a theatre environment for instance. Okay, thank you. Number 3?
3	F3	Yeah, from a cardiology point of view, echoes. I think it would be nice when they come here; they already know certain anatomy and certain views that if they’ve already seen it, e.g., this is how a four-chamber looks like or this is how a long axis looks like. So I think that will be very helpful, and if they already have experience of that, and I think the same, even with the cath-lab, if they can be introduced to the basics of a cath lab, and how it works. I think it will be beneficial.
Facilitator		All right. Then I’m going to go to Number 4.
4	F4	Um, from my perspective, as I said, I only just started training students, I only have my first student now. Yah, the basic things are for them actually to like, Number 1 said, no, I mean, Number 2 said the red lines. They actually don’t know anything I think they do teach it at CUT, I don’t think the students take it all in but yah, you can definitely see the basic things they don’t always know. E.g. saturation wise, where to look on a monitor, they don’t really know so, and I don’t know if they just don’t notice when they do BAP practical in the second year or not? Yah but critical care it’s just, it’s a bit wide for basic things so sonar wise if they can just understand how the sonar works so when they see an image, whether it’s now cardiology echo or now with critical care, e.g. neonatal brain sonars, they just understand how the image is displayed on the monitor. I think that will help a lot, and then from there, they can learn what they see what to look for, and communication definitely with patients. A lot of them struggle with that, how to talk to your patient, very important. Yah, I think that’s basically all I have to say.
Facilitator		Okay, thank you. Number 5?
5	F5	That will work perfectly fine the two of us are used to just going on surnames. With our students, especially regarding cath-lab things, this is a sterile environment, a lot of them don’t understand that if you’re working with a patient in theatre that it is a sterile environment, don’t touch this, don’t touch that keep your hands to yourself. Then the other thing that I’ve noticed is, especially with a defib. I mean, we have to defib our patients quite frequently. Some of them are either too scared to touch a defib, others just want to run in, and they want to shock someone. So if they can just understand the basics of why a defib is there, and basically how you can

Facilitator		use a defib. It would help us a lot with the training of the students because they know the basic understanding of what it is, and why we have it there.
8	F6	Thank you. Number 8?
		Okay. Um, neurophysiology, unfortunately, is kind of on its own. There's not much I can tell you regarding simulation. Problems that I've encountered in the neurophysiology unit is that patients that usually come from neurophysiology investigations, especially those coming for EEG are commonly patients that got some disability some neurological disabilities, and it's not always capable of understanding. Some of them just have Aphasia, meaning that they can understand perfectly well, but they cannot talk to you back. In my field, it is extremely important that you are able to distinguish and be able to communicate to your patient as effectively as possible and to try, and distinguish between a patient who is really confused, and a patient who is able to communicate but not verbally. That is one of the things. One of the other things that were a bit of a problem at the beginning of the year was when I sent my students up to get a patient from the ward. They were not; they were not able to do that safely. So my neurologist actually brought it under my attention, and she got someone from physiotherapy to come, and demonstrate how to help a patient on an of a bed especially the ones that got Guillain-Barré, and other neurological disorders that cause them to be weak as well. So, that means that they need assistance in getting them on the bed and off the bed. They can injure themselves, and that is something I think we can look at, and then also the same as Number 2 said, with the monitors, especially in an ICU setting sometimes when we do have EEG's in the ICU. Sometimes you have to lift the head a little bit or turn the head a little bit, and I need them to be sure that they don't accidentally extubate the patient or, or that some tubing is disconnected, and sometimes they don't pick it up. I just need them to be vigilant regarding the normal activity, regarding saturation making sure that patients still on his ventilator, and everything's working well, and just minding the tubing, and all those things in the ICU. So that is all from my side. Thank you.
Facilitator		Okay, great. Thank you. Thank you for letting me know okay Number 7 let's go to you. Do you have any input for us, please?
7	F7	Good afternoon everyone. Um, what I've gathered, I have joined the meeting late, but a major thing for me with the students is, is that a lot of them don't know the basic nursing skills, and yes they don't study to be a nurse, but a lot of times the patient needs to go to the bathroom or patient needs to unclamp his drip, or a patient needs to have blood pressure taken. Those things are really critical for me to be put into the program because it's almost like we lack that as clin techs it's something that you learn as you do the work, but I think if you enter the program, and you have at least a theoretical knowledge about it I think it will make a massive difference.

Facilitator		If you do expose the students to the hospital, and I agree with Number 6 when she said, just to be able to turn the patients head, to know the saturation to know the ECG to know the EEG yeah, so that's from my side.
1	F8	Thank you very much. Okay, our second question is, what specialized biomedical apparatus would you recommend for this specific type of training? Okay, so we're looking at, so Number 6 I'm going to skip you, please don't feel that you've left out. Please just type your comments in the chatbox. I'm going to skip to Number 1. I would say, blood pressure monitoring for me, and also taking it manually. I am aware that they do not actually want us to use manual mercury blood pressure monitors. But yeah, I think it's very important for them to know how to take a blood pressure accurately because that's one of the things that I've noticed with students coming to us that they know nothing about blood pressure. Then the normal ECG, there should be an ECG machine, a defib, and I think blood gas as well, for that matter, would be important as well, and that is what I can think of now.
Facilitator		Thank you. Number 2?
2	F9	So, basically, I looked at, should one do a video recording exposing the student to the look of a different machine? Or as Number 1 mentioned, physically having a blood pressure monitoring or monitor that shows vital signs. Blood gas machine I don't think it's going to be viable for you, for instance, to purchase something like that. Because it's not used regularly but to expose a patient in a stimulatory environment where they can simulate these should definitely assist in preparing them for the real scenario.
Facilitator		Okay, thank you. Number 3?
3	F10	Um, yeah I think at paediatric cardiology it is basically the same as with, Number 1, we do not really measure blood pressure on kids, but I think the thing with children. There is totally different feel, and approach to them, and I think students are sometimes afraid of children, and it can be different because they scream, and you have to, there's a whole different aspect that you have to handle. So, it's maybe not an apparatus thing but more a thing of attitude to have and to be prepared that children are difficult.
Facilitator		Thank you. Number 4?
4	F11	I understand what Number 3 is saying with the children. I'm also working with children. It is a bit difficult sometimes, with equipment so that students

