EFFECTS OF HIGH FIDELITY PATIENT SIMULATORS AS TEACHING LEARNING STRATEGIES ON LEARNING OUTCOMES AMONG NURSING DIPLOMA STUDENTS IN MALAYSIA

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FACULTY OF MEDICINE
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EFFECTS OF HIGH FIDELITY PATIENT SIMULATORS AS TEACHING LEARNING STRATEGIES ON LEARNING OUTCOMES AMONG NURSING DIPLOMA STUDENTS IN MALAYSIA

ABSTRACT

Simulation education with High Fidelity Patient Simulators (HFPSs) is a teaching and learning tool that serves as a bridge between classroom learning and real-life clinical experience for novice learners. Optimization desired learning outcomes of nursing students is challenged by lack of experiential learning in multiple disciplinary settings and failures in communication between health care providers exposing patients to adverse events that threaten patient safety. What makes HFPS so useful is its ability to simulate realistic clinical situations and settings with no risk to the safety of patients. This study aimed to examine the effectiveness in the learning outcomes (knowledge, skills performance, critical thinking, learners' satisfaction and self-confidence) using an adult code blue simulated programme on a High Fidelity Patient Simulator (HFPS) and low fidelity patient manikin (LFPM) for nursing students in Malaysia. This is a quasi-experimental pre and post-test study. The universal sampling included all year-3 diploma-nursing students (N=389) from three participating nursing schools in Malaysia. Instruments used were 30-single best questions for knowledge, 40-items skills performance observational checklist, 75-items of California Critical Thinking Disposition Inventory (CCTDI) for critical thinking and 36-items likert scale for satisfaction and self-confidence. All instruments went through back translation from English to Bahasa Malaysia. All instruments were distributed and pre-tested by all students prior a lecture delivered on managing deteriorating patient. Students and assessors were double blinded in the selection of control and intervention groups whether using HFPS or LFPM. Briefing was given to both students and assessors for control and intervention groups for the roles and responsibilities held in skills performance learning outcome using HFPS or LFPM. The same instruments were distributed and post-tested immediately after students' exposed to HFPS or LFPM but the 30-single best questions were given to all students 2 months later. The demographic characteristics of students were 20-year-old 259 (66%), predominantly female, n=359 (92%) and n=30 (8%) male students. Majority of students (n=384, 98%) possess SPM equivalent qualification. Students were majority from average academic performance, CGPA of 3 to 3.5, has n=110 (61.1%) in control and n=112 (53.6%) from the intervention groups. Students with previous simulation training was n=155 (40%) while those never been exposed was n=234 (60%). A repeated-measures analysis of variance revealed a statistically significant effect of intervention groups with HFPS as teaching learning strategy after controlling for demographic characteristics: knowledge ($p<0.05$, $\eta2=0.1460$), skill performance ($p<0.05$, $\eta2=0.744$), critical thinking ($p<0.05$, $\eta2=0.119$) and satisfaction and self-confidence ($p<0.05$, $\eta2=0.636$). The critical thinking overall means score was found decreased for both post-test intervention and control groups. However, truth-seeking scores shown increment post-test (intervention, 0.86±SD6.71; control, 0.45±SD6.61) adversely decrements in CCTDI subscales. All demographic characteristics have no association with the learning outcomes and non-significant correlation between the each type of learning outcomes in this study. The utmost value of this study is to create awareness and management of change in the current nursing education system to enhance learning, instill the importance of patient safety practices and achieving the learners' satisfaction and confidence in learning process. However, there are pitfalls in supporting the use of simulation education in practice and the learners' ability to transfer learned outcomes to clinical practice in long-term retention. In conclusion, the intervention groups using HFPS had positive effects in learning outcomes and simulation education promotes new innovative experiential learning that enhancing the quality of nursing profession of this country.

Keywords: High Fidelity Patient Simulators; Knowledge; Skills performance; Critical thinking; Satisfaction and self-confidence.

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ABSTRAK

Pendidikan simulasi dengan menggunakan *High Fidelity Patient Simulators (HFPSs)* adalah alat pengajaran dan pembelajaran yang boleh berpaut antara pembelajaran di kelas and pengalaman klinikal yang realistik untuk pelajar baru. Halangan untuk menghasilkan pengajaran optimal telah dicabar oleh kekurangan pengalaman pengajaran di lingkungan disiplin pelbagaian dan kegagalan kakitangan kesihatan berkomunikasi, ianya telah mendedahkan pesakit kepada perkara mudarat yang boleh mengancam keselamatan mereka. Kebaikan pengunaan HFPS berupaya untuk memberi simulasi sebenar di situasi klinikal dan linkungannya di mana ianya tidak mendatangkan risiko terhadap keselamatan pesakit. Kajian ini bertujuan untuk menilai kesan intervensi hasil pengajaran (pengetahuan, praktikal, pemikiran kritikal, kepuasan dan keyakinan pelajar) dengan menggunakan program simulasi *code blue* dewasa atas *High Fidelity Patient Simulator (HFPS)* dan *low fidelity patient manikin (LFPM)* bagi para jururawat pelatih di Malaysia. Ini adalah reka bentuk quasi-eksperimen di antara kumpulan pra dan pasca-intervensi. Sampel universal meliputi semua pelatih diploma jururawat tahun ketiga (N=389) dari tiga buah sekolah yang menyertai kajian ini. Peralatan penilaian digunakan adalah 30-soalan aneka pilihan untuk pengetahuan, 40-item senarai semakan pemerhatian untuk praktikal, 75-item *California Critical Thinking Disposition Inventory (CCTDI)* untuk pemikiran kritikal dan 36-item skala *likert* untuk kepuasan dan keyakinan pelajar. Semua peralatan penilaian telah diterjemahkan dari bahasa Inggeris ke Bahasa Malaysia dan sebaliknya. Semua peralatan penilaian juga diedarkan dan pra-ujian menilai semua jururawat pelatih sebelum kuliah bertajuk pengurusan pesakit yang tenat diberikan. Taklimat juga diberikan kepada jururawat pelatih, ianya merangkumi peranan dan tanggungjawab bersandang dalam hasil pengajaran praktikal samada menggunakan HFPS atau LFPM. Peralatan penilaian yang sama diedarkan dan pasca ujian dinilai serta merta setelah pendedahan kepada HFPS atau LFPM tetapi 30-soalan aneka pilihan untuk pengetahuan diberikan kepada para jururawat pelatih dua bulan kemudian. Ciri demografi jururawat pelatih adalah dari 20 tahun 259(66%), dominasi adalah perempuan, n=359 (92%) dan n=30 (8%) pelajar lelaki. Majoriti pelajar (n=384, 98%) berkelulusan SPM atau kelayakan setara. Mereka adalah dari pencapaian akademik sederhana, CGPA of 3 to 3.5 mempunyai n=110 (61.1%) di kumpulan kawal dan n=112 (53.6%) kumpulan intervensi. Jururawat pelatih mempunyai pegalaman latihan simulasi n=155 (40%) sementara tanpa latihan simulasi n=234 (60%). Analisis berulang langkah varians mendapati kesan kumpulan intervensi menggunakan HFPS sebagai strategi pengajaran pembelajaran setelah dikawal ciri demografi: pengetahuan ($p<0.05$, $\eta 2=0.1460$), praktikal ($p<0.05$, $\eta 2=0.744$), pemikiran kritikal ($p<0.05$, $\eta 2=0.119$) kepuasan dan keyakinan jururawat pelatih ($p<0.05$, $\eta 2=0.636$). Secara keseluruhan skor min pemikiran kritikal menunjukkan pengurangan untuk kedua-dua kumpulan pasca ujian intervensi dan kawalan. Walaubagaimanapun, skor *truth-seeking* meningkat pasca-ujian (intervensi, 0.86±SD6.71; kawalan, 0.45±SD6.61), sebaliknya pengurangan pada skala cabangan *CCTDI.* Kesemua ciri demografi tiada hubungan dengan hasil pengajaran dan tidak signifikan correlasi di antara setiap jenis hasil pengajaran di kajian ini. Pendapatan yang paling penting di kajian ini adalah mewujudkan kesedaran dan penukaran pengurusan ke tahap terkini dalam sistem pendidikan kejururawatan untuk membawa peningkatan dari pengajaran, menekan kepentingan praktis keselamatan pesakit dan mencapai kepuasan dan keyakinan dalam proses pembelajaran para pelajar. Namun, cabaran-cabaran diketengahkan perlu menyokong keseluruhan implementasi pendidikan simulasi dalam praktis dan kemampuan para jururawat pelatih untuk mengagihkan hasil pembelajaran yang telah dipelajari ke klinikal sebenar dan dalam retensi jangka masa panjang. Secara rumusan, kumpulan intervensi mengunakan *HFPS* memberi kesan positif dalam hasil pembelajaran dan pendidikan simulasi menggalakkan pembelajaran berinovatif dan cara pembelajaran berdasarkan pengalaman dalam meningkatkan quality profesen kejururawatan di negara ini.

Katakunci: *High Fidelity Patient Simulators;* Pengetahuan; Praktikal; Pemikiran kritikal; Kepuasan dan keyakinan pelajar.

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TABLE OF CONTENTS

CHAPTER 3: METHODOLOGY

CHAPTER 4: RESULTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Introduction

Simulation education using High Fidelity Patient Simulators (HFPSs) is a teaching and learning tool that serves as a bridge between classroom learning and real-life clinical experience for novice learners. It has been widely adopted by healthcare programmes to meet four purposes, namely education, assessment, research and health system integration in facilitating patient safety. Simulation is a teaching technique rather than a technology. A nationwide nursing study conducted by the National Council State Board of Nursing (NCSBN) demonstrated strong evidence supporting the use of healthcare simulation in pre-licensure nursing education (Society for Simulation in Healthcare (SSIH), 2014). The findings revealed that key success factors in nursing education simulation programmes requires the inclusion of a dedicated team of educators who are well trained in the best practices of theory-based simulation and structured debriefing methods (NCSBN, 2014). The recognition of simulation education is mandated by various training jurisdictions to achieve entry-level nursing qualification in the UK and US to in healthcare settings (Larue et al., 2015; Ricketts, 2011 cited in Cant & Cooper (2017). The right training and dedicated team of educators, and adequately utilisation of available resources in simulation education has significantly improved the learning process and enhanced quality nursing education.

1.2 Background

The use of HFPS is a popular teaching strategy in pre- and post-registration nursing education in Malaysia. The acquisition of clinical skills is an essential component in nursing education, which consists of 40-50% of the curriculum. Nursing education is becoming competitive and commercialised among nursing schools in Malaysia, with obtainment of clinical placements for nursing students a major concern among nursing school administrators. The administrators of these nursing schools need to adhere to the nursing curriculum as regulated by the Nursing Board Malaysia. This includes ensuring that every nursing student is afforded the opportunity to practice their clinical skills and thus fulfil learning outcomes. According to Nehring (2008), Seropian, Brown, Gavilanes, and Driggers (2004b) cited in Maas (2010), the larger student enrolment into various nursing programs in Malaysia has led to a need for additional clinical experience as well as alternative methods for students to practice their clinical skills. It is difficult to provide adequate clinical placements for nursing students to practice the essential nursing skills while also caring for multiple patients (Schultz et al., 2012). Concerns have been raised with regard to the ability for novices to practice in a safe manner in a clinical setting, while balancing opportunities to learn more complex patient care experience within the learning objectives of nursing (Gordan, 2009; Huseman, 2012; Cooper et al., 2013; Cooper et al., 2015). Existing hospitals in Malaysia are overcrowded with students from various programs such as nursing, medicine and other health sciences programmes such as physiotherapy, radiology, traditional Chinese medicine. These include students from a range of different student stages of ability, from diploma to doctorate level. Students who do not meet the necessary clinical placement hours may not fulfil their learning outcomes and are limited by their inadequate learning experience.

The shortened duration of these clinical placements may reduce student opportunity to consolidate practical skills, particularly if the placement time is not used effectively. This results in students that are ill-prepared to develop further appropriate skills relevant to their clinical experience (Jowett & Watson, 1994, cited in McCallum, 2006;

McCaughey & Traynor; Maas, 2010; Richardson et al., 2014; Rushton, 2015; Cooper et al., 2015).

The quality of nursing education is important as it has direct impact in shaping the nation's future and the nursing profession. Thus, nursing colleges and universities should look for ways to enhance instructional efficacy which could lead to increasing both nursing skill and satisfaction, which would in turn help sustain the quality of nursing graduates. Patient safety has been shown to be at risk in clinical settings if students are not well prepared to perform essential nursing skills on real patients. What makes HFPS so useful is its ability to simulate realistic clinical situations and settings with no risk to the safety of patients. Since the anatomically correct mannequin simulates an actual patient, students can make mistakes without harm, allowing them to learn at their own pace and improve by receiving immediate feedback. Scenarios using HFPS can be set-up to replicate patient conditions that respond to communication, electrocardiogram (ECG), heart and lung sounds, vital signs, administration of medications and emergency procedures such as cardiopulmonary resuscitation (CPR), airway management and defibrillation. This simulator can react physiologically through computer control by the instructor as students interact and intervene. Simulation creates experiential learning, which has been shown to help learners with integration of content that is necessary for safe and effective clinical practice (Jeffries, 2012).

Hospital settings are becoming increasingly too restrictive to allow for extensive student practice due to patient confidentiality issues and potential legal ramifications (Richardson & Claman, 2014). Student may not have opportunity to practice complex situations and patient acuity that limit novice student achieving learning objectives according to their level. To the knowledge of the researcher, the Kuala Lumpur Hospital which is the largest government hospital in Malaysia offers specialisation areas such as critical care, burn units and operating theatres for clinical posting to post basic nursing students rather than students from general nursing programmes. Faculty members prefer fewer students to supervise as they feel more secure in the ability to control for and prevent errors with acutely ill patients in a clinical setting (Richardson et al., 2014). Trained nurses who are experienced in technical care are in great demand for effective patient care in hospitals, nursing homes, or ambulatory care settings. Clinical skill laboratories are important centres for nursing education. It is part of the nursing curriculum to allocate designated hours for students to practice in clinical skills laboratories before their clinical posting (Nursing Board Malaysia, 2015).

The use of life-size mannequins in nursing education started in 1911. It became popularised in the 1950s as it helped students relate theories to practice (Hyland & Hawkins, 2009 cited in Roberts & Greene, 2011). The first low fidelity simulators were used in the 1960s, with the resuscitator 'Anne' still used today for resuscitation and emergency care training (Laerdel 2007 cited in Roberts & Greene, 2011; Alinier & Platt, 2013). The models use in simulation improvised over the years. In the application of the Dreyfus and Dreyfus (1980) model of skill acquisition, Benner (1984) outlines how nurses progress from novice to expert status. The third stage of this process is described as 'a passage from detached observer to involved performer, this performer is now engaged in the situation'. Simulation plays an active engagement in this third stage (Roberts & Greene, 2011).

According to Roberts and Greene (2011), the analogy of simulation as theatre outlines the concepts of the theatre and stage (simulation laboratory), the play itself (simulated clinical experience), the actors (nursing students), audience (peer review panel), director (session facilitator), and production team (technical coordinators). According to Gaba (2004), simulation is described as a 'technique and not a technology that can be used to replicate a real-life clinical experience'. The emphasis of simulation in education promotes strategy for pedagogy rather than the confounding the expert in technology. According to Laerdal Malaysia (2017) in the National Simulation User Network conference held in Perdana University, Malaysia, HFPS was first introduced to both Malaysia and Singapore in 2003. Two public universities purchased HFPS for teaching purposes in their medical programmes according to Laerdal Malaysia (2017). In 2011, the first private university located in Selangor purchased the HFPS for the same programme. However, the purchase in Malaysia could not be maximised for use in teaching and learning compared to Singapore due to the high cost of HFPS as it requires regular maintenance, programme upgrading and commitment from faculty members according to Laerdal Malaysia (2017).

For the purpose of this study, the researcher focused on code blue responses on deteriorating patients in simulation teaching for final year diploma nursing students, as this requirement is perceived as a prerequisite before becoming a state registered nurse (SRN). There is a need for early identification and management of patient deterioration as this is the basis of essential nursing care, with potential for major impact by ensuring more positive patient outcomes. In a systematic review conducted by Cant and Cooper (2017), management of a deteriorating patient is categorised as a prerequisite skill for advanced undergraduate students. Role-play in simulation education can help students apply knowledge of theories to simulated practice.

1.3 Problem Statements

1.3.1 Statistic

According to a report from the Nursing Board of Malaysia in 2015, there are total of 99 nursing schools in Malaysia. Of this number, the government nursing colleges and universities comprise a total of 28 schools (Ministry of Health = 21; Public university = 6; Ministry of Defence = 1). The private sector has 71 institutions offering diploma level nursing programmes. There were a total of 100 accredited hospitals by the Ministry of Health Malaysia that accepted these diploma nursing students from both the public and private institutions for its clinical placements in 2015.

The number of private nursing diploma graduates who took the Nursing Board licensure examination increased from 4,025 in 2008 to 7,665 in 2010. Upon closer examination however, the passing percentage decreased from 86.5% to 70.1% during the same period (Star newspaper, 2012). There were a total number of 14,347 nursing students registered for the Malaysian nursing board licensure examination, with 12,923 obtaining their license of practice as state registered nurse in 2013, while 17,042 registered for nursing board licensure examination in 2012 and 15,242 obtained their license of practice as SRNs. The number of nursing students who failed their Malaysian nursing board licensure examination was 1,424 in 2013 while 1,800 nursing students failed in 2012 respectively (Nursing Board of Malaysia, 2015). The Star newspaper (2012) stated the Nursing Board of Malaysia recorded 5,000 graduates from private institutions of higher education who had yet to apply for an annual practicing certificate in 2012.

In Malaysia, nursing students from public and private organizations are required to complete their theory and practical components before they can register for the Malaysian Nursing Board's licensure examination. Nursing students require three years to complete their diploma course while four years is needed to complete the bachelor's degree programme. Both diploma in nursing and bachelor of nursing students are required to take the same nursing board licensure examination. Statistics indicate a decreasing trend in the number of nursing graduates since 2012. It was reported that there were 18,000 unemployed nurses in 2013 in Malaysia, with an average of 15,000-17,000 graduate nurses per year from 2012-2013 (Nursing Board of Malaysia, NBM, 2015).

The Star newspaper (2012) previously reported hospital administration concerns over unemployed, new graduate nurses who were reported as being picky, lacking in soft skills, possessing poor language competency and reluctant to serve beyond their own comfort zone. Vimala Suppiah, the president of the Malaysian Society for Healthcare Delivery stated in response to this that nursing is a technical job and indicated the lack of proper practical work training as the real reason for unemployment among nurses. Staff nurses and matrons have complained of the poor quality of nursing graduates in the past (Star newspaper, 2012). One of the strategies to overcome this issue included the approach by NBM of to allow the use HFPSs as a clinical replacement for 20% of the nursing programme (Guideline on NBM standard 2015, pp, 21). Nursing graduates may also be unsuccessful in securing job placement relevant to their profession due to various other factors. Enrolment of newly graduated SRNs has been tightened in public and private hospitals, owing to the cumulative effect of unemployed graduates from previous years. Both public and private hospitals are also challenged by the poor clinical competency and soft skills for this large group of unemployed nursing graduates. Special training targeting the improvement of this skill set, along with a period of attachment are typically provided to these graduates before joining the workforce. Mentors are also assigned to closely supervise these graduates to ensure patient safety in hospitals. The 1Malaysia Training Scheme (SL1M) in coalition with the Economic Planning Unit have undertaken to ensure that unemployed nursing graduates possess the skills and clinical experience to enhance their employability at selected hospitals for at least a year (MoH, Star newspaper, 2012).

1.3.2 Patient safety movement – awareness of adverse event management

Saiboon (2011) in his presentation in the 1st Simulation User Network conference held in Kuala Lumpur Malaysia stated several challenges in Malaysian nursing education. This included the issue of the lack of clinical nursing skills while being generally knowledgeable, the performance of these skills without basic understanding, and the relatively low confidence levels in nursing skills among students. This can result in patients' safety being at risk in clinical settings if no remedial action is taken.

Abroad, studies on the issues of resource management are generally in line with the current nursing education situation in Malaysia (Feingold et al., 2004; Baxter et al., & Nehring, 2009; Maas et al., 2010; Schultz et al., 2012; Nielsen et al., 2013; Fisher & King, 2013; Mills et al., 2014; Nevin et al., 2014; Cooper et al., 2015). The United States (US), United Kingdom (UK), Canada, and Australia have faced similar issues of resource management in nursing education. Many nursing programs face a lower inpatient census at clinical sites, with fewer clinical preceptors due to the shortage of qualified academicians and the retirement of more experienced senior nurses. Added to this is the increased competition among nursing schools for clinical placements because of enrolments in various nursing programme leading to unprepared nursing graduates in clinical settings.

In today's society, patients and their families are increasingly becoming more empowered and involved in their medical decision-making, thanks to easier accessibility to information and awareness of issues such as medical malpractice and negligence. Therefore, clients and families are increasingly placing greater emphasis on their health care professionals' competency when they seek treatment and care. Computerised stimulation training provides an opportunity to nursing students to practice these skills using clinically based scenarios, which informs clinical competence and confidence without the potential to harm the patients.

1.3.3 Insufficient practice during training

In line with the government policy to increase the number of registered nurses in Malaysia to achieve the ratio of 1 nurse to 200 patients, there was an increase in the number of nursing colleges in Malaysia and a focus on maximising the training of nursing students in order to meet the demand of the country's nursing workforce since 2005. This target was met in 2012 and unfortunately resulted in a glut of graduate nurses in the country (Star newspaper, 2012). Huge numbers of 15,242 nursing students were simultaneously posted to the same clinical disciplines in order to accommodate all of the students from more than 200 nursing colleges offering nursing programmes from the same cohort year (Star newspaper, 2012). The excess of nursing students whom were placed in the same clinical postings within the short period of time proved to be a barrier to adequate learning opportunity. As a result, many new nursing graduates were unable to secure jobs in hospitals after they graduated due to poor soft skills (The Star newspaper, 2012). While to a certain extent the lack of competency in both clinical and soft skills may have played a part in exacerbating this situation, the poor quality of clinical placements for nursing students that did not fulfil learning outcomes was at least in part to blame.

Experiential learning is a pivotal in nursing, as learning without practicing does not allow students to relate theory to practice. Failure of this results in nursing students having limited quality clinical experience with patients in the health care settings. Insufficient training for nursing students in clinical experience places patient safety competencies at risk in clinical areas if unaccompanied by the necessary knowledge, skills and attitude for aspiring nurses (Ironside et al., 2009; Richardson & Clamen, 2014). This makes the finding sufficient clinical sites that promises the quality of education in stipulated time frame important (Richardson and Clamen, 2014). Students who are not adequately prepared to be posted to clinical settings but whom are expected to perform nursing skills in such a setting have a higher potential of committing medication errors (Radhakrishnan et al., 2007; Todd et al., 2008; Sears, Goldsworthy & Goodman, 2010; Henneman et al., 2010 cited in Shearer, 2013). Novice learners have a higher risk of causing harm to patients when performing nursing skills such as in the management of deteriorating patients for the first time if they have not received adequate training. If the learners have insufficient practice to achieve competency and confidence in guided simulated environments, they are not adequately prepared posting in the wards even in their role as students. Moreover, as patient acuity is increasingly complex, nurses must be able o make prompt evidence clinical decisions such as identifying decreased level of consciousnes and changes in vital signs (Cooper, 2010; Fisher & King, 2013 and Murdoch et al., 2013). The components of knowledge, skill and experience are essential for this process for clinical judgement with expected professional competency.

1.3.4 Personal Interest: Local Experience

The researcher has found that there are vast differences in the trend of Malaysian nursing curriculum since the last decade. The researcher has observed through her experience of the evolution of nursing education and faculty management in both private and public settings since 2004. She had also discussed these issues with her colleagues and had interactive sessions with her ex colleagues in nursing conferences and meetings. It was agreed upon by the academicians and the researcher that the nursing education of Malaysia has room for improvement in terms the quality in its' education system. Before the millennium year, the nursing students from nursing programmes in Malaysia were offered opportunities for clinical placements to meet their learning objectives without question by the authority of the Ministry of Education Malaysia, stakeholders, parents and fellow students themselves. Besides the lecturers, the ward sisters, preceptors and staff nurses in different shift duties at clinical settings were adequately given clinical supervision to nursing students.

In the last decade, colleges and universities offering nursing programmes were attached to a hospital where nursing students were posted after their theory classes. Clinical placements did not become an issue until 2008-2012, when changes to nursing education led to a shift in the nursing profession. This was related to the change in student entry requirements for the nursing diploma programme, lowered from 5 credits to 3 credits in SPM to meet the demand of 1 nurse to 200 patients. In order to meet the demand of nurses in the country, there was increased number of school leavers who were offered and successful enrolled in nursing diploma at private colleges with minimal entry requirement of 3 credits in SPM. Most of these colleges were not attached to a hospital that could facilitate their students' clinical placement. While some of these colleges had memorandums of understanding with government hospitals which allowed their students would be sent to these clinical areas wherever the placements, some of these other colleges did not prepare their nursing students to enter any sort of clinical placement. These colleges operated on the assumption that the education in

Nursing is similar to the other non-healthcare programme where it is much of it revolves on a theory-based curriculum. Nursing is a skill- based profession, thus students are required to consolidate their knowledge and skills in relation to providing care to the patients in the hospitals. Clinical placements as a result were very much limited due to massive numbers of students from private nursing schools. Even if the opportunity was given, the students did not necessarily meet their learning objectives.

It should be noted that government hospitals in Malaysia cater not only to private nursing students but also their own government sponsored student nurses. This situation has escalated the lack of clinical placements for the students in the private nursing sectors due to overflow of students, with far more nursing students in the clinical settings than the number of patients needed to be cared for.

In addition, the movement of qualified lecturers and supervisors from one healthcare institution to another is another matter of concern. This movement is chiefly because of the demand and highly remuneration offered by recruiters from the private institutions. Staffing turnover has remained high based on the researcher's experience working in three private nursing schools for the past 15 years in education. There is a high staff turnover involving migration from academia to other nursing schools for career advancement, reflecting the transition from diploma level nursing programmes to the popularisation of bachelor degree programme offered in certain private universities between 2008 to 2012. This workforce transition has contributed in part to the lack of consistency in teaching and learning processes for nursing students. With the departure of more experienced senior staff and the advent of inexperienced staff in teaching, so did the learning process deteriorate. The inevitable outcome was that students were trained by thousands in those five years and compared to less than a hundred graduates per year in the last decade. These students were reported to do poorly in clinical settings when evaluations and competencies were conducted. These included issues with problem solving skills, prioritising care and decision making in clinical evaluations.

To the researcher's best knowledge, there is limited local literature in this area. The researcher quotes the statement by Prof Dr. Saiboon (SUN Meeting, 2011) from a public university in 1st ASEAN simulation user network conference. He stated that nursing students were poor in skills, with knowledge learned without regard to foundation in clinical practices. Students were also not confident in carrying out nursing procedures with patients. This comment was from the medical professional on nursing students' performance, whom they expected to be well prepared clinically given that it directly impacts patient outcomes. Remedial action was discussed to adequately prepare nursing students.

The issue of appropriate clinical training for the nursing students of today is an important one, as they comprise our future nurses, educators and leaders of tomorrow. In 2012, there were 18,000 unemployed nursing graduates in Malaysia (Star newspaper, 2012). Many of these students were unemployed as a result of their poor knowledge, competency and soft skills, which is the basic requirement to be a state registered nurse, as are these basic skills expected by most employers (Star newspaper, 2012). The government eventually revised its policy in 2012 and implemented audits for nursing schools which offered nursing programmes, as well reverting entry requirements back to the original 5 passing credits in SPM, tightly monitoring qualifications for lecturers and supervisors and enforcing the 80% compulsory clinical placements for each student enrolled in nursing programmes. Are these revisions able to solve the problem in nursing education and its profession?

The use of High Fidelity Patient Simulators (HFPSs) serve as one of the teaching and learning strategies that can prepare nursing students for clinical practice (Kaddoura et al., 2015) and increase the self-confidence of graduate nurses in caring for their patients (Yuan et al., 2011; Aebersold & Tschannen, 2013; Alinier & Platt, 2013). The impact of a poor foundation in clinical practice among nursing students is reflected in their clinical nursing care to patients after graduation. For the 18,000 qualified and unemployed nurses requiring refinement in clinical competency and soft skills, it is hoped that the HFPS may prove useful in helping them regain their confidence, self-efficacy and most importantly their interest in working in the nursing profession. It is distressing for those who are very much interested in nursing to have undergone training in and chosen a career in nursing, only to fail to qualify to serve the community and nation despite their investment of cost and effort. Also, additional training with the HFPS could help nurses avoid becoming a danger to patients. Use of HFPSs also serve as a training tool to various other healthcare professionals including doctors, nurses and other healthcare providers on how to work collaboratively as a team in a safe environment. This is important, as a lack of effective communication and team collaboration have been reported as a main issue affecting patient mobility and mortality in health, ahead of deadly diseases.

1.4 Conceptual Framework

The framework in Figure 1 shows a simulator model and the relevancy of HFPS and its attributes that directly affect nursing students' learning outcomes (knowledge, skill performance, critical thinking, learner satisfaction and self-confidence).

The framework presented was developed based on theoretical and empirical literature related to simulation in nursing, medicine, and other health care disciplines as well as in non-health care disciplines. It was tested in the study from Jeffries (2005), with modifications added on CGPA, gender, entry requirements and exposure to simulation for the local population with the use of code blue in the simulation.

The Nursing Education Simulation Frameworks has four conceptual components. This includes: 1) Student factors, 2) Educational practices in instruction, 3) Simulation design characteristics, and 4) Expected student outcomes.

1) Student factors

Students are expected to be responsible in their learning as well as be self-directed and motivated. The learning environment in simulation should minimise competition, allow individual pace of learning, support learning and acknowledge mistakes in the process of simulation learning. Roles will be assigned to each student during simulation, and they are required to actively participate in simulation experience, decision making, problem solving, and team interaction with other members, patients and their family. The students are respondents from various backgrounds characteristics such as age, gender, equivalent entry requirement in Diploma programme such as STPM, SPM, diploma and matriculation, history of exposure to high fidelity patient simulation from previous learning, role assigned in simulation and the CGPA from the previous semester.

3) Educational practices in instruction

This component addresses the features of active learning (engagement in learning process), diverse learning styles (uses five senses in learning), collaboration (mutual respect in the team), and high expectations (guided learning and support to be successful and performing task completely).

4) Simulation design characteristics

This component incorporates five features: objective/ information of learning, fidelity (realism), problem solving (complexity), student support (cues), and reflective thinking (debriefing) based on the code blue drill simulation scenario as the intervention.

5) <u>Expected student outcomes</u>

The effectiveness of the learning outcomes will be measured through knowledge, skill performance, critical thinking, learner satisfaction and self-confidence using an adult code blue drill simulated programme on a High Fidelity Patient Simulator (HFPS).

6) <u>Adult Code Blue Drill</u>

The adult code blue drill refers to a scenario in simulation for airway management, cardiopulmonary resuscitation, administration of medication, identifying life threatening arrhythmias and team collaboration on a deteriorating patient. At the end of the session, students will be able to:

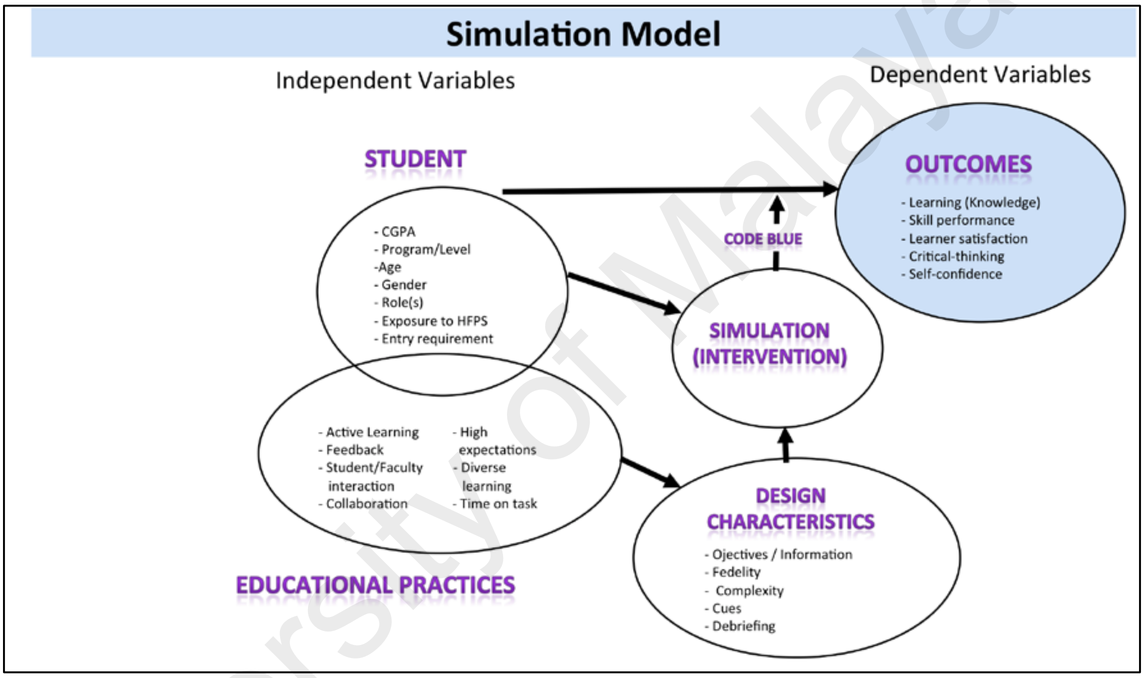
a. Establish priorities of care for the deteriorating patient
b. Rectify responsiveness of the deteriorating patient with the assessment of airway, breathing and circulation
c. Demonstrate correct CPR technique on the patient
d. Assemble correct psychomotor skills as follows:
   -Oxygen apparatus
   -Suction apparatus
   -The application of ECG leads
e. Identify life threatening electrocardiogram
f. Interpret life threatening electrocardiogram
g. Perform appropriate nursing interventions on the patient with life threatening ECG
h. Establish IV therapy for infusion
i. Assist in intubation

j. Demonstrate effective communication and coordination as team

k. Document code blue intervention on nursing care plan

7. <u>Simulation</u>

Simulation is a teaching strategy used in this study and a technique to facilitate teaching. Students were divided into control and intervention groups. The intervention groups were exposed to the High Fidelity Patient Simulator (HFPS) while the control groups used Low Fidelity Patient Manikin (LFPMs).