		do have some of the equipment in the second year, and then you get a neonate, and then their saturation probe is quite different from the ones that they were trained on. But I agree with all the vital signs a vital signs monitor, especially if it's difficult because every equipment is different, you come, you work in *****, and they have for e.g. Mindray, and then you come to *****, and they have Nihon Kohden, and then it feels different. But to focus on the equipment, more for them to, how do I explain this? Go to the basics understand? Okay, this is a puzzle, this looks if it will fit in the BP's place, things like that. Just how to set up the equipment from a vital signs perspective, ECG, SATS. We also use blood gases, as well. But I agree with the simulation there. It will be more viable to have a simulation of a blood gas machine, just to understand how it would work. In critical care, so much equipment. Maybe a sonar machine. If there are simulations as well, I think there is a new simulation in regards to a sonar machine so that they also have a feel how to work with a probe and the placement of the probes, and then dialysis they also have an old Gambro machine there currently at the simulation unit. Which is fine because, any dialysis machine if they know they have to follow the path, e.g. this is the arterial side, they should be able to work with any other dialysis machine, and then ventilators as well. We work with quite a few different types, but also just a basic ventilator so that they know how it works, how the alarm settings work all the basic things that you would set on a ventilator, and yah we also work with EEG, maybe placement is different from the EEG that Neuro does. It's just a basic amplified one, but just the placement of the electrodes how to work with the electrodes. Just to show the students. That's all I can think of, currently.
Facilitator		Thank you. Number 5?
5	F12	I think I so far agree with everyone like especially what Number 1 said with our students and say now blood pressure, everyone knows what a standard blood pressure reading should be but when they're looking at the machine, and you asked them questions like: 'Can you take the blood pressure again or can you set the time?' or something they sort of look at you with a blank expression. That seems to be the standard thing that we got when we asked them. How many leads do you use for an ECG, and all that stuff they seem to lack that sort of critical thinking. Or okay you can put 12-leads, and you get something out, or just the basics on what these machines look like, and if they don't understand something they must learn to troubleshoot it. So if they can play around with machines like blood pressure, and ECG it would be very good for them. I can't think of too many other things, but just the fact that they can play around with the machine physically would be nice but I think especially blood pressure and ECG.
Facilitator		Thank you. Number 8?

8	F13	Regarding simulation, I don't really have any options here. Because as you know that the simulation doesn't really give you brain activity or nerves to work with, so that is a bit difficult. I usually do all that training in the unit myself. And so regarding that, I don't have any anything in their first few years that they can really learn, regarding this speciality.
Facilitator		Okay, thank you. Number 7?
7	F14	Okay, what I would add is a drip stand or drip monitor, ECG, BP machine that everyone mentioned, oxygen, machine, even if it's just a manual one where it's an oxygen cylinder with a mask because, a lot of the students are not sure how oxygen works, and how it's been given, and what type of mask to wear. I'll add a defib, a suction machine. Blood gas everyone mentioned, and the dialysis machine everyone mentioned so that's what I would add from my side.
Facilitator		Thank you very much. Okay, our next question, and now we're looking at the procedures that you would recommend for this type of training. So Number 6, are you with us?
6		Hello, can you hear me?
Facilitator		Yes, wonderful to hear from you.
6	F15	If you don't mind can I just add on to the previous question, and then answer this question as well. So I think with regards to basic biomedical apparatus, I think it's also important for the students to really know the basics as well. With regards to a different type of syringes, needle size where would a physician use, for example, what needle. And those are really the basic things that I've seen that students lack in the clinical setting. With regards to specialized procedures, and so I'm from the field of critical care. So I will try not to be biased, but with regard to critical care, it is really important for the students to be able to know how to draw blood from an A-line, how to help set up an intravenous infusion set how to set-up an A-line, and how to work obviously a monitor, and how to interpret these values as well. And I think that is really something that the students lack is they don't have any insight in clinical, practical biomedical apparatus or any procedures within a field.
Facilitator		Okay, thank you. Number 1?
1	F16	For me, from working in a cardiology scenario, I would say if every time it comes if we speak to the basic stuff. Every time it comes down for me to the blood pressure, and the ECG. And, yeah, as I said there was a time I

Facilitator		know there was a time when students when they had the BAP subject they went actually to *****, and take some blood pressures. In pulmonology there was a guy that was giving that subject, and also ECG's, and stuff but I don't know it's not possible now, and it didn't happen for quite a while, but it is really a big problem because you have to learn somebody to do it. Example heart sonar, but this person doesn't even know how to take blood pressure, accurately. So, the gap is so big that I think those basic things will have to be incorporated in one way or another way, maybe if it's possible, even they can have what we have. They've got, for instance, a certain amount of blood pressures that they have to do, then only simulate or whatever they use in the lab on each other. Maybe that they must have to say, for instance, you have to take like 50 accurate blood pressures. Every student has to sign those off or ECGs, and things like that I don't know if it's possible and viable, but I would think, maybe that could help them when they get to the units to have a better idea of these two absolute basic things. Thank you. Number 2?
2	F17	In our unit, the gap seems to come in; we basically train them on what is a transducer, and what it is used for. I come across my students passing a basic practical, and then thereafter, we struggle with them maintaining the practical they passed. They keep on doing the things the wrong way around. It could be due to COVID etc. That was quite a frustration we picked up this year. Further on, Number 1, and the others also said that the basic machines, and working thereof like Number 4 said previously, going back to the basics of a monitor. All monitors are basically the same; they all have a pressure input, they have an ECG input, and a SATS input, a touch screen or knob that they turn, really basics. If they can be exposed to these in the simulation environment, it would be immensely helpful for us, definitely.
Facilitator		Thank you. Number 3?
3	F18	It's one thing to know the anatomy of the heart, but it's another thing to have a transducer in your hand, and to know that when you are moving anterior, you're gonna expect to see this feature or this organ. They struggle with the basics like where is the left the right, or to orientate themselves with regard to basic anatomy features.
Facilitator		Thank you. Number 4?
4	F19	Number 6 may already have touched on the things for critical care. Definitely important things like the A-lines, and IV's, how to work with Ivacs to set it up, because we work a lot with the equipment, helping the nurses, because they understaffed to set-up things, and sometimes not even

Facilitator		things that we normally help with. So just the basic things how to set it up. And like I said with a ventilator if they can know how to set-up a ventilator that really helps. And as I mentioned before equipment-wise a sonar if they can have a simulation where they as Number 3 also said have to know if you can move the probe to look anterior so that they actually know where to look. Because I also have my student where I tell her to go posterior, then she goes the wrong direction, and I am like ‘No, know your basic anatomy, with these procedures it’s very important. Then maybe I do believe the simulation has something where they can practice to draw blood from a patient, taking ECG of when you actually know how deep you would go with the patient because with the neonates we have to place aEEG needles just subcutaneous of the skin, and I can see my students, she’s very afraid she doesn’t know how deep to go, how to or where to put the needle placement. So they can just at least have the feeling, whatever you feel like if the needle goes into the skin. Just something like that even if they have to practice it on oranges or something that will be helpful.
5	F20	Okay, thank you. Number 5? Well, what I have to say most people have already touched on, like with the blood pressure. I mean they need to know exactly how the apparatus works, so they need to play around with it. Taking ECG you also have to know if you push a button what’s going to happen with this button, and different machines have the same button just in a different place. And then also with the sonar machines, they have to understand the anatomy I mean it’s critical to understand if we say okay move the probe in this direction it must go in that direction. It’s too much for them to handle if they have to learn everything that advanced, and then they still don’t have the basic information tucked in their brain somewhere. So, yeah, I think, pretty similar to what everyone else has said already. Thank you.
Facilitator		Thank you. Number 8? I don’t know if you will be able to get a seizure simulation, but I would like to have my students now what to do and to be able to observe, and distinguish between what is a seizure, and what it is when a patient is having a heart problem, or what do you call it, when a patient ‘kollabeer’, I don’t know what to say for that in English but anyway. Because I’ve had one case where a patient actually had a seizure-like effect, but her heart stopped, and then like they called me for a seizure, and they didn’t start the CPR, because they thought the patient was having a seizure. And I think, you know if they’re just assessed the patient very quickly before they make assumptions, and start with a normal ABCs or whatever you call it before they call someone incorrectly. They have to call someone obviously, but before they waste time then the patient can have a better outcome. And then the other thing is sometimes with the Guillain-Barré patients some of them are quite short of breath, and talking here for the pulmonology part as well. Patients
8	F21	

Facilitator		coming in for pulmonology with COPD, and asthma, shortness of breath, they've just walked for a while, and are severely short of breath, and then you know... the first day you can't ask a student please just put on the oxygen, not the oxygen probe but the oxygen cannula. Then they don't know how to work the oxygen cannula they don't know how to work the oxygen, how much oxygen to give as well. And to monitor the SATS, and giving oxygen while the patient is feeling out of breath will also be helpful I think even, not only in my department but also in some of the other departments I think in cardiology, and pulmonology as well. It will be helpful.
7	F22	Thank you. Number 7? Okay so, um, my list is obviously what everyone mentioned the blood pressure machine, how to do proper blood pressure, and what to do if it's high or low. My second point would be oxygen on how to give oxygen when to give oxygen also how to monitor the oxygen that's been given. My third point will be how to use a suction machine, and when to use the suction machine. And my fourth point will be how to interpret basic x-rays, and how to interpret basic pathology. My fifth point will be how to set up a drip. My six-point is how to draw blood or why certain types of blood are taken at certain spots in the body. ECG how to do basic ECG, 3-lead, and 12-lead. BLS training is quite important. How to do basic CPR, how to do it with a heart attack with a seizure, manual CPR, or AED. CPR or when to start CPR. And then my next points, Um, it kind of links with this topic, but it's the other side of this topic. So a lot of these students what I'm picking up they don't know how to work with people, they don't know how to cope with stress. Emotional immaturity where they don't understand that they're now in the world. And many students when they come from the university, it seems like they don't understand the basic concept of general measurements like a BP, and because they don't understand the basic concept, they don't know they don't act on it if it's abnormal. Another thing that might be included in the training is emergency evacuations how to do that, because wherever we go, we need to know how to do that, to evacuate if there's a fire or something like that, that's maybe something nice to add. And then for me very important what a lot of students struggle with is to-do ethical reporting and documentation. So they will do blood pressure, but they won't document it correctly. Incidents will happen, and it's not for them naturally to document that they intervened in the patient's treatment so that for me is also quite important what the students' needs to be exposed to more.
Facilitator		Thank you. Okay, our next question is: 'Do you think exposure to practical scenarios, is important, and please motivate your answer.' You will see the questions on your screen for those of you who would like to read a little bit ahead. But Number 6, I'm gonna come to you, comments on that question?

6	F23	I just want to ask the practical scenario is that specifically referring to simulation, or actually in a unit? The simulation environment.
Facilitator		
6	F24	Students are book smart and not street smart. So they perhaps know theory from the book, but they don't know how to apply it. Therefore I will say, it will be very good if students can perhaps spend more time in a practical scenario, and learning different skills, and how to apply their knowledge, and how to troubleshoot or how to solve problems as well. I think that will also just boost the confidence a bit going into a setting. That's all I can think of now.
Facilitator		Thank you. Number 1?
1	F25	I think we, experienced the same things year after year. I actually involved in the training of students for years now, and we speak about these things every time, but every time it comes back to the thing that what they learn, and when they come, and they are so new in the actual hospital situation in the practical scenario, where they are put that in most of the cases only maybe March, maybe, June, some of them get the hang of it. So, yeah, I know it's not possible at this stage to let students go to the real departments to get that exposure. But I know they do it in the simulation, but I don't think it really helps, because I know in the simulation lab they do a lot, and with the lectures at the CUT. But why can the students when they get to us, it is as if they were in grade-12 yesterday? So, something must happen, something must really happen, because I also agree with people that said something about the CPR, and the oxygen administration, like they don't even know how to give a patient, oxygen, and how to monitor it, how much to give. And that is, apart from the fact that they have no clue how to work with a patient. No clue at all, and that type of thing, I think that they are not going to learn in a simulation. I don't think it's going to happen there. So that's just what I want to say, Yeah, thank you.
Facilitator		Thank you. Number 2?
2	F26	I do agree in some scenarios we won't be able to expose them. I'm sorry, I just want to say something else. I've managed to get Number 9 on a WhatsApp video call that he can just at least take part, and see the screens, and stuff. So if he can give his opinion, that's the only way, he is struggling immensely to get the links going.
Facilitator		Now it's fine as long as we have input, the more input, the better.

2	F27	Sorry. Okay, sorry. You know, if we go back to exposing the students. So I just want to see I think it was Number 7 that talked about getting the students to get to know how to work with patients. And then, ethical reporting, stuff like that. I don't think that's going to be that much done in a scenario or simulation video, I mean they can exercise these things, maybe the researcher can work magic with that, to get a student to get exposure to working with patients, and so the only thing I've picked up with the students in a professional environment. Previously we had 'tannie', and 'oom' not doctor, mister or missus little ethical things like that. Um, that's from my side. Number 9 don't know if you want to say hi to everyone.
9		Can you hear me?
Facilitator		Yes, I can hear you.
9	F28	I can't really see what the question was, can you perhaps just tell me what the question was? The question was: "Do you think practical scenarios for first, and the second year, clinical technology students are important, and motivate your answer?"
9	F29	I think it's very important because it's a different world that they approach in hospitals. It depends on what you mean by practical scenario. Is it about the work is it about the ethics, patient handling, it is a lot of things? So I think exposure to all these kinds of stuff in a very basic kind of manner is very important, and I think it differs from various disciplines. So I think it's a very big topic to go into especially with every speciality, and I think you must break it up maybe to see more in detail, what the basic need is for these students.
Facilitator		Okay, thank you very much. Number 3?
3	F30	I think simulation will definitely be helpful, and the more experience you have, the better it would be for you, but I don't think it will actually replace the real experience. I just think many times we go to neonatal ICU and stuff, and it's overwhelming all the sounds, and the things you see on the monitors the blood pressures, the SATS, and you have to combine everything and integrate that knowledge. I think sometimes they don't have the basic knowledge, and now they have to integrate different things and say: 'I see one thing, but is it correlating with what's on the monitor.', or how the patient looks, and yeah I do think simulation has its place, probably, the