Adopted from Jeffries & Rizzolo (2006).

Figure 1: In this study the simulation model was adopted and adapted to the research objectives.

1.5 Purpose of the Study

The purpose of this study is to examine the effectiveness of a High Fidelity Patient Simulator (HFPS) compared to low fidelity patient manikins (LFPMs) on learning outcomes (knowledge, skill performance, critical thinking, learner satisfaction and self-confidence) among nursing students using a simulated adult code blue drill programme in Malaysia.

1.6 Research Questions

i. Would students who participate in high fidelity patient simulation as part of a teaching/ learning experience in managing an adult code blue patient situation have better knowledge levels compared to participants using low fidelity patient manikins?

ii. Would students who participate in high fidelity patient simulation as part of a teaching/ learning experience in managing an adult code blue patient situation have better skills performance levels compared to participants using low fidelity patient manikins?

iii. Would students who participate in high fidelity patient simulation as part of a teaching/ learning experience in managing an adult code blue patient situation have better critical thinking skills (judgment performance) compared to participants using low fidelity patient manikins?

iv. Would students who participate in high fidelity patient simulation as part of a teaching/ learning experience in managing an adult code blue patient situation have higher levels of satisfaction and self-confidence compared to participants using low fidelity patient manikins?

v. Would there be any association between demographic characteristics and learning outcomes (knowledge, skill performance, critical thinking, learner satisfaction and self-confidence) of nursing students using an adult code blue drill simulated programme before and after using high fidelity patient simulator compared to low fidelity patient manikins?

1.7 Specific Objectives

The specific objectives of this research project were to:

i. Assess the knowledge levels of nursing students using an adult code blue drill simulated programme before and after using a high fidelity patient simulator (HFPS) compared to low fidelity patient manikins (LFPM).

ii. Assess the clinical skill performance of nursing students using an adult code blue drill simulated programme before and after using a HFPS compared to LFPM.

iii. Assess the level of critical thinking skills (judgment performance) of nursing students using an adult code blue drill simulated programme before and after using HFPS compared to LFPM.

iv. Assess the level of satisfaction and self-confidence of nursing students using an adult code blue drill simulated programme before and after using HFPS compared to LFPM.

v. Determine the association between demographic characteristics with learning outcomes (knowledge, skill performance, critical thinking, learner satisfaction and self-confidence) of nursing students using an adult code blue drill simulated programme before and after using HFPS compared to LFPM.

1.8 Hypothesis

H_0, Null hypothesis:

There is no significant difference in learning outcomes (knowledge, skills performance, critical thinking, learner satisfaction and self-confidence) between students who use High Fidelity Patient Simulator (HFPS) in teaching/ learning for adult code blue situations compared to low fidelity patient manikins (LFPM).

H_1, Alternative hypothesis:

- There is a significant difference in knowledge between students who use HFPS in teaching/ learning for an adult code blue situation compared to students using LFPM.
- There is a significant difference in skill performance between students who use HFPS in teaching/ learning for an adult code blue situation compared to students using LFPM.
- There is a significant difference in critical thinking between students who use HFPS in teaching/ learning for an adult code blue situation compared to students using LFPM.
- There is a significant difference in learner's satisfaction and self-confidence between students who use HFPS in teaching/ learning for an adult code blue situation compared to students using LFPM.

1.9 Significance of the study

Patient safety is of the utmost importance in healthcare and is guided by protocols and policies for delivering care services to the patients and family in the healthcare settings (Cant & Cooper, 2017). The World Health Organisation (WHO) 2011 cited in Tosterud, Hadeline and Hall-Lord (2013) highlighted that the use of simulation as a pedagogical method for enhancing patient safety is necessary. The significance of this study is that it closely examines the use of HFPS to enhance the skills and level of satisfaction and self-confidence of nursing students in code blue management. This study will test the efficacy of delivering competencies in this area through HFPS exposure prior to clinical posting with real patients. The use of HFPS may help safeguard patient safety, as students can learn from any mistakes made during practical sessions using the HFPS. This will effectively enable them to learn from their limitations to improve their knowledge and skills.

Nursing is essentially a skill-based profession that draws from experiential learning. Nursing students and nurses who provide direct care to patients and families play an essential role. Thus, learning without practicing safely and competently prevents students from relating theory to practice. If the required nursing skills do not reach acceptable competency levels to practice prior to clinical placement, patient safety will likely become an issue. Students who do not have the requisite knowledge and are poor in the nursing skills identified during their practical sessions in schools need to be identified as students whom are not prepared to undergo their clinical attachment. These students have a higher possibility of making mistakes in nursing tasks and patient care such as medication errors (Anderson, 2010), failure to identify deteriorating patients (Fisher & King, 2013), miscommunication with intra-disciplinary and interdisciplinary teams pertaining to standard care practices (O'Daniel & Rosentein, 2008). Due to the increasing complexity of the clinical environment in the healthcare setting, this preventive measure should be taken seriously. The impact of simulation education using HFPS minimises the use of patients as “guinea pigs” for attaining professional competency and reduces the risk of jeopardising patient safety.

Simulation education is tailored to the needs of students learning to achieve specific learning outcomes. With structured and specific exposure to different health conditions and its management using simulation education, all available time is optimised for nurses to interact and perform their actual clinical experience with patients. This study represents an in-depth investigation of the impact of simulation education on acquiring potential transferable skills in clinical practice, such as relating knowledge to clinical performance skills, critical thinking skills, confidence in nursing patient in given scenarios and investigating the level of satisfaction among students after exposure to HFPS. Simulation education is a tool that can be utilised to prepare students prior to clinical exposure, and may thus assist nursing schools in achieving their desired learning outcomes in a learner-friendly environment.

A learner-friendly environment enables students to explore without feeling stressed and learn from mistakes as facilitated by an instructor in the debriefing session. It also caters to different student levels in terms of their learning capability, allowing them to learn following their own pace and moulding them as active learners and team players with decision making ability in a given health condition. According to Murdoch et al. (2013), simulation is an educational technique that supports active learning; learners were satisfied with the inter-professional simulation education and simulation techniques which were found to support the development of knowledge, skills, and attitudes needed for collaborative practice. Henderson (2016) reported that in response to medication errors commonly occurring in medical-surgical units and ICU, solutions to combat this included continuing education and training using simulation-based training.

There is limited published research on the use of simulation education in the nursing profession in Malaysia. Simulation education is well established and has been proven to be an effective learning strategy that has been fully utilised in most nursing schools in Singapore, Korea, US, Australia and other European countries (Liaw et al., 2012; Sundler, Pettersson, & Berglund, 2015; Najar, Lyman, & Miehl, 2015; Adamson, 2015; Kaddoura et al., 2016; Cant & Cooper, 2017; Adib-Hajbaghery, & Sharifi, 2017). In fact, the use of HFPSs is also recognised in documented form by health professional boards. In Malaysia, few schools use the simulation education teaching strategy in their nursing programme as there is a lack of structural design and trained academicians supporting simulation education. Most nursing schools in Malaysia underutilise this teaching strategy in their nursing programmes. There are difficulties that must be surmounted if this innovative strategy is to be fully engaged in the implementation of simulation education in Malaysia. In interviews with nursing school administrators and principals, some of the barriers to widespread adoption included the high cost of HFPSs, the architectural design of standard simulation education learning environment and its maintenance. Other factors include the lack of awareness of the benefits of simulation education by the stakeholders, a lack of preparedness on the part of academic staff which are currently not well equipped given the need for trainer certification and experience, and also time constraints involved in the process of implementing the various simulation scenario in a timely manner that is in line with the syllabus of the nursing programme prior to students' clinical postings. Lastly, the learning style of nursing students in Malaysia whom are generally passive learners as well as the adjustment period required for this mindset transition to active learning that is expected in simulation training are other barriers to widespread use of HFPS thus far. It is hoped that this study will change the perception of nursing students towards simulation education in Malaysia and will subsequently encourage wider adoption as a result of the researcher's evidence-based findings.

Common critique from academicians on nursing students nowadays include the lack of ability to think rationale and critically. Anecdotal evidence indicates that the teachers reported they are challenged by the students' background of academic achievement. Students who come from two opposing backgrounds; one is the high performing academic achievers while the latter are the slow learners. The traditional nursing teaching method is not able to measure critical thinking skills objectively. Imparting the ability to think critically and make sound clinical decisions are the key responsibilities of academicians towards their nursing students. In addition, this element needs to cater to students from different backgrounds in any given cohort. Innovation in teaching with high fidelity patient simulation emphasises an outcome-based education and assessment. Simulation experiences can be designed to fit nursing students' learning needs by tailoring learning objectives and scenario content to facilitate the development and implementation of the simulation with pedagogy specific to simulation for future development and research.

HFPSs mimic real clinical situations; students are exposed to different health conditions and the management according to their level and learning, at their own pace (Fisher & King, 2013; Najar, Lyman, & Miehl, 2015). The various health condition scenarios require students to think critically before making any decisional steps in managing the patient from each given scenario. Students also learn to work in a team and that prepares them to collaborate with others and experience including non-nurse healthcare professionals. Overall, simulation education provides mature and analytical thinking for problem solving ability in the learning process.

The outcomes of this study can provide self-motivation to students and lifelong learners that are committed to the nursing profession. Simulation education supports students develop analytical and problem solving skills that enhance their clinical confidence and competence. Simulated learning can facilitate learning and acquisition of knwledge and skills in safe environments. Trained faculty staff members can encourage active learning and inculcate this sense of achievement in students. Simulated learning allows students to learn, practice and review their knowledge and applied clinical skills. Video recording of simulation sessions can aid students identify aspects of their practice that requiring them to be well developed and those that required strengthening. Students are allowed to make mistakes in the simulation training without penalty, and are encouraged to express their feelings and identify their course of actions that are perceived as correct or incorrect following the simulation in the debriefing sessions. The comments also come from their peers from the same team. The students make their decision on the remedial actions to be taken to improve their skills with recommended suggestions. The facilitator will facilitate the debriefing session and ensure the session achieves all identified learning outcomes and verifies the decision making discussed between the individual student and peers.

Moreover, another benefit of this study includes the promotion of professionalism in nursing that is in par with the current trend of the teaching-learning strategy. The current nursing education should include simulated learning environments that have the potential to asisst students develop a sense of identity as they learn, practice and acquire knowledge and skill performance. Students also develop skills in problem solving and decision making through active participation and interactive experiential learning. Simulation education is believed to produce good quality future nursing graduates that have the capability to relate evidence to practice decisions, which informs clinical competence and confidence in any challenging situations within the scope of nursing practice. It prepares nursing students and new graduates for transition into the clinical workforce with optimal education experience to ensure the future workforce has safe and competent nurses. Simulation learning is a relatively new approach in Malaysia. Successful studies in this area in the Malaysian setting provides the opportunity to other public and private universities to learn the experience and share resources in promoting stronger professional nursing development in Malaysia.

1.10 Operational Definitions

1.10.1 Student Nurses

In this study, student nurses refer to Malaysian students undertaking the 3-year diploma in nursing programme in their first and second semesters. The nursing students in this study are required to have completed the following requisite courses or modules: (1) anatomy and physiology of the human body, (2) cardiovascular and respiratory disorders, (3) pharmacology, and (4) fundamentals of nursing.

1.10.2 Fidelity

Fidelity refers to the extent to which the simulation model resembles a human being. It refers to believability or the degree to which a simulation approaches reality; as fidelity increases, realism increases (Kardong-Edgren, 2010, cited in Aebersold & Tschannen, 2013).

1.10.3 Simulation

Simulation is a technique used to replace or amplify real experiences with guided experiences that evoke or replace substantial aspects of the real world in a fully interactive manner (Gaba, 2007).

1.10.4a High fidelity patient simulator (HFPS)

In this study, HFPS refers to a full human torso manikin that provides students with a realistic recreation of a patient and safe environment for learning (Cooper & Taqueti, 2004 cited in Jeffries, 2007). The HFPS has software that is retained within the manikin, and can be accessed via laptop or desktop computer. HFPS can mimic diverse parameters of human anatomical structures and high response fidelity, human anatomical physiology. Examples of physiological changes include those involving the cardiovascular, pulmonary, metabolic, and neurological system. HFPS has the ability to respond to nursing or pharmacological interventions in real time. The construction of these manikins enables educators to design practice laboratories that are realistic to a variety of healthcare settings.

1.10.4b Low fidelity patient mannequin (LFPM)

LFPM is a full human torso static mannequin without computerised software equipment but with the necessary body parts for nursing procedures to be conducted in practical sessions.

1.10.5 The Assessor/ Teacher

In this study, the assessor/ teacher refers to the researcher and her research assistants. An assessor is a qualified registered nurse who possesses the minimal requirement of a general nursing in Diploma/ Bachelor of Nursing or equivalent and with a minimum of 3 years working experience in the clinic and education or both. Assessors will evaluate students' clinical performance on an adult code blue situation using a standardised code blue checklist.

1.11 Outline of the thesis

There are six main chapters to this thesis. Chapter 1 is the introduction of the study, which discussed the background, problem statements, the conceptual framework, objectives, the significance of the study and the specific operational definitions in the study.

Chapter 2 is a review of the related literature. It is an in-depth examination of studies that include the selected model specific to this study.

In Chapter 3, the research strategy, the methodology of research study, research approach, data collection process, sample selection, research process of the study, type of data analysis, steps in obtaining ethical approval and the research limitations of the study is delineated.

Chapter 4 describes the analysis of the data and relates the findings to the research objectives and answers the research questions used to guide the study. Data were analysed to identify, describe and explore the effect of HFPS as a teaching strategy among nursing diploma students, the control of variables on its effectiveness of HFPS and its association with other variables in the study.

In Chapter 5, a discussion of the major findings of study are discussed and interpreted.

Chapter 6 constitutes the conclusion, which discusses the implication of simulation education in nursing practice by highlighting the contributions of research findings on the aspects of clinical practice, education, management, training, this research and development of nursing profession. The strengths of this research and the limitations for this study are also presented. Suggestions and recommendations for future research to increase the quality of research are emphasised in this final chapter.

1.12 Summary

This chapter outlines the research background and explores the issues specific to simulation education globally and locally. It includes the information of objectives, research questions, hypotheses, operational definition and conceptual framework. The overview of significance of the research problems was discussed.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this chapter, the researcher starts with a description of the literature search undertaken, with a systematic review as the end product that appraises various related studies. It attempts to provide an overview of the research pertaining to high fidelity patient simulation in nursing education including the advantages and disadvantages, learning theory and its challenges in previous research studies. Based on this literature search, the conceptual framework was reviewed, adopted and modified to suit this study. The literature search also helped to identify the gap for the study.

2.2 Literature Search

The utilisation of Boolean Operators includes simple words (AND, OR, NOT or AND NOT) as keywords in the search engine, resulting in more focused and productive results.

2.2.1 Criteria

The search articles were in English and related to simulation education in nursing programmes. The review was on the most recent articles updated to 2017. The researcher reviewed and included articles in the last 10 years of the current study, which was related to articles on the history of simulation education, theoretical and conceptual studies. The studies conducted for other healthcare programmes were reviewed and it aimed to serve as important reference for the researcher.

2.2.2 Sources

The researcher focused on literature which provided the strongest evidence and proved capable of answering research questions related to this study following the hierarchy of evidence in the following order: randomized controlled trials, experimental studies, case study, correlational study and cross-sectional survey.

The researcher used full text databases such as Ovid Proquest, Medical database (EBSCOhost), Science Direct, Evidence Based Medicine (EBM) Review @ Ovid, CINAHL, MEDLINE and Google Scholar.

2.2.3 Keywords

Besides the Boolean Operators, keywords or key phrases such as ‘Simulation education’; ‘High Fidelity Patient Simulators’; ‘Knowledge’; ‘Skills performance’; ‘Critical thinking’; ‘Satisfaction and self-confidence’ were used to refine the searches.

2.2.4 Results and key studies

A total of 87 articles were retrieved from the keywords and phrases. Most of the studies revealed the use of simulation education or training outcomes with a scenario or programming condition specific to each study. These studies focused on patient safety issues, knowledge, competencies, critical skills, self -confidence, self-efficacy, level of satisfaction, clinical judgement, communication and teamwork, benefits, pitfalls and challenges in simulation education. There were nine systematic review articles retrieved from 2006- 2017 that provided an overview of simulation education in nursing. Between seven to fifteen articles were selected specifically to suit the objective of this study, namely the studies which focused on knowledge, competencies, critical skills, self-confidence and level of satisfaction from the year of 2006 onwards.

2.3 History of Simulation in Health Care Education

Simulation, the art and science of recreating a clinical scenario in an artificial setting, has been an important aspect of the nursing program curriculum in recent years. More than 2,500 years ago, Confucius offered wisdom on the educational merits of performance practice and experiential learning. These learning concepts are relevant even today. Historically the airline and nuclear industries have used real-life simulations to train and respond to potential crises that could have very serious consequences, which, fortunately, rarely occur.