Facilitator 4	F31	times we live in, it's going to be more, and more becoming a thing. I think that's the future. I don't think it will actually replace experience, but I think it's very important. Thank you. Number 4?
Facilitator 5	F32	Um, I think, simulation, helps, and exposure is very important, because I also worked at CUT with the researcher, and his current simulation unit, and if I compare it when we were students. We only had four monitors to simulate, compared to what they have now. It's a big improvement, and I'm very jealous of the students currently. I think that would have helped us a lot. And the practical scenarios, the more realistic we can make it the better for the students. I don't know. I do think it's the students as well that causes a problem because you give them the perfect scenario, but they don't know how to pretend that this is a real operation, and that's how they really do it. And then when they do get into the hospital, and work with patients, and then it's different for them, and it's a bit overwhelming especially ICU environment, and all its monitors, but like I have witnessed it, and they have been trying a lot to simulate it accurately as if it is in the hospital with a lot of alarms going to expose the students how it would be. So I definitely think it helps. As they have just said, it doesn't compare to what it would be in a hospital. It helps them a tiny bit just to give the idea. I think if we can incorporate it more frequently because currently they only have to practice in the simulation unit, they don't have real-life patients. If they can do it from the first year to the second year, and not just once a year, with the exam, if they can have it more frequently. I think that would be more beneficial. Yeah, so they can have more exposure to the practical things, and working and hearing the sound, and working with patients, and having different scenarios. So with a practice exam, you only have one scenario, and they choose which one if they are exposed to. If we can expose them to all the scenarios that we can show them, I think that would help us a lot in the hospital when we get them. And just on that point, that's something that's frustrating me with my current student. I don't know it's probably the new students, their phones they are stuck to their phones. They would be busy with a patient, and then they feel the phone vibrate, and they would rather look at the phone, and what the message said rather than look at the patient. So I don't know how we're gonna fix that. If we can put that in simulation as well to get them off their phones that would be much appreciated. Thanks. Thank you. Number 5? Um, one thing that I've noticed that our students struggle with is, say know identifying their patients. I mean we in cardiology work with patients of all

Facilitator 8	F33	sorts we work with those in heart failure, cancer patients, everything, and now as qualified we can see, okay, this is a heart failure patient we can see if this guy is going to struggle to lie down flat. So, we know that the patient must be on an elevated bed with oxygen. If the students can sort of learn how to identify these patients, and see who needs more help than the next person or if there's a very old lady that's frail, and you call her name, and you walk around the corner already. This lady is struggling to get up so that they can sort of getting an idea of; you need to help your patients along a little bit and be a little bit more compassionate. I mean, we had a patient that student calmly came to me, and said: 'This patient is not really responding to me I don't know what's wrong.' I got to him, and he had agonal breathing and almost no heartbeat. So if they can just identify patients a little bit better, and see who needs help more than the next person, I think that will be a very big deal for us, especially in cardiology. That's the only point that I can think of. Thank you very much. Number 8? Sorry, regarding simulation it's a bit difficult, regarding neurology, and neurophysiology in that regard but what I want to point out in my situation is that the patients that we deal with paediatric patients, geriatric patients, and psychiatric patients. So there was one time that a student was attacked by a patient. So usually the first thing I have to tell them is to just put away all the sharp things like as if you are working with an inmate or something. Because sometimes you don't know what the patient is going to do, they are very unpredictable sometimes. And it's very difficult to try, and you know, they hear that you must not have sharp scissors lying around, and things like that. Sometimes, you know, having a situation, and then they didn't listen, and then someone can get hurt. It is only the odd patient here, and there but sometimes it does happen, especially some of them that have temporal lobe or frontal lobe epilepsy. They can present with aggression, rather than a seizure. And then the other thing I want to point out is assessment, being observant, and I've also had a problem with the cell phones in that regard because the EEG, it takes some time to do, sometimes an hour or so. So the first 30 minutes will be busy placing all the electrodes. Then the next half an hour you have to record, and the thing that I have to do is have to observe the patient for any strange behaviour, any changes in their behaviour at all. Sometimes they miss seizures because not all of the seizures are tonic-clonic seizures. Some of them are silent seizures, and they don't notice it. They miss it completely, so observation skills will be quite helpful, I think, and it's to be able to observe more carefully. Not only the patients but also the vital signs and those things. I think for the other units as well. And also, you know, working with paediatric patients is quite a difficult thing for them to handle a lot of the time. So usually they're paediatric patients that we deal with are having neurological problems as well, so that adds on to the difficulty of managing a patient like that. Not all are able to work with a patient like that.

Facilitator		Okay. Number 7?
7	F34	Okay, so I do feel that this simulation is very, very important. And, um, I've noticed a lot, for the last few years with the practical site being set-up at CUT the students are coming in more knowledgeable, so I do like that part. It shouldn't go away. However, the reality is much different. It will be 20 people to assist this patient because there are 20 students. In practice, it gives you, and allow you to develop the skills; practice makes perfect. And also, when you are in reality, you start to form that patient-staff relationship which in a mock simulation you won't necessarily have that patient-staff relationship being formed because it's you, and 20 other students. I like it where Number 6 said that they are book smart, but they're not street smarts, I can really vouch for her saying that. At the end of the day, we don't want these clin techs to come in, and they qualify, and they can't really do anything, lives are at stake! I don't want to be seen as a clin tech where my reputation is not the same, and people say oh, a clin tech comes in, but they can't do anything. A lot of these students I've noticed they come in, and they have this ideal world where they all watch Grey's Anatomy and this medical shows. As soon as they start working the reality sets in off long hours, and, actually, they need to do the work, and they need to play their part. Then eventually some of them become a bit depressed, and then they get over it, and life moves on, where I feel if they are exposed to the practical that will happen sooner, and it will be over sooner. I do believe that practical scenarios will teach these students to have empathy with patients and not sympathy.
Facilitator		Okay, so the next question is: 'What are the best modes of delivery to train students in the mentioned skills?' Now we're talking about how would you suggest we teach the students to be professional or be a communicator or how to treat a patient or how to act ethically? So I'm going to go down the list, Number 6?
6	F35	I think this is a very interesting topic that you're mentioning, and it's quite a broad aspect. I think firstly, we need to, everything is changing, not only with regard to COVID but the overall teaching method is also changing. So we need to look at the generation we are working with. Currently, we are all experiencing problems with the current generation, and basically, they have an attitude problem. And I think we as educators cannot change that. The student needs to change his attitude or her attitude. And I think that is really the key that can be addressed for students to take on teaching and learning content. And basically, I feel students don't know how to study. They don't put enough work or time behind these studies. And as I've seen with my own students, they don't go through the content. They leave it till the end until there's a test. And then they want the scope to be given for the test, etc. Basically, they are students, and they need to study, which I think CUT is really covering is the teaching of basic science which is important. We all laugh at ethics, until we in that situation, and then you don't really

Facilitator		know what to do, general practice training problem-based training, and continuous evaluation. I think our aim is to get the students ready for work-based assessment therefor at the end of their second year, they should be able to do written, and skill-based assessments and they need to integrate all the content that they learned over the first and a second year.
1	F36	Okay, thank you. Number 1? Yeah, I, I cannot see because we speak about how we can implement the things that we spoke about now, and I cannot see how we can do it if they're not coming to the different departments. They can observe how do I talk to the patient. What do I do, how do I do it? Simulation is not going to take that part; it might give a basic understanding. I can't say more than this, and I know it's not possible now, but we've seen this all the time for years now, and I know there is a simulation lab for how long now, and I can't see that it really makes a difference. So we will have to make another plan, something to get them exposed to practical scenarios, and not just a simulation because I think they take it as this is a simulation, and I don't even have to give my attention to it. Yeah, that's all. I just want to say something about the cell phone complaints. If you're the supervisor, you just take the phone if they are on the phone when they're busy with a patient. And then they can't get it back for the day, so that is absolutely something that works immediately. Right, that's all I want to say thank you.
2	F37	Thank you. Number 2? You know, difficult times, and the ethics, time management, how to study, students are struggling today, they demanding that scope be given I fully agree with Number 6. I think it's just the manner of, I heard in the interviews, telling me I will work up to two o'clock the morning to hand in my assignment on time, and then two weeks later I haven't received it. So, in that case, obviously, they get zero. I think it's a way of being brought up, students not knowing how to study exactly. And then the implementation of the ethics. Um, you're in an environment in the simulation with bypass. They definitely experience, asystole on a patient on bypass. When we practice that, and that is with real surgeons, and real sisters are working in the simulation lab. So, on our side, that is now third, and the fourth year, but exposing them to such simulations I don't think that's going to be possible on your side though, but just the basics of getting back to the implementation of noticing a patient with asystole, agonal breathing, lowered blood pressure or oxygen. I think of the BLS. Number 7 mentioned, definitely will help the student, exposing them to this, and just to give them a wakeup call as to what you have to look at. 'Om wakker te wees in jou omgewing.'
Facilitator		Number 9?

9	F38	Yes, I do think the ethical aspect is very important. But I think it differs from discipline to discipline. And I agree with Number 1 because it's difficult too. I think you must have knowledge about handling a patient what to do, what not to do, but it differs from various disciplines. I agree with the practical thing that the student must come and have a look in our department. How do you get a baby to lie still, or how do you handle the parents? What must you do ethically to get your job done? I think it's a very important thing, but I agree with Number 1 that you can't do it in a simlab you've got the theoretical knowledge, but I think the practical exposure is very important as well I don't know how to integrate that, but I think it's a very important thing.
Facilitator		Okay, thank you. Thank you. Number 3
3	F39	Yeah, I think, the interesting thing that I experienced was maybe to transition from this simulation to real experience, this is with some of the medical students were they in the training they actually have real people, they're actually drama students. And they're trained to react a certain way when you do something or say something. And it was just quite interesting to me. Maybe that's also to get that patient contact, not just being a dummy or simulator. I think that's something one can also maybe look in to with regard to giving them exposure to handling physical people rather than just a dummy.
Facilitator		Okay, Thank you. Number 4?
4	F40	It' is a really difficult question to actually to deliver it to students. Like, Number 6 has mentioned, um, it's up to the students to actually take in what you learn them. But I think with simulation I think I touched on it when I said, repetition. Suppose we can do more simulations more frequently. Sooner or later, they will be able to take a blood pressure without thinking twice, and knowing what it actually means when they have a measurement. And as Number 3 now said, drama students, that would help a lot for them to actually have other people, because practising on your friend in class is always fun and games, and they love it, and they don't really take it seriously. If they can have someone they don't know to practice on, that will help a lot. I know specifically, and the researcher can also mention this. A previous student from critical care, she could be a drama student, because practical exams she pretends she's deaf, or she pretends she is a psych patient, and those students they have memories of that practical exam, and how to handle that type of patient. So some of the students have had a touch of those scenarios. But like I said, I think more repetition of things like that with other people. I think it's just; it's going to be difficult because it's going to cost money, and it's going to cost people's time. But the repetition

Facilitator 5	F41	of things like that I think that's the only mode of delivery, and then willing students, that's all. Okay, thank you. Number 5? I think it's a very difficult topic to touch on here as many of the younger generations; everything is cyber-based they're all doing everything on their phone or through computers, and everything else. So they do lack a lot of people's skills, but one thing that they have to remember with say now cardiology, our patients are almost always if we're doing a heart sonar or ECG or stress-ECG our patients are exposed. So a lot of the students don't realize that we are dealing say know with a young lady in her 20s, she's exposed her top is removed, that you have to understand not to just barge into a room, and start talking or finish a procedure, allow her to cover up, quickly leave the room, those sort of things I think are very important for us because I've noticed our students will leave the room the patients lying there not knowing can they get dressed or not. So that's one thing that I've really noticed they need to be placed in the environment and see exactly what is expected of them, what is expected of the patient, and how to get it out of the patient. And that's something that a lot of them don't seem to understand. It's difficult to just go to a young woman and say, remove your clothes, and lie on the bed for me. So they have to understand how to work with the people and see how we do it in a professional manner that we are still respectful of the patient at the same time as getting what we need out the patient. And I've also noticed that the students they struggle a little bit with taking criticism, like if I correct the student, and say, you may not say this to a patient, they get very defensive with me. And that's not something that they're supposed to. They're supposed to know when I tell them something's wrong, they have to take it, and then correct it. So that's something that I've also realized is a difficult thing with the students nowadays, I'm not too sure how to fix this, but they need to understand to take the criticism, and become a better clin tech as a result of it.
Facilitator 8	F42	Okay, thank you. Number 8? Hi, I think it's more of the same actually. What I wanted to add to this, patient ethics have become extremely important in neurophysiology as well. Sometimes a patient is not able to give consent, and you have to get consent from the family to go on with the procedure. Sometimes a patient is confused or not working with you, and you sometimes have to restrain a patient then you have to know what the patient's rights are regarding that. Regarding children as well, the parent can get quite upset, and you almost have to have a psychology degree to be able to handle it, and sometimes before you can touch the baby or the child. Sometimes, working with autistic children, and children that have special needs is very difficult sometimes. I think I would suggest that maybe if they can help in the community or at a school with a special needs children, and just help out