In the literature review by Alinier and Platt (2013), early records of the use of simulation for educational purposes date back to 18th century and the pioneering work of a midwife named Madame du Coudray who was commissioned by the King of France, Louis XV to conduct an educational campaign in rural France to demonstrate a safe delivery process. She invented a model of a female pelvis with a uterus as a task trainer (Gelbart, 1998 cited in Alinier & Platt, 2013). It was reported that Madame du Coudray trained an estimated 10,000 peasant women as birthing assistants over 23 years, teaching them the safe delivery method and performing maneuvers for managing childbirth related complications. The first simulation models used in health care education came on the scene in 1960s with the introduction of “Rususci@Anne” (a resuscitation trainer) made in Norway. A manikin torso to help practise life-saving skills such as CPR and SimOne, was developed in the USA in 1990 (Cooper & Taqueti, 2004, cited in Jeffries, 2007; Issenberg, 2006a, cited in Alinier & Platt, 2013). “Harvey” was designed as a full-sized manikin designed to train professionals in cardiology (Cooper & Taqueti, 2004 cited in Jeffries, 2007).

During the 1980s, anaesthesia educators studied how simulation was being used in aviation and military training, as well as its impact on team and individual performance during critical events. The aeronautics industry, the defence industry and medical schools have used learning through the high-fidelity simulation for decades, but simulation learning is in its infancy in nursing education (Haskvitz & Koop, 2004 cited in Waxman & Connie, 2009). As an adjunct to clinical experience, simulation has allowed deliberate practice in a controlled environment. Students are able to practice procedures prior to performance on a live patient.

Experiential Learning Theory describes the importance of using simulation learning to improve knowledge (Comote, 1798-1857 cited in Roberts & Greene, 2011) which is derived from the philosophy of positivism. Knowledge originates from actual perceptual experience, with learning passing through three phases: the theological, the metaphysical and the positive. Positivism provides the philosophical underpinnings for simulation education. Learners are taught the theory behind and fundamental principles of anatomy and physiology. They then experience the application of these practical experiences in clinical skills labs. Comote's theory has been expanded in that knowledge is learned through experiential learning (Kolb, 1984). The process for experiential learning theory consists of the actual experience, a period of reflection for learning to take place (Roberts & Greene, 2011). This theory is based on the conceptual analysis of simulation through the active participation of learners that assumes the transfer and relation of theory learned to real life skills with the use of simulation learning.

2.4 Simulation Training in Nursing

High fidelity simulation refers to a structured student learning experience with the use of technologically advanced computerised manikins where the software simulates a healthcare situation through integrating patient pathophysiology and their interaction to resemble an environment that mimics a true clinical setting. Full scale integrated simulators is tailored for healthcare training. Composed of computer programmes, it permits complex physiological and pharmacological responses such as respiratory and cardiovascular functions and various nursing procedures involving medical, surgical and specialised disciplines. Nurses and healthcare professionals trained with HFPS are administered sequential decision-making events within an environment resembling various clinical settings and laboratories and also respond to simulated medical emergencies. Instructors can control the manikin responses, create real-time demonstrations, and give immediate feedback to interventions carried out by nursing students using their video-recorded activities (Seropian, 2004; Spillane, 2006 cited in McGonigle & Mastrian, 2012). Simulated learning encompasses the cognitive, psychomotor and affective domains of learning to provide holistic care and can accommodate the learning preferences of all nursing students (Price, 2004; Comer, 2005; McCaughey & Traynor, 2010 cited in Ricketts, 2010).

Simulation training provides a mechanism to simulate real-world events and provide feedback to actions, questions, and decisions in a controlled environment. Evidence from systemic reviews have shown HFPSs lead to positive outcomes in the domains of clinical reasoning with improved critical thinking ability, clinical skill performance, knowledge acquisition, self-reported level of confidence and students' satisfaction with simulation experience (Howard, 2007; Ravert, 2008; Schumacher, 2004; Alinier et al., 2004; Radhakrishnan et al., 2007; Brannan et al., 2008; Hoffmann et al., 2007; Howard, 2007; Jeffries & Rizzolo, 2006 cited in Lapkin et al., 2010). Simulation offers an alternative for nursing programs dealing with a limited number of clinical sites that have inadequate learning opportunities. Sustaining the high quality of graduate nurses in the nursing profession is the responsibility of nursing academics who need to ensure graduates possess the basic knowledge competency essential for practice, as well as design and evaluate curricula that can help develop these necessary attributes prior to graduation.

2.4.1 Simulation Model in Nursing Education

The first simulation model for simulation in nursing education was established by Jeffries and Rizzolo in 2006. The National League for Nursing (NLN) and the Laerdal corporation joined venture to conduct a national, multisite, multi-method study of the use of simulation in nursing education across the United States. The project was led by the a team of individuals from eight schools across the US over the duration of 3 years.

The model of simulation in nursing education established by Jeffries and Rizzolo in 2006 has become a framework which guides nurse educators in exploring new teaching learning methods and educational practices to provide high quality education to nursing students. The simulation model framework component consists of the teacher, the student, education practices and simulation design characteristics. These five learning outcomes (knoweldge, skill performance, critical thinking, self-confidence and saisfaction) of nursing education simulation framework in the simulation model are relevant and connected to each other and serve to enhance the development, implementation, and evaluation of simulation in nursing education. This nursing education simulation framework is a key guide to the design, implementation, and evaluation of simulation activities. This simulation model which measures the effectiveness and the instruments used to evaluate simulation education involves both objective and subjective categories (Kardong et al., 2010). The objective category is a knowledge test and observational questionnaire based on a checklist, with self-reported measures of confidence and satisfaction taken into account. A review conducted by

Adamson (2015) concluded that the simulation framework by Jeffries and Rizzolo (2006) is the theory which best expounds the practice of simulation.

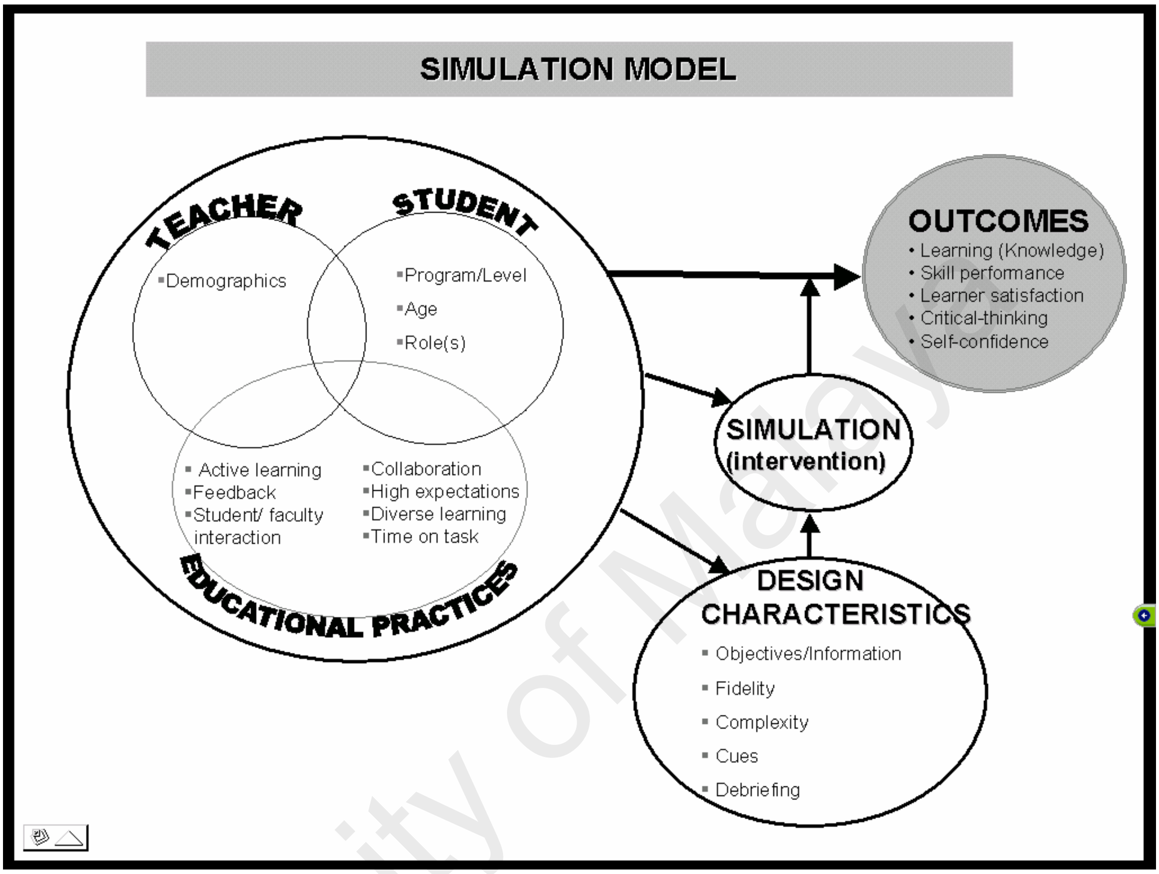


Figure 2: shows simulation model of nursing education (Jeffries & Rizzolo, 2006)

According to the simulation model by Jeffries and Rizzolo (2006), students play a vital role in the learning process. Although students may experience the simulation differently, the expectations are that students need to be responsible for their own learning including the commitment for self-direction and motivated learning. In order to fulfil this responsibility, students need to be provided with clear expectations and ground rules for all activities. The rule emphasises encouragement and support in the learning environment. Acknowledgement of students' mistakes is part of the process with minimised competition. The ground rule specifies the roles that various students will play during the simulation. Common roles in simulation are that of the patient, nurse, family member, another health care professional or an unlicensed assistive staff member or student as the observer or recorder. The instructor should inform students about the specific role each is to play in each of the simulation training. Students may rotate through various roles as the simulation is experienced, and should discuss each role during the debriefing at the end of the simulation training. Students' roles include as observers (response-based role) or active participants (process based role). Observers are instructed not to talk, make decisions, or solve problems during the simulation while active participants are required to make decisions on the information sought from written resources, the patient and/ or family within a stipulated time to obtain important information. Students participate in simulation training as self-evaluation while viewing a videotape of their performance in the 'live' patient scenario. Students are evaluated using the same checklist on the respective learning domains such as knowledge, skill performance and critical thinking skills. Variables included in the student concept of the simulation model by Jeffries and Rizzolo (2006) include age and any experience in nursing care prior to their formal education. Ironside et al. (2009) considers student factors to include program, level and age, which are augmented with measures of students' tolerance for ambiguity and self-reported cumulative grade point average to determine the relationships of these factors to simulation outcomes. In the study conducted by Mills et al. (2013) on 47 nursing students and Tawalbeh & Tubaishat (2014) on 100 nursing students, the criteria for program, level, age and cumulative grade point average were also included. Other studies such as that by Tosterud et al. (2014) and Gates et al. 2012 examined 86 and 104 nursing students respectively only by age, gender and experience in simulation learning.

The teacher is one of the most important individuals to the success of any learning experience. Traditional classrooms teaching are teacher-centered while simulations are student-centered. The teacher plays the roles of either facilitator and evaluator or both in this study. The teacher serves directly as an observer and may provide support and encouragement to the learner throughout the simulation, asking questions, proposing what if' situations, and guiding the debriefing at the conclusion of the simulation experience. The teacher can prepare the simulations and may require assistance with designing the simulation, technology and in setting up equipment. The roles of teacher include that of facilitator and evaluator. Both teacher and students can experience anxiety and discomfort while participating in this new experience. The teacher demographic such as years of experience, age, and clinical expertise are believed to be associated with the role, experience, comfort and overall use of simulation. Mills et al. (2013) evaluated teachers' opinions on simulation using a qualitative approach. The role of the teacher as a factor was found to be little considered in simulation studies, as emphasis was more on students and the learning outcomes in the simulation model by Jeffries and Rizzolo (2006). More research is needed to explore the student and teacher concept in simulation training and its impact on learning outcomes (knowledge, skill performance, critical thinking, satisfaction and self-confidence).

In the model of simulation by Jeffries and Rizzolo (2006), the educational practices component of simulation framework addresses the features of active learning, diverse learning styles, collaboration, and high expectations. These are considerations that need to be taken into account when designing a simulation aimed at improving student performance and satisfaction with their learning. Simulation design characteristics are another key element that requires address when developing a simulation. There are five features should be incorporated in simulation design characteristics, namely, objectives, fidelity, problem solving, student support and reflective thinking (debriefing). *Objective* refers to the tool that guides learning in simulation training; it reflects the intended outcomes of the simulation experience, and expected specific learner behaviours. *Fidelity* is the extent to which simulation mimics reality. A computerised manikin such as the HFPS, which can mimic or replicate real-life situations as closely as possible is categorised as highly sophisticated.

Problem solving relates to the level of complexity of the simulation, and is based on the knowledge and skill level of students. In order to assess problem solving, the teacher provides the students an opportunity to prioritise nursing assessments and care, followed by student self-evaluation. *Student support* emphasises the form of cues that offer enough information for learners to continue with the simulation but in a way that does not interfere with their independent problem solving. The teacher, patient and individual involved in the simulation can provide cues to students when support or assistance is needed. *Reflective thinking/ debriefing* is a reflective thinking session which provides students with an opportunity to express their feelings, thoughts to access their actions, decisions, communications, and ability to deal with the unexpected in the simulation. These questions have evolved from the objectives of the simulation experience and help the teacher to determine how well students meet the learning outcomes.

2.5 Patient Safety and Quality of Care

HFPS offers many advantages, including minimising unnecessary patients risk and/or discomfort, as well as increasing opportunities to encounter infrequent and atypical clinical problems. This prepares nursing students and new graduates for transition into the clinical workforce. Information technology has been identified as a key measure in improving patient safety and quality of care and has enormous impact in nursing education. When virtual technology application is correctly matched with nursing curricular objectives, it serves as an efficient and affordable avenue to students to achieve their learning objectives in a realistic learning environment that is tailor-made to their needs (Institute of Medicine, 2000; American Academy of Nursing, 2003; Hebda, Czar, & Mascara, 2005; Carty & Ong; Bligh & Bleakley, 2006 cited in McGonigle & Mastrian, 2012).

Simulation allows for the creation of environments and scenarios that enable students to experience the reality of practice. In the increasingly complex clinical environment, it is no longer justified to use patients as “guinea pigs” to attain professional competence. In simulation, students are able to identify areas of improvement in their practice and learn from their mistakes in a way that safeguards the patients in actual clinical practice (Gaba, Haskvitz & Koop, 2004; Rhodes & Curran, 2005; Hunt et al, 2006; Overly et al., 2007; Crofts et al., 2007 cited in McCaughey et al., 2010). Computerised stimulation training provides opportunity to nursing students in the approach of clinically based scenarios and relates evidence to practice decisions, which informs clinical competence and confidence.

2.6 Knowledge acquisition

Knowledge can be learned through various methods in the teaching and learning process. It is an attribute related to competency that is essential for nursing professionals. The best scientific evidence is the knowledge to make accurate clinical judgment in clinical situations. Pearson & Pells (2002) cited in Mantzoukas and Watkinson (2006); Lapkin et al. (2010) and Lee & Oh cited in Cant & Cooper (2017), indicated that advanced nursing practice is typified by three basic principles, namely experiential knowledge, theoretical knowledge and the clinical implementation of these types of knowledge in order to produce high standards of clinical performance. Simulation can provide more focused and deeper learning experiences and should be regarded as learning techniques, not just advanced technologies. Past studies show that a significant increase in knowledge gain in groups exposed to HFPS with higher scores indicated higher levels of cognitive skills (Gaba, 2004; Jeffries & Rizzolo, 2006; Hoffmann, O'Donnell & Kim, 2007; Howard, 2007; Brannan, 2008; White & Bezanson; Mikkelsen et al., 2008; Cant & Cooper, 2010; Gates & Hughen, 2012; Fisher & King, 2013; Adamson, 2015). Simulation assists learners understand the relationship between theory and practice; provides a method for students to apply knowledge and skills and have their performance evaluated in risk free environment.

Knowledge provides essential building blocks for the development of required skills in nursing. Simulation training shortens this learning curve and instils immediate feedback through debriefing with more diverse educational interventions and innovations (Robertson, 2006; Brannan et al. 2008; McCaughey et al., 2010). Students can then improve their knowledge base, and observe consequences of their actions. According to a systematic review by Cant & Cooper (2017), a number of review studies report promising evidence in that simulation was found to improve student knowledge (Weaver, 2011; Yuen et al., 2012b; Norman, 2012; Fisher & King, 2013; Tawallbeh & Tubaishat, 2013; Berdidt, 2014; Skrable & Fitzsimons, 2014; Stroup, 2014 cited in Cant & Cooper, 2017; Cant & Cooper, 2010, 2014; Adamson, 2015). Yuen et al. (2012b) cited in Cant & Cooper (2017) reported that nursing students' knowledge and skills of first aid and CPR were significantly improved in eight studies while Cant and Cooper (2010) in their 12 quantitative studies mentioned statistically improvements in knowledge after simulation.

2.7 Clinical Skill Performance

The role of nursing education is to make certain that nursing students are provided with optimal education experiences so that the future workforce are provided with safe and competent nurses. Despite the obvious benefits in areas of nursing training and clinical skill and experience, there is still a paucity of evidence regarding the efficacy of HFPS as a teaching method beyond the acquisition of psychomotor skills. It has been questioned whether simulation assists students in acquiring and integrating knowledge and critical thinking skills, and how it fares when compared to traditional, clinical or real patient encounters used previously (Fisher & King, 2013; Cant & Cooper, 2017). It is also questionable as to what degree HFPS would be an appropriate and suitable substitute for real clinical experiences required by the state regulations for nursing programs.

The typical learning process follows the teaching of theory in classroom settings by lecturers with written examination used to test knowledge based domains. In the nursing profession, the assessment for skill performance to fulfil the competency domain is important because adequacy of these skills helps ensure safe patients outcomes and practices. According to Cant, McKenna & Cooper (2013), rigorous, valid and reliable evaluation of students' clinical performance is essential to ensure readiness for practice. Objective Structured Clinical Examination (OSCEs) is commonly used to assess practical skills. It aims to determine baseline student clinical and communication skills in nursing programmes. Other assessment methods include summative assessments such as case studies, essays, group collaborative examinations or poster presentation. Nevertheless, the feedback to students using these methods to aids learning contain potential bias and often lack standardisation. Validation using OSCE as a clinical measurement tool is described as a standardised checklist used by trained examiners to rate students. OSCEs aim to measure performance using both valid and constructive criterion to fulfil the construct validy and reliability for repeatable assessment. The objectivity is inter-rater reliability based on agreement on student performance by trained and expert raters. Thus, OSCEs are an important tool in simulation-based learning, removing the subjectivity of traditional assessment and enabling assessment equity (Cant, McKenna, & Cooper, 2013).

HFPSs have the ability to measure the effect of practice on various skill levels, including the clinical practice parameters of safety, basic assessment, focused assessment, interventions, delegation, and communication skills. This is backed by various studies (Radhakrishnan, Roche, & Cunningham, 2007; Pike & O' Donnell, 2010; Alinier, Hunt, & Gordon, 2004, cited in Lapkin & Levett-Jones, 2010; Aebersold & Tschannen, 2013; Cant, McKenna, & Cooper, 2013; Shearer, 2013; Adamson, 2015 ; Cant & Cooper, 2017). These findings from various systemic reviews conclude that clinical skill performance needs to be assessed at various intervals and with different methods. The results generally indicate statistically significant improvement post-simulation, with nursing students using HFPSs attaining significant improvement in their ability to identify deteriorating patients in comparison with OSCE scores, care for complex patients such as disorders in cardiology, pulmonary, neurology, renal nursing, monitoring lines, and others. A student using a HFPS has greater capacity for learning and opportunity to care for more complex patients compare to OSCEs. This is important to students so that they acquire relevant learning experience prior to clinical placement with more complex, real-life patients.

One area of clinical practice that may benefit from high-fidelity simulation is the assessment of an early intervention for the patients with acutely deteriorating conditions (Abe et al., 2013; Fisher & King, 2013; Tawalbeh & Tubaishat, 2013; Alinier & Platt, 2013; Oermann et al., 2014). This will allow medical staff to improve their proficiency in advanced life support following simulation training compared to clinical experience alone (Wayne et al., 2005; Moretti et al., 2007; Peter & Boyde, 2007 cited in Gordon, 2009). Simulation training is not limited to nursing programmes. Simulation promotes the skills and competencies in both nursing and medical literatures (Murdoch et al., 2013). The skills acquired during simulation exercise are transferable to the clinical setting for the advantage of patient care (Beyea et al., 2007; Kory et al. 2007; Maslovitz et al., 2007; Shukla et al., 2007; Tuttle et al., 2007; Steadman et al., 2007; (Ti et al., 2006; Barsuk et al., 2006 ; Wayne et al., 2005 cited in McCaughey et al., 2010); Tosterud & Hall-Lord 2013; Richardson & Claman, 2014.

2.8 Critical Thinking

Critical thinking skills are essential in the nursing practice. The nursing practice is a process by which nurses deliver care to patients, supported by nursing models or philosophies. It is a systematic approach that is used by all nurses to gather, critically examine and analyse data, identify client responses, design outcomes, take appropriate action, then evaluate the effectiveness of action. This systemic approach requires the use of critical thinking skills to prioritise and make decisions on patient care. Critical thinking involves the use of the mind in forming conclusions, making decisions and drawing inferences. Similarly, critical thinking is a self-regulatory judgment that results in a demonstrated ability to interpret, analyse, evaluate and infer (Facione, 2001).

2.8.1 Critical Thinking Instrument

There are many tools can be used to evaluate critical thinking skills using CCTDI (Hwang et al., 2010 ; Yuen et al., 2012b ; Shinnick & Woo, 2013; Weatherspoon, 2015; Adib-Hajbaghery & Sharifi, 2017). Among many tools in the evaluation of critical thinking skill, the CCTDI was selected in this study for diploma nursing students which was recommended by Jeffries (2006) in her simulation framework for nursing education. The researcher has viewed other critical-thinking evaluation questionnaires such as the YCREATIVE-CRITICALS (2010), Torrance test of creative thinking (1982) and Watson-Glaser Critical Thinking Appraisal (1980). However, these critical thinking tools lacked strong evidence of suitability for this study. The nursing studies related to simulation from the literature review in Chapter 2 also used CCTDI as their primary tool in main research studies.

Based on the literature, the CCTDI was found suitable for use in nursing. The questionnaire has consistently been updated and monitored, with the reliability of the questionnaire monitored by the licensed company Insight Assessment Press. CCTDI has been widely used in many research studies outside of western countries. It has also been widely used in China, Hong Kong, Taiwan, Japan, Korean and Indonesia. These countries reported the measurement of internal consistencies using Cronbach alphas ranging from 0.71-0.80 (CCTDI User Manual, 2015).

Core critical thinking skills as described by Facione (1992) include:

1. Interpretation – The ability to understand and explain the meaning of information or an event.

2. Analysis-The investigation of a course of action based on objective and subjective data.

3. Inference-To identify relevant information and draw reasonable conclusion.

4. Evaluation-The process in assessing the value of the information obtained.

5. Explanation-The ability to clearly and concisely explain one’s conclusions.

6. Self –regulation- Involves monitoring one’s own thinking. This means reflecting on the process leading to the conclusions.

There are seven scales on the CCTDI: Truthseeking, Open-mindedness, Analyticity, Systematicity, Confidence in Reasoning, Inquisitiveness and Maturity of Judgment. Each scale score describes an aspect of the overall disposition toward using one's critical thinking to form judgments about what to believe or what to do. People may be positively, ambivalently, or negatively disposed on each of seven aspects of the overall disposition toward critical thinking.

Truth-seeking:

Truth-seeking is the habit of always desiring the best possible understanding of any given situation. It follows reason and evidence wherever they may lead, even if they lead one to question cherished beliefs. Truth-seekers ask hard, sometimes even frightening questions; they do not ignore relevant details; they strive not to let bias or preconception colour their search for knowledge and truth. The opposite of truth seeking is bias which ignores good reasons and relevant evidence in order not to have to face difficult ideas.

Open-mindedness:

Open-mindedness is the tendency to allow others to voice views with which one may not agree. Open-minded people act with tolerance toward the opinions of others, knowing that often we all hold beliefs, which make sense only from our own perspectives. Open-mindedness, as used here, is important for harmony in a pluralistic and complex society where people approach issues from different religious, political, social, family, cultural, and personal backgrounds. The opposite of open-mindedness is intolerance.

Analyticity:

Analyticity is the tendency to be alert to what happens next. This is the habit of striving to anticipate both the good and the bad potential consequences or outcomes of situations, choices, proposals, and plans. The opposite of analyticity is being heedless of consequences, not attending to what happens next when one makes choices or accepts ideas uncritically.

Systematicity:

Systematicity is the tendency or habit of striving to approach problems in a disciplined, orderly, and systematic way. The habit of being disorganised is the opposite tendency. The person who is strong in systematicity may not know of a given approach, or may not be skilled at using a given strategy of problem solving, but that person has the desire and tendency to try to approach questions and issues in an organised and orderly way.

Confidence in Reasoning:

Confidence in reasoning is the habitual tendency to trust reflective thinking to solve problems and to make decisions. As with the other attributes measured here, confidence in reasoning applies to individuals and to groups. A family, team, office, community, or society can be trustful of reasoned judgment as the means of solving problems and reaching goals. The opposite habit is mistrust of reasoning, often manifested as aversion to the use of careful reason and reflection when making decisions or deciding what to believe or do.

Inquisitiveness:

Inquisitiveness is intellectual curiosity. It is the tendency to want to know things, even if they are not immediately or obviously useful. It is about being curious and eager to acquire new knowledge and to learn the explanations for things even when the applications of that new learning are not immediately apparent. The opposite of inquisitiveness is indifference.

Maturity of Judgment:

Maturity of judgment is the habit of seeing the complexity of issues and yet striving to make timely decisions. A person with maturity of judgment understands that multiple solutions may be acceptable while yet appreciating the need to reach closure at times even in the absence of complete knowledge. The opposite, cognitive immaturity, is imprudent, black-and-white thinking, failing to make timely decisions, stubbornly refusing to change when reasons and evidence would indicate one is mistaken, or revising opinions willy-nilly without good reason for doing so.

2.9 Self Confidence & Learner Satisfaction

Nursing is a skill-based profession. Knowledge and skills are required to safeguard patient care with integrity. The level of self-confidence in students while performing nursing skills with patients requires hours of practices in laboratories/ simulation wards prior to clinical placement. Without practice and familiarisation, the tasks cannot be ably performed. Good cooperation and trust from patients is easily obtained as is consent for nursing procedures with nurses who are able to perform nursing skills confidently. Patients have the right to refuse treatment when nurses are not confident and portray a lacks of competency. HFPSs can be used to simulate specific scenarios for students/ nurses to gain confidence. It is a building block for acquiring confidence through practice according to their learning pace and time in a friendly environment. Feedback can be provided in debriefing to self-evaluate their own strengths and weaknesses with guided discussion post simulation. Mistakes made can be addressed and rectified via a video recorder (Fisher & King, 2013). Nurses can practice technical and non-technical skills for various given scenarios until competency and confidence in carrying out the task on the real patients in the clinical areas is achieved. Learning with experience begins with the simulated learning environment and this increases the level of learner's satisfaction through guided experiential learning. This process is ultimately the most importance to incalculate lifelong learning and building commitment to the nursing profession. Building self-confidence and increasing learners' satisfaction using simulation education is supported by many researchers (Maas & Flood, 2010; McCaughey & Traynor, 2010; Yuan et al., 2010; Blum & Parcells, 2012; Fisher & King, 2013; Mill et al., 2014; Najar, 2015).

Past research using HFPSs show that students reported that using simulation learning contributed to their self-confidence when working with patients in the clinical areas because they had become familiar with similar problems exposed during simulation education. Students exposed to HFPSs were also more ready to enter clinical areas (Alinier et al., 2004; Jeffries & Rizzolo, 2006; Brannan et al., 2008; Pike & O'Donnell, 2010; Lewis et al., 2012; Ricketts et al., 2013 cited in Cant & Cooper, 2017). Students in simulation groups recorded higher scores of confidence, better learning outcomes and increased competence (Mayne et al., 2004; Jeffries & Rizzolo, 2006; Howard, 2007; Cooper, et al., 2010; Boelland et al., 2014; McCabe et al., 2016). The ability to learn at an individual pace that did not induce anxiety gave student nurses the feeling of being able to perform the task, helped them feel that the skills lab learning was meaningful and helpful, with the discussions useful and overall an enjoyable experience (Johnson et al., 1999; Lev, 1998; Hilton, 1996; Cook and Hill, 1995; McAdams et al., & Love et al., 1989 cited in McCallum, 2006); McCaughey et al., 2010; Yuan et al., 2011; Cant, McKenna & Cooper, 2013; Aebersold & Tschannen, 2014; Cant & Cooper, 2017).

2.10 Team Collaboration

In diverse healthcare settings, nurses provide care to the clients along with other healthcare professionals with the goal of attaining positive patient outcomes. Learning to effectively collaborate with healthcare providers from different disciplines as a team is important. This training needs to be initiated in nursing schools before nurses enter clinical placements. Simulation using HFPS can provide a platform to students to communicate effectively, work as a team and inculcate leadership. Students also report their enjoyment of working in a team, working together to solve problems and learning how to effectively communicate. Simulation has been successfully used to enhance team-working ability in healthcare (O'Daniel et al., 2008; Baxter et al., 2009; McCaughey et al., 2010; Huseman, 2012; Murdoch et al., 2013; Kaddoura, 2016).

Collaboration in health care is defined as health care professionals assuming complementary roles and cooperatively working together, sharing responsibility for problem-solving and making decisions to formulate and carry out plans for patient care. Effective teams are characterised by trust, respect, and collaboration. Employees work together to achieve a goal and common aim. When considering a teamwork model in health care, an interdisciplinary approach should be applied. Unlike a multidisciplinary approach, in which each team member is responsible only for the activities related to his or her own discipline and formulates separate goals for the patient, an interdisciplinary approach coalesces a joint effort on behalf of the patient with a common goal from all disciplines involved in the care plan. It is important communicate based on common team collaboration lexicon. Studies have shown that when health care professionals do not communicate effectively, patient safety is at risk for several reasons: the lack of critical information, misinterpretation of information, unclear orders over the telephone, and overlooked changes in patient status (Joint Commission on Accreditation of Healthcare Organizations (JCHAO), 2005).

Simulation training encompasses the element of communication and team collaboration in a role-play based scenario. Students/ nurses are assigned on a role to act in a given scenario. They can be assigned as the nurse that discovers the unresponsive patient, or the nurse that helps manage airway management and leads the team, or as responsible in interpreting ECG for life threatening arrhythmias, in medication administration or as a doctor to perform resuscitation and intubation or as a relative who is anxious and worried. Interpretations of simulation involve standardised patients who can be involved in role play, whereby individuals are trained to portray patients in a consistent and realistic manner, initiating the expectation of rapport and communication skills in addition to patient assessment and management (Decker et al., 2008; Seropian et al., 2004; Maran & Glavan, 2003; cited in McCaughey et al., 2010; Kuehster & Hall, 2010; Murdock et al., 2013). In simulation, students report their enjoyment of working in a team, working together to solve problems and learning how to effectively communicate; simulation basically enhances team working ability and value as a member of healthcare team (Schoening et al., 2006 cited in Baxter et al., 2009; McCaughey et al., 2010; Murdoch et al., 2013).

2.11 Communication

In the National Center for Health Statistic's list of the top ten causes of death in the United States, medical errors ranks at number 5—ahead of accidents, diabetes, and Alzheimer's disease, as well as AIDS, breast cancer, and gunshot wounds (Joint Commission resources, 2005). A lack of team collaboration and communication can lead to preventable medical errors resulting in excess mortality and morbidity (Burke, Boal & Mitchell, 2004, cited in O'Daniel & Rosenstein, 2008). This is a concern as it is estimated that there are 850,000 adverse incidents a year in the UK and in the US (Glavin & Maran, 2003). These are reported as being due to poor communication and team working errors (Davis, 2005 cited in McCallum, 2006; Kuehster & Hall, 2010; Terry, 2015; Handerson, 2016). When health care professionals are not communicating effectively, patient safety is at risk for several reasons: lack of critical information, misinterpretation of information, unclear orders over the telephone, and overlooked changes in status (Joint Commission on Accreditation of Healthcare Organizations, 2005). In critical situations such as a cardiac arrest, there is a need for rapid, accurate and effective clinical decision-making, which inherently involves nurse-doctor communication. It has been suggested that integrating the concepts of team collaboration into simulation sessions provides the students/ nurses a more realistic experience communicating with team members.

SBAR is the acronym for Situation, Background, Assessment and Recommendation (Meeter, 2013). Firstly, in Situation (S), the respondent describes the specific situation, including the patient's name, consultant, patient location, code status, and vital signs. In Background (B), the respondent will give the patient's reason for admission, explain significant medical history and then inform the consultant of the patient's background including admitting diagnosis, date of admission, prior procedures, current medications, allergies, pertinent laboratory results and other relevant diagnostic results. For this, respondent needs to have collected information from the patient's chart, flow sheets and progress notes. In Assessment (A), the respondent will have considered what might be the underlying reason for the deteriorating patient's condition. Nursing assessment and laboratory results are vital to report. Finally, in Recommendation (R), the respondent will specify requests and time frames, make suggestions and clarify expectations. Note taking on orders given over the phone needs to be repeated back to ensure accuracy before ending the conversation with the doctor.

It is an easy to remember mechanism that respondents can use to frame conversations, especially critical ones, requiring a doctor's immediate attention and action. This method enables respondents to clarify information that needs to be communicated between members of the team, and how. It can also help participants to develop teamwork and foster a culture of patient safety. This statement was supported in the study conducted by Messter et al., 2013.

2.12 Debriefing in Simulation

Debriefing is a reflective practice of experience based on an individual's actions and is addressed as part of simulation training. According to Dreifuerst (2009), debriefing is a process whereby facilitator and students re-examine the clinical encounter, and foster the development of clinical reasoning and judgement skills through reflective learning process. Reflection is a learned self-correct and assimilate new experience with prior ones; it is a think-in action as well as think-on action (Rudolf et al., 2007; Schon, 1983 cited in Dreifuerst, 2009). In simulation training, the facilitator focuses debriefing discussions on learning outcomes and intended objectives through the simulated learning experience. Debriefing is structured to promote reflection and encourage students to analyse their own assumptions as well as think about how to enhance or develop more skilful nursing practice.