Facilitator 7	F43	maybe with some of the children in such a school may help them a lot to be able to deal with the difficult type of persons, especially children, and people with disabilities. Maybe help out at the place where patients are recovering from a stroke or from being, you know, being in the hospital for a very long time in patients being intubated for a long time having to start all over again. Walking, and getting back to their normal lives maybe that would be helpful I don't know, but definitely, ethics is very important in our situation, and especially, if the patient seems strange, the students find it very funny. They can laugh about it a lot, so I usually have to kind of keep reminding them that even though the patient isn't aware, you know, of his own behaviour, is strange that you're still working with the human being, and even though, you know if the person seems strange to you the patient still got the right to do be treated humanely. And that is all I have to say about this. Thank you. Number 7? Okay, for me the best the mode to deliver training to these students is number one, we need to realize that we're dealing with millennials, and millennials are very different people. We need to get on their level. Otherwise, we are not going to get anywhere with these people. So we need to understand that they love technology, they love their phones they love the internet, they love music. So we need to incorporate our training by using these tools. First of all, we talked about how are we going to teach these people how to talk to people? Number two I suggest life coaching or a course in character development. And also, the psychological effect of how to debrief with your stress how to debrief with what you see at work. I think that's quite important how to manage your time. I like the suggestion that was made when they do the mock simulations that they actually use drama students. Maybe you guys can set up something with the University, and drama students can come in. I almost want to say 'New Age' training where you use videos when you train students. You need to relate on their level and guide them. There is a game I play with the students on the phone it's called Kahut, and I usually do the questionnaire on there, and then they answer on the phone. And if you play against each other, they quiet loved that, or if you use dance music. There where they say what the students are lacking is that they don't see themselves in the patient's body, and the patient's feet. Um, so, what my suggestion is, this is maybe quite rude, a cruel way of teaching. To actually to have a student, and say okay, will do the BP on you while you lie naked, and then they'll realize, oh, what about my privacy. Ah, what about my patient's privacy? I know it is a cruel method. I've also realized that a lot of students they can't read so, and what I mean by that with they can't read, is that you ask them a question, and they don't answer the question. I realized that they don't read. Our students just study for the test. The next day, they don't remember anything. Students talk to one another they know the scope from previous years, because of the test, being mostly similar. Therefore, refrain from the previous because the test being mostly similar. Also, a friend from the previous year will be helping them out. My suggestion will be to change

Facilitator 6	F44	the test more frequently not to use the same questions year in, year out with the tests maybe have a theoretical approach and a practical approach? When you put these students in scenarios and actually see how are they thinking. Then on the ethical side, I don't know if this is possible. I don't think they understand the seriousness of a court case. For me, as clin tech, I understood it the day I was exposed to it. For me, I'll maybe suggest either there is case studies being read to the students, or actual court case exposure that they can see where they will end up if it goes all sideways. That's my suggestion on how we can deliver training to the students my main message is, if you're dealing with millennials, we need to know what we are dealing with. Otherwise, no matter what we do, it will not sink in what we are trying to teach them, it will not sink in! Okay, the next question you're on, I'm going to ask you again, to just scroll down a bit. I don't know if you add it? Okay, you've added that. Okay, so your next question is: 'In your opinion, what role can simulation play in training, and assessment of this first, and second-year students?' So we want to know, do you think that a simulation program can be used to train, and assess the first, and second-year students? So Number 6? So personally I think yes students should be exposed to the simulation program, but it should not end there. Debriefing afterwards, discussing what happened in the simulation, why they had to have a specific approach to the simulation scenario. I think all of that needs to be taken into consideration. But as it was also said that some students don't understand something, until they stand in the shoes that day or next to the bed. And so I think a holistic approach to the simulation program would be useful.
Facilitator 1 Facilitator	F45	Thank you. Number 1? I think, from my side I made it clear that the simulation didn't help too much in the past, I know if I look at yes, there may have been some advantages, but taking into account all the things that I experienced year after year I cannot see that it makes that big difference. So, in my opinion, it's got a limited place I think the other universities that opt for a thing that the students in first, and second-year as far as I know, or third year, I'm not sure they get six months' theory, and six months practical. With us, it is full time, a two-year theoretical experience that they have. And it is if just not we just don't get the 'product of a student' that I would have liked to have in my third year. So I think they, they definitely will have to get more exposure to a real hospital environment. I don't know if it's possible, but I think the simulation is just limited; it's got a limited advantage at this stage. I don't know if we do it another way, apply it in another way, maybe it can work, but for me, it's not working at this stage. Thank you. Okay, thank you. Number 2?

2	F46	Understanding where Number 1 is coming from with this. I think some of our other specialities, going back to start with the basics to fill the gaps that we currently experience. We can give it a go, and see where we will end.
Facilitator		Number 9?
9	F47	I think what you must ask the question of what is your aim with the simulation thing. Is it just to teach some basic stuff? Because I agree with Number 1, we don't have very good results on the simulation thing, but the question is what, what is the aim? So I do think there is some positivity in the simulation lab for the basic stuff like basic imaging, how to handle a patient, and all the basic stuff, but that differs from discipline as well. I think there is something positive in a simulation-lab for the basic stuff. It depends on what your aim is for the simlab?
Facilitator		Okay, thank you. Number 3?
3	F48	I think simulation does have its limitations. But I think that's going to be kind of the way going forward. If it's going to be perfect is something else. But I think as technology enhance, you'll also have to keep up, and do more the technology is the way you're going. I don't think it will totally replace experience, but I think it's going to play more, and more an important part in the future.
Facilitator		Okay, Thank you. Number 4?
4	F49	In my opinion, I do think the simulation can help for the first year, and the second year, as I also mentioned just have to know what your end goal is, so this simulation wouldn't be for a complete critical care technologist. It is just for them to be prepared to step into a hospital environment. So, currently, the simulation that the students get at CUT it's just a small part. If we can get simulation, up to were 'Kovies' has it, I think it would really benefit our students if they can do it from first, and the second year. And if we have simulation as basically almost like a subject that they can do. So then like I said repetition so the more they have exposure to a simulation unit, and a full functioning one with all the equipment that we would like to have, critical care all the specialities because currently there's only a couple of things they get exposed to they don't get exposed to everything in all the specializations. So if we can get a fully-fledged simulation unit, and have a subject first, and the second year, and get drama students involved. Number 8 also said to go to communities to work with different people. I really do think we can use it as assessment for first, and second years, just with the end goal, namely the second year so only basic things, not a specialization yet. So yeah, that's what I think.