The aims of debriefing in simulation training are included as follows:

- Identification of the different perceptions & attitudes that occurred
- Linking the exercise to specific theory or content & skill-building techniques
- Development of a common set of experience for further thought

- Opportunity to receive feedback on the nature of one's involvement, behaviour, and decision making
- Reestablishment of desired classroom climate, such as regaining trust, comfort, and purposefulness

Teachers must provide opportunities for students to debref following clinical simulations. Debriefing involves the students' experiences in feedback, as well as encourage students to express their feeling and their assumptions in a friendly learning environment. They should facilitate student identification of their own strengths to share with other team members and improve self-limitations for future practice. Reflective practitioners are who engaged in self-reflection can self-correct and assimilate new experiences based on prior experience. This action can improve their professional competency. Debriefing provides opportunities to foster reflective learning, encompassing the ability to think-in-action as well as think-on-action (Schon, 1983 cited in Dreifuerst, 2009; Jeffries, P.R., 2012; Adamson, 2015).

2.13 Challenges of HFPS

Several challenges are described in the literature and should be considered when determining how and when to utilise this teaching modality. There is evidence that simulation activities and the use of simulators may not be suitable for all. Some students have described uneasiness when interacting with a lifeless manikin and have suggested that they would prefer to talk to a 'real' person (Baxter, 2009; Mills et al., 2014). Bantz et al. (2007) also reported that students felt uncomfortable talking to a manikin and would have preferred to talk to a 'live' individual. What is interesting to note is that even though students recognise that they are not dealing with a live patient, they do, at times, find the simulations so realistic that they are frightened and stressed (Childs & Sepples, 2006 cited in McCaughey et al., 2010) and can be traumatised (Reilly & Spratt, 2007 cited in McCaughey et al., 2010). Although some students have found the scenarios to be lifelike, others find that the skills that they learn are not transferable to real clinical environments (Feingold et al., 2004; Parr & Sweeney, 2006).

Reports from studies revealed that students commented they were very stressful when being graded (Reising et al., 2010, cited in Murdoch et al., 2013; Garrett et al., 2010 & Weaver 2011, cited in Boelland, 2014). Students reported needing to get into a certain mind set to feel comfortable in the simulation environment and feel of being watched in video recording (Mills et al., 2014). Many capabilities are also often not set up such as using an upgraded HFPS, a variety of simulation techniques, audience response didactic lectures, clinical and community settings because the costs may be too prohibitive (Roberts & Greene, 2011; Murdoch et al., 2013). According to Baxter et al., 2009, the scenarios prepared in the interventions have limited emphasis on the communication skills between students to patient and family. This is because this aspect requiring additional settings by the faculty staff to provide responses in communication (projection of voices, sounds and body movements) on the HFPS, which is considered as additional step in preparation of the simulation education. Laboratory situation are not as good as the clinical placement for teaching clinical skills. Simulation cannot replace real patients and the real world, or the fact that students do not have sufficient access to “real contact” (McAdams et al., Gomez & Gomez 1987 cited in McCallum, 2007; Baxter, 2009; Roberts & Greene, 2011; Murdoch et al., 2013).

One of the students' factors can be challenging in the process of using HFPS in the simulated education process, the active students tend to dominate or take over the scenario while less confident students stand back and observe during the simulation education. Teachers facilitating the simulation training need to be aware of the possibility of dominant and recessive students in order to provide equal chance and balance in group dynamics for effective learning outcomes.

On the whole, simulation training is costly and labour intensive (Fisher & King, 2013; Adamson, 2015; Kaddoura et al., 2016; Cant & Cooper, 2017). Faculty support, reliability in IT support and qualified academicians are the key to success in simulation training. The use of technology is complex and requires time for learning. Thus, faculty is often wary of this teaching technology when nursing programme syllabi are planned with theory, practical and clinical placements in a stipulated time frame (Richardson et al., 2014).. Simulation training requires small focused groups in learning to achieve desired learning outcomes, while time is often limited in a given programme. Faculty members are fearful and stressed that their teaching may not go smoothly, thus jeopardising stipulated training time. Because of budgetary limitations and the lack of incentives for faculty to purchase HFPSs, efforts to learn the technology and develop scenarios remain scarce. The costs of HFPS may be prohibitive for many nursing schools in view of decreased numbers in nursing enrolments (Star newspaper, 2012). The maintenance of HFPS including servicing, changing of parts, items and equipment, computerised system upgrading, video recording and sound system functionality, antivirus protection, purchasing of the special scenario teaching software and upgrading of existing software packages, wireless internet facility, electrical consumption during prolonged usage of the HFPS for different groups of students and other miscellaneous costs contribute to the high costs of HFPS. In addition, a study described by (Scherer, Bruce, & Runkawau 2007 cited in Gordon, 2009) using a quasi-experimental design study to test knowledge of cardiac event management on the pitfall of using HFPS suggested that simulation alone in teaching may not effective in supporting the domain of knowledge. Other studies have discovered that there are no positive learning outcomes for using high fidelity patient simulator over traditional methods for delivering clinical skills education (Leigh, 2008; Wenke et al., 2008 cited in Roberts & Greene, 2011).

In term of costs, simulation using high fidelity patient simulation is expensive to establish for laboratory design and the cost of the simulators (Hyland & Hawkins, 2009 cited in Roberts & Greene, 2011), with the need of ongoing maintenance on the simulators and its accessories. Investing money in the simulation learning may not be a priority as many other factors require detailed justifications, using a cost-benefit analysis.

Nehring and Lashley (2004) reported faculty members are wary and fearful of using high fidelity patient simulator technology. Faculty members need to make the effort to learn and allocate time to learn new skills, as facilitating and debriefing are special skills required in simulation education. Students can also become anxious and uncomfortable when performing in front of their peers and being video recorded (Nehring & Lashley, 2004).

HFPS are widely used in programmes other than nursing. According to Schwartz, Fernandez, Kouyoumjianm, Jones, and Compton (2007) cited in Gordon (2009), there was no difference in the performance of fourth year medical students during an objective structured clinical examination of patients with chest pain when case-based learning was compared to learning using simulation. This suggests that simulation is not a substitute for traditional teaching.

Nevertheless, students who repeatedly used the HFPS and were acquainted with the simulated environment expressed satisfaction and gained positive learning outcomes through their experiences of using the HFPS. The benefits of using HFPSs outweigh the pitfalls identified. This statement is supported by the latest systematic reviews (Cant & Copper 2017; Adamson, 2015; Yuan et al., 2011; Lapkin et al., 2010).

2.14 Summary

There is growing evidence that the use of simulated learning assists clinical capability of health care students and professionals. The literature indicates that students using HFPSs show increased knowledge, skill performance, critical thinking and perceived increased satisfaction and confidence after receiving simulation education using HFPS. The simulation education is associated with the benefits to the teaching and learning process. However, the literatures reviewed affirm that the benefits far outweigh the costs of simulation education in the majority of the studies discussed in this chapter. Despite the benefits of simulation education in fostering positive learning outcomes, this strategy is still adjunct to clinical experience and is not a replacement for real patient-nurse interaction in the hospital and clinical settings. The next chapter describes the methodology of this study.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter outlines the research process adopted. The research design, study setting, population and sampling plan, research instruments, procedures for data collection and type of data analysis used are presented in figures, tables and explained descriptively.

3.2 Study Design

The research design is the outline, plan, or strategy that is used to answer a research question (Johnson & Christensen, 2014). A plan is identified and used in data collection that adequately tests the hypotheses. Quantitative designs are divided into experimental and non-experimental research. In an experimental (or randomized controlled trial, RCT), researchers are active agents, not passive observers. The experimental design is better for revealing cause-and-effect relationship compared to other research designs and it is the best possible designs to illuminating the causal relationships (Polit & Beck, 2017). However, it is not always possible to use an experimental design for various ethical or practical reasons. Three characteristics of experimental design or RCT are manipulation, control and randomization. Manipulation involves the researcher subjecting at least some participants in the type of intervention. Control refers to researcher introducing a control in the research does not receive the intervention. Randomization refers to the researcher assigning the participants to a control or experimental situation on a random basis. The goal of all RCTs is to have an identical intervention for all people in the treatment group (Polit & Beck, 2017).

This study used a 2-group, quasi-experimental pretest-posttest design. A quasi-experimental research design was used in this study because the researcher did not have full control of the potential confounding variables. According to Cozby (2008) cited in Huseman (2012), quasi-experimental designs are appropriate when the aim is to study the effect of an independent variable in a setting where the control of a true experimental design cannot be achieved.

The researcher conducted a study in a convenience sample of available year 3 semester 1 or semester 2 nursing students in participating nursing schools within the stipulated time given by the school authority to complete the data collection process. The reference from the systematic review conducted by Cant & Cooper (2017) stated that the reviews of simulation-based education most often incorporate quasi-experimental cohort studies, who are tested before, and again after, the intervention to detect the influence of education. In the hierarchy of evidence levels, these reviews provide level 2- evidence.

The groups consisted of intervention and control groups. The intervention groups were exposed to HFPS while the control groups used the LFPM. Both groups were measured at baseline pre-test and post-test to examine the effectiveness of simulation education in a code blue scenario.

3.3 Study setting

Two main distributor companies who supply HFPSs in Malaysia identified nine schools using HFPS in nursing school programmes and this information was shared with the researcher. Invitation letters were then sent to these nine schools during the screening period from June 2012 to June 2013. Only three schools replied and consented to be a part of this research study. The location for these participating universities/institutions were in the Federal Territory of Kuala Lumpur, Shah Alam, Selangor and Nilai, Negeri Sembilan.

The school situated in the Federal Territory of Kuala Lumpur is a semi-government nursing school that is attached to a teaching hospital. The second school from Shah Alam, Selangor was a public university, which is not attached to a teaching hospital and the third nursing school was a fully private university situated in Nilai, Negeri Sembilan. The nursing school from Shah Alam, Selangor and Nilai, Negeri Sembilan both used the Meti Man while the school in the Federal Territory of Kuala Lumpur situated nursing school used SimMan 3G. Both Meti Man and SimMan 3G are classified as HFPS. These schools were also equipped with low fidelity patient manikins and required students to attend a compulsory clinical skills laboratory for students to practice prior to clinical placements. The three schools had a minimum total of 40 students in their year 3-diploma nursing students and were using HFPS to support teaching in its courses/ programmes.

These universities/institutions offer various nursing programmes at different levels such as diploma, post basic courses, bachelor degree, master degree and doctoral studies. The researcher focused on diploma nursing programmes as most nurses in Malaysia are diploma trained nurses.

3.4 Sampling methods

3.4.1 Target population

The study was conducted from June 2013 to July 2015 in three nursing schools. The target population were student nurses in their third year nursing programme offered by the respective schools. Students enrolled in the diploma of nursing programmes of participating universities/ institutions are similar in terms of the duration of study, entry requirements and programme syllabus as this is regulated by the Nursing Board of Malaysia and approved by the Ministry of Education, Malaysia. One of the participating universities/ institutions had only one intake per year of nursing diploma students in the programme. Only one public university has three intakes per year with smaller numbers of students, therefore a combination of two final semesters of the same year-3 nursing students were recruited to ensure essential knowledge and skills were learned as prerequisites in this study. The total number of students in these universities/ institutions varied and the exact number of students in the study was confirmed before the commencement of the semester.

3.4.2 Sample size

Universal sampling was used in this study as all year-3 diploma-nursing students from all three schools participating in the study. There were 64 participants from school one, 99 participants from school and 246 from school three. The total participants were N = 409 student nurses for this study.

Sample size calculation for experimental studies can be calculated by comparing the mean difference between group 1 and group 2 and standard deviation (or variance) (Rosner, 2016). Group 1 is the intervention group whereas group 2 is the control group. The researcher should enter the sample size and standard deviation of the main study variables based on previous studies (Brannan et al., 2008; Hoadley, 2009 and Fero et al., 2010), which was done prior to the study. In this study, all parameters were calculated from the previous studies and it was concluded as per the following:

$$n = \frac{2\sigma^2(Z_\beta + Z_{\alpha/2})^2}{\text{difference}^2}$$

n = Sample size in each group (assumes equal sized groups)
σ = Standard deviation of the outcome variable
Z_β = Represents the desired power (typically .84 for 80% power).
$Z_{\alpha/2}$ = Represents the desired level of statistical significance

$n = (\text{Zscore}+1.96)^2\,(SD(1)^2+SD(2)^2)/(d)^2$

Z score table:

Z score	Power
0.53	for 70% power
0.84	for 80% power
1.29	for 90% power

The total sample size was calculated for knowledge, skill performance, critical thinking skills and satisfaction and self-confidence. The sample calculation was calculated to take into account a power of 90% and confidence interval of 95%. Based on this sample size calculation comparing two means for knowledge was 110; for skill performance it was 64; for critical thinking it was 223; for satisfaction and self-confidence respectively it was 214. The critical thinking skills was chosen with the justification that critical thinking stand at the highest hierarchy of learning goals in Bloom's taxonomy compared to others three learning outcomes of this study (Bloom, 1956 cited in Anderson and Krathwohl, 2001). Critical thinking had the highest sample size among all other learning outcomes. Critical thinking as it requires analysis in problem solving, which is the key outcome of the study. Therefore, the minimal sample size required to be calculated for this study is N= 223.

3.4.3 Inclusion and exclusion criteria

The inclusion criteria for students who participated in this study included the required completion of the theory of anatomy & physiology, fundamental nursing, communication skills, psychology and sociology in nursing, pharmacology, disorders in fluids and electrolytes, CVS, and the respiratory management. Participating nursing students were also required to have completed their clinical posting for medical and surgical nursing to achieve the objectives stated in the first inclusion criteria.

Exclusion criteria for nursing institutions were institutions, which did not have HFPS in their educational systems during the recruiting period from June 2012 until June 2013. In addition, institutions that did not provide consent via response to the invitation slip of the agreement for participation in the study, which was attached along with the invitation letter, was excluded from the study. Exclusion criteria for selection of students were students who had deferred the semester, had not completed clinical placement, or had withdrawn from the program.

3.5 Research tools

There were four tools used to measure participants' knowledge, skills assessment, learner-satisfaction, self- confidence and judgment performance in critical thinking in this study.

The questionnaires packet consisted of the following: Set 1 was a 30-Single Best Questions (Appendix B); set 2 was a 12-domain skill performance checklist (Appendix C); set 3 comprised of 7-items demographic questions for each participant (Appendix C), section A, 16 items-*Simulation Design Scale (SDS)* and section B 20 items-*Educational Practices in Simulation Scale (EPSS)* questionnaire (Appendix C) while set 4 was the 75-item *California Critical Thinking Disposition Inventory (CCTDI).*

The researcher chose the SDS and EPSS Likert scale type questionnaire for the following reasons: the SDS is designed to evaluate the learners' satisfaction and self-confidence based on EPSS on the responses following the implementation of HFPS. The EPSS is a questionnaire meant to evaluate design and development of a simulation that is important to establish learner satisfaction and self-confidence. The SDS questionnaire was chosen because it was the work of 9 leading experts in the field of simulation: Jeffries, Childs, Decker, Horn, Hovanchek, Childress, Rogers, Feken, Spunt, and Politi (2004) cited in Jeffries, 2007. The internal consistency and reliability for each scale was tested. The coefficient alpha for the overall scale was 0.94. EPSS was tested when simulation was implemented; it went through a result of factor analysis and was collapsed into four factors. The four educational practices are active learning, diverse ways of learning, high expectations, and collaboration. The content validity was established through a review by nine expects in the field of simulation. The coefficient alpha was 0.92. Subsequently, the SDS and EPSS questionnaires were used in the National League Nursing on a project proposal across US nursing schools to review the current state of framework for designing, implementing and evaluating simulation used as teaching strategies in nursing education.

The CCTDI chosen in this study aimed to evaluate the critical thinking skills of nursing students as this was recommended in the Jeffries' simulation framework. The researcher previously considered other critical thinking evaluation questionnaires such as the YCREATIVE-CRITICALS (2010), Torrance test of creative thinking (1982) and Watson-Glaser Critical Thinking Appraisal (1980). However, these critical thinking tools lacked strong evidence and were deemed unsuitable for this study.

In the literature review, the CCTDI was found to suitable for use in nursing and the questionnaire has consistently been updated. The licensed company Insight Assessment Press monitors the reliability of the questionnaire. The CCTDI has been widely used in many research studies other than western countries and also used widely in China, Hong Kong, Taiwan, Japan, Korean and Indonesia. These countries reported an internal consistency ranging from 0.71-0.80 (CCTDI User Manual, 2015).

Knowledge and skill performance were assessed using self-administered questionnaires that were specifically designed after detailed discussions with an expert panel and reviewed with consensus for management of code blue situations for year-3 nursing students in identifying deteriorating patients in Malaysia.

The tools measuring each variable of interest are listed below:

a. Knowledge

The 30-Single Best Questions distribution comprised of: determine responsiveness (1-item), airway management (7-items), breathing (6-items), circulation (6-items), drugs (5-items) and defibrillation management (4-items) and team collaboration (1-item).

- The rating for 30 Single Best Questions is as follows:

  Exemplary : 27-30 marks

  Proficient : 21-26 marks

  Marginal : 13-20 marks

  No Pass : 0-12 marks

The maximum total score for the 30-Single Best Questions (SBQ) is 30 marks. One correct answer was awarded one mark each. The student participants were instructed to answer the question and shaded only one answer for each SBQ on the answer script provided with a 2B pencil. They were required to answer all 30-Single Best Questions. A total of 45 minutes was allowed for student participants to complete these questions (Appendix B: 30 -Single Best Questions).