Facilitator		Good. Thank you. Number 5?
5	F50	Um, yes I do think that simulations can play a part if you do it correctly with the students as Number 4 had previously mentioned. That if you do a simulation, and it's your friends, it's all fun and games. We have to teach these students that when you're working with a patient even when you're talking to them, anything can go wrong with them at any point in time, they have to understand that they have to be very wary of patients at all times. People do die in our profession, and we have to know how to react very quickly in the right way to prevent this. So if they have simulations that can sort of predict these things, and get them to identify problems quicker like they can see a patient is about to crash or something then I think it would be a little bit more useful for us, they can understand how to look at their patients, and understand what to do, and when to do it under a stressful environment, not the fun, and games of, oh 'haha' this is so nice, and fun we should do this more. It must be a very stressful environment to simulate the real world like in theatre or anything that goes wrong with our patients, it's for them to understand, and they need to know how to react to it.
Facilitator		Okay, thank you. Number 8?
8	F51	Um, to be honest, I'm not entirely sure how much help simulation would be for neurophysiology department? I can imagine that it is quite powerful in all of the other disciplines. I don't know really what the extent of the simulation, can be? I think for neurophysiology it can be a bit limited? I would really like to see the students, except for the fact that they could give oxygen, and take blood pressure, and things like that, that they are able to communicate very effectively, especially with different kinds of patients because that's the main thing where the CUT simulation can actually be helpful in my case. And I think community projects would be very helpful maybe help with epilepsy awareness. They can go out and do something for epilepsy awareness or for the kidney awareness day. Maybe do something for the community regarding kidney awareness day? Maybe take some blood pressures, and, you know, assess patients for pre-assessment may be for patients at the hospital. I don't know if that's possible at all? And just assist maybe in primary care clinics a little bit, you know, getting them exposed in the early years as well. And also, what I wanted to add is that I think students don't really have a clue about what they really want to do unless they come for their unit visits. And I think it would be good if they actually in their first year, do a little bit of research on the different disciplines because I found that a lot of students apply for neurophysiology and halfway through they feel this isn't really for them. They really don't understand what they want to do. I think if they can be trained, or expose to have some knowledge or some research regarding each discipline, and what it requires I think that will also be very helpful, especially so that you can help the students that really want to be in your unit do to end up in your

Facilitator		unit. I think I have gone off the point here, but that is just something I wanted to add.
7	F52	That is fine. Okay, Number 7? Yes, I do feel that simulation is very good. However, I do feel simulation should not replace your practical exposure, and your simulation, the approach needs to be changed to be on the same level as the clin techs, and it needs to be the most realistic scenario possible that it can be, then I think it will work. And I think if there's no practical exposure, you will end up with clin techs that will have a qualification but they can't do anything. I just want to add on the first question I forgot to mention another thing I do feel the students' needs to be exposed to is hand hygiene and sterility just basically how to wash your hands, and how to keep your environment sterile. So that you don't walk into a theatre, and contaminate everything. And on the previous comment that was made, we should say, my suggestion they maybe have a person from every group from nephrology from critical care etc., and actually have a session with these students, and actually saying this is what I do on a day to day basis. I wake up at 4 am, this time I start at work. This is what I do at work, here are photos of what I do ask me questions because a lot of times, I think when they do the rotation at that moment they too shy to get a real feeling for what every division is about for example.
Facilitator		Okay. I have one last question for you. We've discussed a lot of things today, and I would just like to know if there is something that is most important for you, and that you would like to express regarding the practical, and skills training of first, and second-year students. Number 6?
6	F53	Yes, with regards to simulation I have to agree with Number 9, and Number 1 that, in retrospect over the last few years, we haven't seen much results of the students, you know, coming through the program, but I also have to add, I think it's only recently that the researcher is taking up the simulation, and skills lab, and I think his aim is definitely to develop a proper skills lab to equip the students, but I also think that one needs to clearly have specific objectives that one would like to achieve. And one can perhaps have an ethical station, a history station, starting with the basics, and working the students through with that. And then once a person has clearly set goals, we can take the students through that, and maybe review the simulation program over a few years again.
Facilitator		Okay, thank you. Number 1?
1	F54	Yeah, I agree with Number 6, I think, as far as I know, the students in first, and the second year, it was always like that. I'm not sure it's still like that, especially the second year students had a lot of time on their hands a lot of

Facilitator		free time. And yeah, if they can maybe incorporate more time in that simulation lab of theirs, maybe it will help that's my opinion. Thank you very much. Number 2?
2	F55	I really agree that simulation will definitely make a difference. We're still in a learning curve with the simulation program running for the first, and second years. So every input every year, every struggle that we get, and that we give back feedback to you. I think we will definitely be able with the research to fill those gaps. Everything will not be covered. But if basics can be covered. I really agree that it will definitely better outcome.
Facilitator		Number 9?
9	F56	I do think the simlab is in important. I think it's gonna play a bigger role in future. But, as they said, CUT is just in the process of developing this whole thing, and I think that the way things going more with simlabs, and stuff like that, but I think there must be a follow-up discussion here with every discipline, and to identify clearly what the need is for regarding a simlab, for example, cardiology or pulmonology or whatever their discipline is. So I think if the researcher exposed more the different disciplines, and see what the need is there is definitely a positive thing regarding the simlab. That's how I am feeling.
Facilitator		Thank you very much. Number 3?
3	F57	I think it is a complex field with all the specialities you have to cover, and you have to get input from the different people. And I think that's what why we're doing it today as well, so I think that you need to cover the whole spectrum.
Facilitator		Thank you. Number 4?
4	F58	Yes, I agree with everyone. I'm very excited. If CUT can get up their simulation lab that's fully-fledged with everything. So the most important part of the simulation unit that I would like to emphasize again is just observation skills of the students if we can just get them to actually notice things, and know how to act, just the basic things with their vital signs. I know with my lecturer in the third, and the fourth year, I didn't understand why he would go to bed, and tell me okay what do you see wrong? And then you think of all these major things is the patient bleeding is, is this, or this, and then just to notice it's a small thing, the saturation probe, and the BP cuff is on the same leg. Small things like that so if we can get a unit,