The total score of knowledge was recoded using rubric scoring. The scoring rubric is an efficient tool that allows scoring to objectively measure for student performance on an assessment activity. It used a range to rate performance and is arranged in levels which standard is met based on learning objectives (Washtenaw Community College (WCC) Education Department, 2015). The WCC was founded in 1965 and is located in Michigan, America. The rubric scale was used because it explained evaluations objectively with a scoring system that suited in this study and is in line with the NCLEX professional board scoring percentage. Exemplary (4) is the score which indicates a very high level of overall knowledge preparedness necessary to support the scope of code blue management. Proficient (3) score indicates the level of knowledge of code blue management meet the standard. Marginal (2) score refers to a pass score for the knowledge of code blue management while No Pass (1) score indicates very poor in knowledge of code blue management. This rubric scale is reviewed, suggested and verified in its suitability by the expert panels from this field.

There are two types of rubric scoring, the holistic analysis and primary trait analysis. The holistic analysis was selected as single score is given for overall achievement of multiple learning outcomes. The primary trait analysis is used for learning outcomes being assessed and separate scores to be given each trait or outcome (Truemper, 2004; Reynold, 2015). The rubric is an evaluation tool that helps to provide consistency in assessment, reduces subjectivity and enhances objectivity. The rubric refers to quality performance in assessing nursing knowledge and skills.

The total of 30 marks was converted to 100% in the knowledge performance. Four scores were categorised and it was modified from the Washtenaw Community College (WCC) Education Department framework: 4 (Exemplary) = 27-30 marks or 90-100%; 3 (Proficient) = 21-26 marks or 70-89%; 2 (Marginal) = 13-20 marks or 40-69%; 1 (No Pass) = 0-12 marks or 0-39%. The highest cut off point is 69% for the passing rate on the NCLEX professional board exam (Reynold, 2015). To the researcher's best knowledge, there are limited published nursing articles that relate to the use of rubrics in assessing knowledge performance. Therefore, the guideline was adopted from established, published literatures from the United States.

Knowledge

Table 3.1: Rubric Score for Knowledge

SCORE	CONVERTION (Total 30 Marks X 100%)	SCORE
4 (Exemplary)	27-30	90-100%
3 (Proficient)	21-26	70-89%
2 (Marginal)	13-20	40-69%
1 (No Pass)	0-12	0-39%

b. Skills assessment on Code Blue Drill for simulation/ practical assessment

- There are 12 domains listed in the Code Blue Assessment Checklist
- The assessment for the practical is named as ‘Checklist for Adult Code Blue Drill’. The checklist consisted of 40 items from 12 (twelve) domains. The 12 (twelve) domains are activation of Code Blue (3 items), preparation of environment (2 items), preparation of patient (4 items).
- Domain 1 (Activation of Code Blue) - 3-items; Domain 2 (Preparation of Environment)- 3-items; Domain 3 (Preparation of Patient) - 4-items; Domain 4 (Arrival of Crash Cart)- 3-items; Domain 5 (Oxygen) - 4-items; Domain 6 (E.C.G)- 2-items; Domain 7 (Setting Up of I.V.I) - 4-items; Domain 8 (Suction Apparatus)- 3 -items; Domain 9 (Intubation)- 3 items; Domain 10 (Drugs)- 4-items; Domain 11 (Defibrillation) - 5-items; and Domain 12 (Post Code Blue)- 2-items (Appendix D: Code Blue Check-list).
- The paired assessor used this standardised checklist to rate the score of student participants' performance, both control and intervention groups for their skills in a code blue practical situation.

The scoring used for skill performance comprises levels ranging from competent, average, pass and poor. Competent (above 35 marks) refers to possession of required skills in code blue management; Average (27-34 marks) indicates skills in code blue management are at satisfactory level; Pass (19-26 marks) is and acceptable level and Poor (Below 19 marks) refers to unsatisfactory performance. This rubric scale was chosen because the cut-off identifies and compares students who are competent and average to those who require improvement and relearning of code blue management skills in order to pass. This rubric scale was sent for review and the expert panels from this field suggested modification on its suitability in adoption for code blue management assessment.

The rating for the code blue checklist is as follows:

Competence	: Above 35 marks
Average	: 27-34 marks
Pass	: 19-26 marks
Poor	: Below19 marks

The (a) 30-Single Best Questions and (b) skills assessment on code blue drill measures theory and skills using checklist evaluations. Expert panels from Malaysia, Singapore and Australia reviewed these questions. Subsequently instruments (a) and (b) underwent back-to-back translation. Scores were allocated for the 30-Single Best Questions to measure students' knowledge and the code blue checklist to evaluate students' competency in managing code blue situations.

The rubric scoring system was similarly used for skill performance in the study. A total of 40 marks was converted to 100% in the skill performance. Four scores were categorised and modified from the Washtenaw Community College (WCC) Education Department, 4 (Exemplary) = 36-40 marks or 90-100%; 3 (Proficient) = 28-35 marks or 70-89%; 2 (Marginal) = 16-27 marks or 40-69%; 1 (No Pass) = 0-15 marks or 0-39%. The highest cut off point is 69% for the pass rate on the NCLEX professional board exam (Reynold, 2015).

Skill Performance

Table 3.2: Rubric Score for Skill Performance

SCORE	CONVERTION (Total 40 Marks x 100%)	SCORE
4 (Exemplary)	36-40	90-100%
3 (Proficient)	28-35	70-89%
2 (Marginal)	16-27	40-69%
1 (No Pass)	0-15	0-39%

c. **The *Simulation Design Scale (SDS*) by Jeffries (2007*),***

- A 20-item instrument using a five-point scale was designed to evaluate the five design feature of the instructor-developed simulations used in this study.
- The five design features include objectives/ information, support, problem solving, feedback and fidelity.
- SDS is measured by average mean scores using a five-point Likert scale in the five design features.

Appendix C: Questionnaire for Satisfaction and Self-Confidence

d. **The *Educational Practices in Simulation Scale (EPSS)* by Jeffries (2007*),***

- A 16-item instrument using a five-point scale, was designed to measure whether the four educational practices (active learning, collaboration, diverse ways of learning, and high expectations) were present in the instructor-developed simulation, and the importance of each practice to the learner.
- EPSS was measured by average mean scores from a five-point Likert scale for the four educational practices.
- The questionnaire for (c) and (d) were combined as one set of questionnaire with an attached invitation letter to participants, a written consent agreement between researcher and participant and the seven items measuring student background characteristics.
- This questionnaire has three sections: A, B and C. Section A consisted of the population demographics which comprised seven demographic questions on the subjects' background with age, current semester, gender, highest education, current Cumulative Grade Point Average (CGPA), experience with computerised patient simulator before this study and role assigned in the simulation/ practical session.

- Section B was the *Simulation Design Scale (SDS)*, a 20-item instrument and section C was the *Educational Practices in Simulation Scale (EPSS)* that has 16 items. Permission was granted to use the SDS and EPSS from Prof. Dr. Pamela Jeffries, School of Nursing, University of John Hopkins, US. Appendix 5 shows the SDS and EPSS as developed by the National League for Nursing and supported by Laerdal in a 3-year project across nursing schools in the US from 2003-2006. Prof Dr. Pamela Jeffries is the pioneering simulation training in nursing, with her research instrument cited in more than 100 publications.
- Both sessions B & C used a 5-point Likert scales aimed to explore the students' perception on educational practices.

  1 - Strongly Disagree with the statement

  2 - Disagree with the statement

  3 - Undecided - you neither agree or disagree with the statement

  4 - Agree with the statement

  5 - Strongly Agree with the statement

NA - Not Applicable; the statement does not pertain to the simulation activity performed.

- Each student was required to use the following rating system when assessing the simulation designs elements (SDS) and educational practices in simulation (EPSS) on the left side of the questionnaire

e. The *California Critical Thinking Disposition Inventory (CCTDI)*

- Consists of 75 items, used to measure creative and critical thinking style of the students.
- Domains are composed of truth seeking (12 items), open mindedness (12 items); analyticity (11 items); systematically (11 items); confidence in reasoning (9 items); inquisitiveness (10 items) and maturity of judgment (10 items).

This questionnaire was developed by Professor Dr. Noreen Facione and authorised by the Insight Assessment Company from the US and is based on a 46 cross-disciplinary expertise tool to evaluate critical thinking disposition among college students, adults and professionals on the use of CCTDI (Facione & Facione, 1992). Over time, the CCTDI has undergone many revisions, translated into many languages and used by many scholars to research the critical thinking disposition of nurses and nursing students (Yeh, 2002; Profetto-McGrafh, 2003; Kawashima & Petrini 2004; Shin et al., 2006, cited in Hwang et al., 2010).

3.5.1. Translation

The CCTDI is strictly copyrighted and its use requires purchase from the company. The set of questionnaire shipped by the company and the analysis of study was also tabulated as a package of this service. The researcher was given the permission to translate the 75 items questionnaire into Bahasa Malaysia and worked as a team with two qualified translators. The *Simulation Design Scale (SDS)* and The *Educational Practices in Simulation Scale (EPSS)* questionnaires were constructed bilingually. The English language was the original questionnaire and it was then translated to Bahasa Malaysia to suit the local university/ intuition. Back to back translation was done to ensure the consistency in meaning of the questionnaires. Two translators, one expert in English and another expert in Bahasa Malaysia were invited to assist in the process of translation. The original questionnaire in English was given to the Bahasa Malaysia language lecturer for the translation into that language. After obtaining the Bahasa Malaysia version translation, these questionnaires were then sent to the English language lecturer to translate back into the English language. Upon completion, the original questionnaires were matched and compared with the translated back-to-back set of questionnaires to compare discrepancies. Minor necessary revisions were performed between both translators.

3.6 Data Collection Procedure

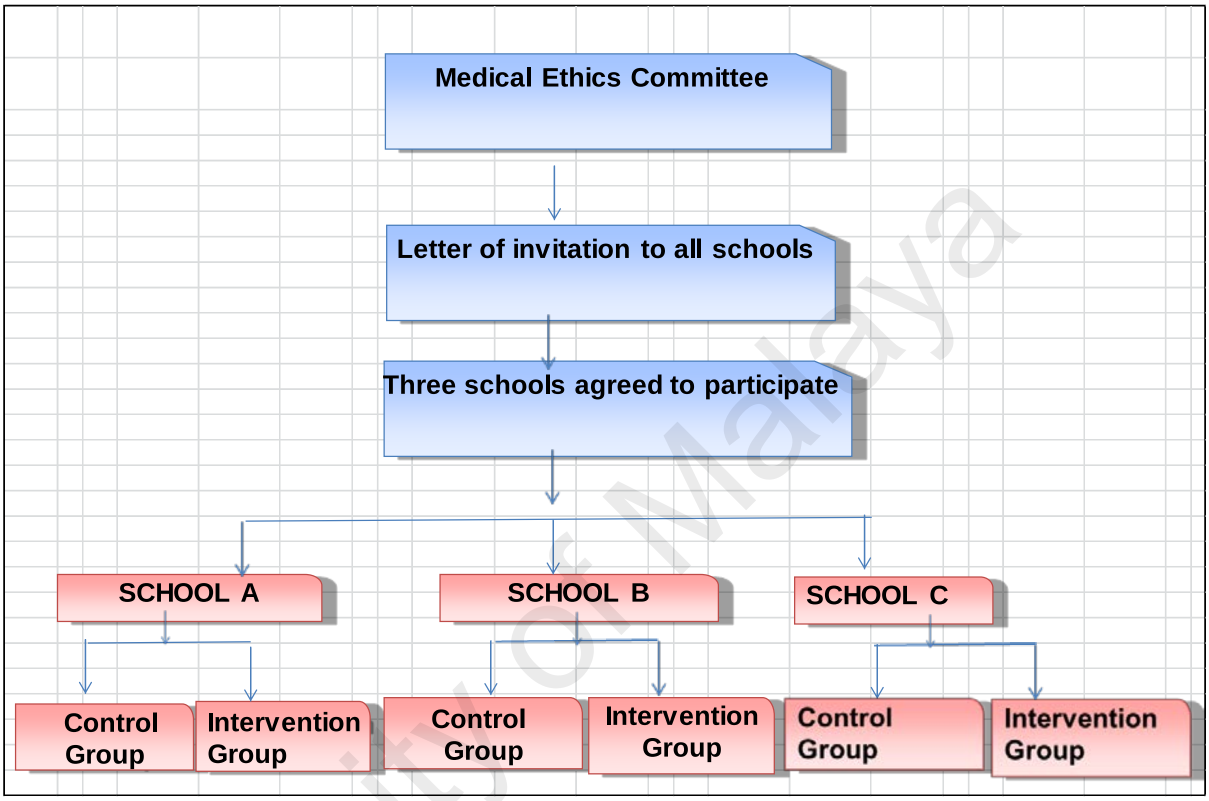
The study was conducted from June 2013 to the July 2015 in three nursing schools. The target population were student nurses in Year-3 diploma from participating schools. The researcher and her research assistants divided the control and intervention groups, with questionnaires and assessment questions distributed to these two groups of student nurses in this study.

A cover letter explaining the purpose of this study, consent, participation and type of questions required were attached together (appendix A). This was to assure respondents understood the process of their participation and that protected the confidentiality of their responses. Instructions were provided to respondents to complete the questionnaire and return it to the researcher or her assistants. The 30-Single Best Questions and three set of questionnaires (CCTDI, demographic particulars, SDS and EPSS) were distributed before and after the teaching session of code blue drill lesson and subsequently when the practical session and debriefing was completed. Pre-test to evaluate knowledge in code blue situations, questionnaires on satisfaction, self-confidence and critical thinking was tested prior to the teaching and practical session. The three sets of questionnaires for both groups of student nurses were collected within 24 hours, regardless of whether they had completed the questionnaires or not, to ensure that there was no exchange of answers among the students or reference to related material in the validity measurer.

Students participating in the study were evaluated for both theory and practical sessions of a code blue situation. In the practical session, a self-administered skills checklist was used and assessed by two assessors assigned on each group, this included both control and intervention group. Prior to each research activity for each recruited school, the researcher and interrater assessors met and discussed the flow of the simulation training to achieve mutual understanding and standardisation of the evaluation criteria. A pair of assessors assessed each control and intervention groups. The intervention group was exposed, post practical assessments, to the new teaching strategy using high fidelity patient simulator while the control group did not receive exposure.

The criteria for selection of research assistants as the assessors for the practical sessions include the recruited assessor who is a registered nurse possessing a bachelor nursing degree with minimum of at least 3 years working experience in clinical or education. The practical evaluation on both controlled and intervention was paired with two assessors. Both assessors evaluating students' practical sessions would observe independently in a 10 minutes' active practical session based on a standardised checklist. They observed and evaluated each subgroup of five students independently. Upon completion, they concluded after a discussion of the given scores and arrived at a consensus on an average final score for each subgroup. The scoring criteria between these two assessors on the marks awarded following each practical session were based on a standardised checklist for each control/ intervention groups, and could not exceed a discrepancy of more than five marks. Any such discrepancy was discussed and finalised. The researcher and her assistants sought advice from the lecturer in charge of year 3 students from each recruiting school to obtain the name list of the relevant students. For both control and intervention, the environment of the code blue drill was set and arranged in a similar manner except for the control groups with LFPS while the intervention groups were exposed to the High Fidelity Patient Simulator (HFPS).

Table 3.3: Data collection flow chart



3.7 Intervention

3.7.1 Before Intervention

- The batch was further divided randomly into 2 groups based on randomisation using Microsoft excel from the name lists and then systematic sampled from the randomised name list. The randomisation using Microsoft excel was used to sort the names of students by alphabetical order. It was then followed by further dividing the students' names in the list by numerical order. Every odd number from the name list was categorised into the control group while every even number from the name list was designated as part of the intervention group. The first group was the control group with LFPM and the second group was the intervention group with HFPS.

They were further divided (by control and intervention groups) so that 5 participants in one group. The researcher briefed them in the classroom during the pre-debriefing session and lecture on code blue.

- Both vendors of HFPS and the laboratory manager from the recruited schools assisted the researcher for technical support in this study. The researcher held several discussion sessions with the vendors and laboratory manager on the content of the simulation algorithm, objectives of the code blue drill and the desired and expected running time of the simulation scenario. The rehearsal was conducted prior to each research activity for each recruited school. The simulation scenario on an adult code blue situation was pre-programmed in the computer-based system. It was played during the simulation training for each group of the team, which consisted of 5 respondents that were involved in the intervention groups. The computer monitor screen in the simulation training displayed setting of changes in the essential vital signs that included an ECG waveform, monitoring of pulse rate, blood pressure, respiratory rate and the oxygen saturation (SPO2). These changes were controlled by the technical support staff in-charge. The HFPS has the ability to communicate with the team of the respondents and the technical support personnel manipulated through a speaker that amplified the voice.

Appendix F: Scenario on an adult code blue

- All respondents in the control and intervention group attended a power point presentation lecture on code blue situation and pre-debriefing in the lecture hall by the researcher. The controlled group did not participate in simulation training with HFPS but would attend practical session with LFPS with the same scenario.
- Pretest question of 30 Single Best Questions was given to all respondents to assess baseline on code blue theory before the commencement of pre-debriefing and lecture on code blue situation. This took 45 minutes including reading time.