Facilitator		that's fully-fledged, and with all the things can just repeat, and have their first, and second-year students from the beginning of the year, be in that unit with all the free time that they have. I really do think the simulation could benefit us a lot, and then when they come, and decide which specialization they are going to go into, then we focus on the specialization itself, and not have to go back to the basics with all the students. So yeah, I'm excited, so good luck.
5	F59	Thank you. Number 5? I do believe that simulation like this; it could have a lot of potential for the students if it's done correctly. If every speciality could say that listen here we lack skills with say now ECGs, we need the students to know say now A, B, and C, we need them to know this, in order to do it better, so I think a lot of feedback will be a lot of positive help here. Like, say now we can see what our students are doing in the next few months, and say our students still struggle with taking a blood pressure reading or so, and so. Then, that can be implemented into the skills lab I think that those sort of things can be very beneficial for the students, and they can also get the idea of the environments that they're going to be working in. Because going to different environments, critical care is completely different from saying cardiology, completely worlds apart, but yet we are doing something similar. So if they can get the basic ideas of everything, and we can get feedback I think it'll be a very very beneficial thing for students. I'm quite excited to see what results from the simulation lab.
Facilitator		Thank you. Number 8? Hi, regarding simulation lab I'm not entirely sure that it's going to really benefit neurophysiology that much, and I would really have to see what the simulation lab can give us, but I think for the overall students in clinical technology it will definitely be beneficial. I think with neurophysiology, maybe not so much but maybe we can work something out later on. Neurophysiology is a bit different we don't usually have ECG's, and things like that, in our labs, you know. So, I think it's a bit limited regarding our specialization. But I think overall for clinical technology will be quite helpful.
8	F60	
Facilitator		Thank you. Number 7? Just, in conclusion, I'm very excited to see the outcome of this simulation unit. If the researcher needs any help in nephrology, he is more than welcome to contact me, and I can give you my two cents of worth. My final message will be for these students or my wish for these students is that they know the basic things. They know, and they take in their surroundings. They know how to apply basic things, and they know how to work with
7	F61	

Facilitator		people, to have compassion with people and the most important that they love a career, and that they have fun. Because, yes, it's all serious, but at the end of the day you still need to love your career, and that's our wish that at the end of the day that will be the main objective for these students. I would just like to thank everyone thanks so much for your participation. We really appreciate all the time that you spent with us on a Friday afternoon. I think it was a very successful discussion, and your opinions will be a very valuable asset in this study. Just one last thing before I conclude the meeting, please just remember to complete the questionnaire that was sent to you by the researcher, and please return it. And then I wish everyone a happy, I always want to say holiday, but it's only a weekend so have a wonderful weekend. Hope to see you guys soon. Meeting concluded

Appendix: D1



Dear **Mr Johann Perkins**

Ethics Number: UFS-HSD2020/0165/2104

Health Sciences Research Ethics Committee

19-Jun-2020

Ethics Clearance: **A sustainable clinical simulation framework for pre-specialisation clinical technology training in South Africa**

Principal Investigator: **Mr Johann Perkins**

Department: **CUT - Central University of Technology SUBSEQUENT SUBMISSION APPROVED**

With reference to your recent submission for ethical clearance from the Health Sciences Research Ethics Committee.

I am pleased to inform you on behalf of the HSREC that you have been granted ethical clearance for your request as stipulated

below:

Minor Amendment:

Due to the COVID-19 outbreak, face-to-face Focus group and Nominal group meetings will be changed to online or virtual meetings.

The online meetings will be conducted via an online meeting platform/application e.g. Zoom or GoToMeeting

The online meetings will adhere to current Worldwide and South African lock-down rules and regulations of social distancing

and limited travel between provinces.

An electronic index card document, that can be submitted electronically (Appendix C4) will be used during the nominal

group meetings via the online platform instead of paper index cards which would have been used during a face-to-face nominal

group meeting.

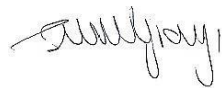
The HSREC functions in compliance with, but not limited to, the following documents and guidelines:

The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this request for ethical clearance and we wish you continued success with your research.

Yours Sincerely



Dr. SM Le Grange

Chair: Health Sciences Research Ethics Committee



Health Sciences Research Ethics Committee Office of the Dean: Health Sciences

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Appendix: D2



Research Ethics Committee

The TUT Research Ethics Committee is a registered Institutional Review Board (IRB 00005968) with the US Office for Human Research Protections (IORG# 0004997) (Expires 14 Jan 2023). Also, it has Federal Wide Assurance for the Protection of Human Subjects for International Institutions (FWA 00011501). In South Africa it is registered with the National Health Research Ethics Council (REC- 160509-21).

September 16, 2020

REC Ref #: REC2020/08/003

Name: Perkins, JJ

Mr JJ Perkins C/o Dr L Botes

Department of Health and Environmental Sciences University of Free State

Dear Mr Perkins,

REC Ref #: REC2020/08/003

Name: Perkins, JJ

Decision: Gatekeeper permission - Final Approval

Name: Perkins JJ

Project title: *A sustainable clinical simulation framework for pre-specialisation clinical technology training in South Africa*

Qualification: Doctorate in Health Sciences (Clinical Technology),

Supervisor: Dr L Botes

Co-supervisor: Prof MJ Labuschagne

REC Ref #: REC2020/08/003

Name: Perkins JJ

Thank you for submitting the revised project documents for review by the Research Ethics Committee (REC), Tshwane University of Technology (TUT). In reviewing the documents, the comments and notes below are tabled for your consideration, attention and/or notification:

Proposal

The revised proposal is in order and duly noted.

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Appendix B1, Letter of Invitation

The revised Letter of invitation is in order and duly noted.

National Lockdown and COVID-19 guidelines

Please take note of and adhere to the guidelines stipulated in the document included with the feedback letter entitled, “Implications of alert levels for researchers and postgraduate students during the COVID- 19 pandemic.”

The Chairperson of the Research Ethics Committee, Tshwane University of Technology, reviewed the project documents at its meeting on September 16, 2020. **Gatekeeper permission** is granted to the study.

The proposed research project may now continue with the proviso that:

The researcher/s will conduct the study according to the procedures and methods indicated in the **approved proposal**, particularly in terms of any undertakings and/or assurances made regarding the confidentiality of the collected data.

The proposal will be submitted to the Committee for prospective ethical clearance if there are any substantial **deviations** and/or changes from the approved proposal.

The researcher/s will act within the parameters of any applicable **national legislation, professional codes of conduct**, institutional guidelines and scientific standards relevant to the specific field of study. Strict adherence to the following South African legislation, where applicable, is especially important: Protection of Personal Information Act (Act 4 of 2013), Children’s Act (Act 38 of 2005) and the National Health Act (Act 61 of 2003).

The researcher will inform the REC as soon as possible of any **adverse events** involving research participants that may have occurred during the course of the study. It includes the actions and/or processes that were implemented to mitigate and/or prevent any further injuries and/or adverse outcomes.

The researcher will inform the REC of any **new or unexpected ethical issues** that may have emerged during the course of the study, as well as how these ethical issues were addressed. The researcher must consult with the REC for advice and/or guidance in any such event.

The current ethics approval expiry date for this project is **September 15, 2022**. No research activities may continue after the ethics approval expiry date. An application for the extension of ethics approval must be submitted for projects that need to continue beyond the expiry date.

Note:

The reference number [top right corner of this communiqué] should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants.

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Yours sincerely,



H Mason (Dr)

Chairperson: Research Ethics Committee [TUTRef#2020=08=003=Perkins JJ]