- Pre-debriefing on simulation was then delivered in a power point presentation and a video presentation on simulation and practical environment. Students were informed their role in the simulation training and consequently divided in a small group team of 5 in a group for both control and intervention groups. This process of briefing took 10-minutes. There were 5 specific roles for each of the 5 respondents to act in the simulation training or practical session. These 5 specific roles include nurse 1, nurse 2, nurse 3, a doctor and a relative. A card, which was written a number indicating the specific role, would be randomly picked on by each of the 5 respondents in each group and assigned by the assessors. This procedure was assigned before the teaching session and further emphasised during the 10 minutes pre-debriefing by the researcher with the purpose of increasing understanding of the roles assigned.
- The code blue theory teaching power point presentation format took 30 minutes and was conducted in a lecture hall/ classroom. The code blue teaching consisted of a refresher on how to recognize deteriorating patients, preparation of a patient before cardiopulmonary resuscitation (CPR), correct technique in performing CPR, administering of oxygen, use of suction apparatus, assisting in medications, preparing of intubation, interpretation of ECG, assistance in defibrillation, team communication and documentation. The lecture also stated the learning objectives and content of code blue drill that includes scenarios in simulation for airway management, cardiopulmonary resuscitation, administration of medication, identification of life threatening arrhythmias and team collaboration on a deteriorating patient using SBAR.

3.7.2 During Intervention

- Students from the control and intervention groups were prepared to participate in the 5 specific roles to play as Nurse 1, Nurse 2, Nurse 3, as a doctor and as a relative.
- The role of Nurse 1 was to activate code blue and position the patient followed by initiation of CPR on the deteriorating patient. Nurse 2 held the role of arriving with an emergency trolley, received the assessment from Nurse 1 and calling the doctor in line with SBAR concepts. Once that was done, Nurse 2 would switch on the defibrillator and apply the ECG leads on the patient. Nurse 2 was responsible for aassisting the doctor in patient intubation upon arrival. Nurse 3 was to administer 15 liter per min oxygen via high flow mask and set up the suction apparatus, followed by the setting up of IV therapy and medication, as well as rotation CPR with Nurse 1. The patient relative's role was to call Nurse 1 for her/ his help and ask Nurse 1 questions. The role of the doctor was to assess the patient after being briefed on the patient's situation by Nurse 2, following SBAR concepts. The doctor was to interpret ECG rhythm and order defibrillation, orders to administer medications (IV infusion, IV adrenaline, IV Atropine) and perform intubation. The respondents in team were assessed using a code blue checklist on their specific roles during the code blue situation. Students were informed that their simulation training for those only exposed to HFPS in intervention groups would be recorded for review purposes during the debriefing session. It was made clear that the video was only used for research and teaching purpose for improvement of clinical skills in each debriefing discussion. The assessors observed and evaluated the student-participants in the practical session and subsequently discussed with the students in groups of 5-6 during the structured debriefing session. For the control groups using LFPM, feedback was given after the practical sessions without need for video recording.

- The simulation training for the practical session was held in the skills laboratory and it took 10 minutes to run a single group, which consisted of 5 respondents in a team. Respondents were assigned as Nurse 1, Nurse 2, Nurse 3, a doctor and a relative. Active participation was expected. The respondents from the intervention groups were evaluated and the video recorded for participants involved in simulation training, while for the control group there was no video recording, although the same evaluation process was conducted. A checklist was used for the evaluation and observed by paired assessors.

3.7.3 After Intervention

- The structured debriefing session was conducted right after each practical session by the research assistants. This debriefing session addressed the post simulation training in the discussion session specifically to each of the students involved in the role-play. The focus of the debriefing session which took 15-20 minutes in the discussion aimed to help students to identify the different perceptions and attitudes that occurred in post simulation; linked the exercise to specific theories or content and skill-building techniques; developed a common set of experience for further thought and opportunity for students to receive feedback on the nature of individual involvement, behaviour, and decision making.
- The structured debriefing session started upon completion of each simulation session and was discussed among students in a discussion room. The debriefing session took 15 -20 minutes for each group of students for the intervention group and was facilitated using video recording playback. While the control group, feedback was given to each group without video playback and no specific timing for the feedback. A paired assessor guided the students with encouragement to express

their feelings, performance in simulation and remedial actions for improvement for intervention groups based on the standardised assessors' debriefing checklist.

- At the end of debriefing session, respondents were directed to a classroom to attempt the 2 sets of research questionnaires as a post-test which required a completion duration of 45 minutes. Set 1 was the Simulation Design Scale (SDS) and Educational Practices in Simulation Scale (EPSS) while set 2 was the California Critical Thinking Disposition Inventory (CCTDI).

3.7.4 Two months after Intervention

- The post-test of 30-Single Best Questions was subsequently delivered to respondents two months after the simulation training for all respondents involved in the research activities. The answer scripts were collected in the classroom for students in the theory block while for those students in clinical areas it was collected within 24 hours by the assigned student leaders.

Appendix E (i): Flow chart on simulation programme training & Appendix E (ii) Flow of procedure.

3.8 Ethical Considerations

An application letter to conduct this research study for Year-3 nursing students was sent to the Medical Ethics Committee in September, 2012 and approval was obtained on 22nd November 2012. The letter of approval was received by the researcher from the Medical Ethics Committee in December, 2012 and then sent to the Head of Nursing through an email and by hand in January, 2013. Invitation letters with the attachment of a proposal and a reply slip to conduct this research study for Year-3 diploma student nurses were then sent to the dean and head of the respective nursing programmes in the nursing schools using HFPS in December, 2011. Three schools out of nine responded to this invitation and agreed to participate in the study. A reply slip with the stamping acknowledgement and signature indicating the approval of the research participation were returned and sent to the researcher from the schools respectively.

These three nursing schools, which were already using the HFPS in their university/ institution are located in Federal Territory of Kuala Lumpur, Shah Alam, Selangor and Nilai, Negeri Sembilan. During the discussion session, the heads of these schools were briefed on the flow of simulation in several visitations to the schools. The discussion also includes the date of the study, number of students that would be involved, communicating and rapport with the group lecturer in charge of the batch on scheduling, logistic arrangement, equipment used in simulation and preparation needed prior to simulation training.

The consent to conduct the study on Year-3 diploma nursing students was obtained verbally and subsequently signed by the individual student indicating she/ he agreed to participate in the research. This was documented on the cover letter of the research questionnaires before commencement. The researcher registered the study with the National Medical Research Registry in 2015 in order to obtain approval from the Malaysian Nursing Board and obtain the latest statistical information pertaining to this study on nursing students, graduate nurses and nursing schools.

3.9 Pilot study

For the pilot, n=59, student nurses from year-3 voluntarily participated to ensure validity and reliability of the questionnaires. One of the earliest schools was selected for both pilot and preliminary study. The cohort has a total of 129 students. Different students in the same cohort group participated in both preliminary and pilot study. The 59 students were divided into intervention (n = 30) and control group (n = 29). In the usual practice, students from a cohort group are rotated to be posted in the hospital with a smaller group. Only this 59 students were assigned by their lecturer (coordinator) to return to school for the practical session whereas the balance of 70 students were off campus for their clinical posting. These 59 students were further assigned randomly to either of two subgroups by the school coordinator for their involvement in this study. The date for conducting the study was scheduled at the end of the posting by the school coordinator in the students' clinical posting timetable.

3.10 Validity and Reliability Test

3.10.1 Content Validity

The researcher has a responsibility to ensure an observed relationship is real and discriminate the threats to a study to achieve generalisability. According to Polit & Beck (2017), external validity concerns whether inferences about observed relationships will hold over variations in persons, setting, time, or measures of the outcomes. In this study, the participants participated were homogenous in that they were from the same year of study; they were in the diploma-nursing program and had similar education backgrounds, entry requirement into nursing program in Malaysia. Settings were identical with the setup, equipment/instruments used, timing allotted, procedural flow, use of code blue scenario, method of distribution in both control and intervention groups, scope of coverage of study and the research instruments used. Both control and intervention groups were double blinded and separated to prevent bias of the study. The assessors of the study were double blinded and paired to avoid bias in assessments. Internal validity concerns the validity of inferences in a given empirical relationship exists with the independent variable (Polit & Beck, 2017). The threats to internal validity are defined as history, maturation, testing, instrumentation, regression, selection, and experimental mortality. These threats in the internal validity were not applicable to this study.

The research instruments were available in two languages, English and Bahasa Malaysia for use among local diploma-nursing students from public universities. The local and overseas panel of experts in this area reviewed the 30-single best questions, skill performance checklist and satisfaction and self-confident questionnaires. Two professional translators, whom were English and Bahasa Malaysia lecturers respectively from a private university worked with the team during the translation process and the researcher moderated it. Before distributing the questionnaires and assessment checklist in the actual study, the questionnaires were checked and vetted for spelling errors, grammatical structure, unclear instructions or items and the time taken for completion.
The self-administered 30-single best questions on theory and 12 domains of practical assessment code blue checklist were sent to local and overseas expert panels to review the format of content in terms of comprehensiveness, adequate number of questions per objective and essential content to be evaluated. The clarity of the questions and statements were also reviewed. Four reviewers were invited to review the 30-single best questions: these included the head of the trauma nursing programme from a public university in Malaysia, a senior lecturer from a critical care nursing programme from a private nursing institution in Malaysia, a clinical specialist in critical care nursing from a private university in Malaysia and a professor of medicine from a public university in Malaysia. The code blue checklist were also reviewed by a coordinator of intensive nursing course from Australia, a coordinator in simulation training from Singapore, the head of trauma nursing programme from a public university in Malaysia, a senior

lecturer of critical care programme from a private nursing institution in Malaysia and a clinical specialist in critical care nursing from a private university in Malaysia.

The satisfaction and self-confidence questionnaires comprised of 20 items for the Simulation Design Scale (SDS) and 16 items for the Educational Practices in Simulation Scale (EPSS) questionnaires. The Bahasa Malaysia back to back translated versions were reviewed by the local panel of experts both from a nursing specialist and a professor of medicine in this specialty. The local panels reviewed the SDS and EPSS for feasibility and practicability of the questionnaires being used for diploma level nursing students in Malaysia. There were no required changes in the content of the questionnaire after it was reviewed by these expert panels.

The translated version of the CCTDI was returned to the author of CCTDI, Professor Dr. Noreen Facione and Insight Assessment Inc., an academic press who owns this licensed research instrument. The approval was subsequently obtained from both parties before proceeding with the CCTDI questionnaire for the research study in Malaysia. A panel of local and overseas experts were invited to assess the face and content validity of the questionnaires and assessment checklist before the study was conducted.

3.10.2 Reliability test

The purpose of the study was to examine the reliability of the research instruments and assessment tools. The instructor used an adult code blue drill programme on a High Fidelity Patient Simulator (HFPS) or low fidelity patient manikin for nursing students in Malaysia. The study assessed reliability as measured using cronbach alpha interrater reliability for the research instruments and assessment checklist. Fifty nine (59) student nurses were involved in the study to ensure validity and reliability of the study questionnaires and assessment checklist before it was distributed to the actual study sample. Students were from Year 3, Semester 1 and of various ethnic groups, gender, age and educational background respectively.

Cronbach Alpha was used to test of internal consistency of the instruments and assessment checklist in this pilot study. Statistical analyses were done using Statistical Package for Social Sciences (SPSS) program version 21 software (IBM, Chicago, IL) (SPSS Statistics 21, 2012).

Group 1 composed of the control group which were taught the code blue drill with power point presentation and low fidelity manikins in the practical session while group 2 which was the intervention group was provided similar teaching but was taught using HFPS in practical teaching.

There were 59 students who voluntary participated in this study for the same cohort group. They were 29 students in the control group and 30 students for the intervention group. The students were mostly female students (n = 58, 98%) while only one was a male student (2%). They were n = 56 (95%) Malay students and n = 3 (5%) Indian students. The age group of the students ranged between 20-28 years old. The majority of the students n = 56 (95%) were SPM holders while 1 was STPM holder and 1 student was already a degree holder.

<u>Reliability of Research Instruments and Questionnaire</u>

Four (4) research instruments/ assessment tools were used:

- Level of satisfaction and self-confidence: 20 items from the Simulation Design Scale (SDS); 16 items from the Educational Practices in Simulation Scale (EPSS);
- Level of knowledge: 30 items from the Single Best Answer (SBQ) Questions (Theory Assessment);

- Level of skill performance: 12 domains from the Code Blue Assessment Checklist (Practical Assessment);
- Level of critical thinking: the California Critical Thinking Disposition Inventory (CCTDI) for judgment performance in critical thinking will be used in the actual study.

All research instruments obtained approval from the authors. Tools were tested and retested. The consistency or stability of the test scores over time showed a correlation of 0.76, suggesting that acceptable temporal reliability. Both local and oversea expert panels reviewed the research instruments and assessments tools. The review by experts found these research tools suitable for local diploma level students. Interrater reliability was determined based on agreement on student performance by two expert raters as examiners in the skill performance assessment. Four (4) research instruments/ assessment tools were tested to estimate the internal consistency for all scales. Cronbach Alpha of more than 0.7 for all tools indicated that these tools were consistent and reliable. Internal consistency of Cronbach Alpha of >0.7 is acceptable and reliable (Gay & Airasian, 2000).

The SDS and EPSS were tested for internal consistency. The result indicated an alpha of 0.737 to 0.799 for SDS with an average of 0.7724. The EPSS was ranged from 0.688-0.880 with an average of 0.818 (Table 3.4). The 30 items on single best answer questions were used to analyse students’ knowledge indicated an alpha of 0.778 (pre-test) and 0.566 (post-test one month after the program ended) (Table 3.5).

Table 3.4: shows the reliability test , n=59 for SDS and EPSS domains

DOMAIN	CRONBACH ALPHA RESULT
SIMULATION DESIGN SCALE (20 Items)	**Program**
Information (5 Items)	.799
Support (4 Items)	.758
Problem Solving (5 Items)	.738
Feedback/Debriefing (4 Items)	.737
Fidelity/Realism (2 Items)	.830
Overall	*.772*
EDUCATIONAL PRACTICE (16 Items)	
Active Learning (10 Items)	.879
Collaboration (2 Items)	.880
Diverse Learning (2 Items)	.825
High Expectation (2 Items)	.688
Overall	*.818*

The 30 single best questions tested knowledge on theory domains on the preparation of the patient and environment, using the Situation, Background, Assessment and Recommendation (SBAR) to pass report, airway management, cardiopulmonary resuscitation (CPR), administration of intravenous therapy, interpretation of electrocardiogram (ECG), assist in intubation and defibrillation, documentation, team collaboration and communication skills within the team and with patient relatives.

The Cronbach's Alpha was 0.778 for the 30 single best questions on knowledge (Table 3.5). Table 3.6 presented the test-retest reliability which was conducted on a pilot sample of n=59 to measure test consistency over time. The analysis test used was the bivariate Pearson correlation. The test-retest reliability coefficients vary between 0-1, where : 1 = perfect reliability; ≥0.9 =excellent reliability; ≥0.8 <0.9 = good reliability; ≥0.7 <0.8 = acceptable reliability; ≥0.6 <0.7 = questionable reliability; ≥0.5 <0.6 = poor reliability; <0.5= unacceptable reliability and 0 = no reliability (Rosner, 2015). The test-retest reliability in this study for the 30 single best questions were between 0.763 to 1.000 with correlation significant at p-value of 0.01 level (2 tailed) (Table 3.6).

Table 3.5 : Reliability analysis for pre and post test on knowledge items, n = 59

30 single best questions on knowledge	
Reliability Statistics	Test
Cronbach's Alpha	0.778

Table 3.6: Reliability of the test and retest on the 30 single best questions

Single best question	**Test-retest correlation**
1.	0.813**
2.	0.901**
3.	0.822**
4.	0.768**
5.	0.804**
6.	0.776**
7.	0.772**
8.	0.861**
9.	0.945**
10.	0.962**

Table 3.6, Continued

11.	0.946**
12.	0.995**
13.	0.986**
14.	0.773**
15.	0.985**
16.	0.907**
17.	0.920**
18.	0.827**
19.	1.000**
20.	0.763**
21.	0.759**
22.	0.977**
23.	0.900**
24.	0.842**
25.	0.954**
26.	0.869**
27.	0.960**
28.	0.922**
29.	0.902**
30.	0.947**

**Correlation is significant at p-value= 0.01 level (2 tailed)

The assessment checklist used by the paired assessors consisted of 40 items from 12 domains. The paired assessors used the guided checklist to observe the skills performed by nursing students in a given code blue management scenario. Paired assessors then evaluated the skills performed based on their observation. The 12 domains include: activation of Code Blue (3 items), preparation of environment (2 items), patient preparation (4 items) and drugs, defibrillation and documentation (3 items). The Cronbach's Alpha was 0.773 for the paired assessors' evaluation scores in this study (Table 3.7). Paired assessors used the standardised code blue checklist to measure the skills competency of students in both control and intervention groups respectively.

Table 3.7 : shows the interater reliability for the scores evaluated by the paired assessors, n = 59

Reliability Statistics	Assessor 1	Assessor 2
Cronbach's Alpha	0.773	

The California Critical Thinking Inventory (CCTDI) was not tested in the main objective to measure the reliability and validity of the instruments. The California Critical Thinking Inventory (CCTDI) is an instrument from Insight Assessment Inc., USA which has been tested and validated. The California Critical Thinking Inventory (CCTDI) is a research instrument recognised and widely used worldwide. All filled questionnaires for the California Critical Thinking Inventory (CCTDI) were sent to the US for analysis. This set of questionnaire was purchased under a research grant. The California Critical Thinking Inventory (CCTDI) was bilingual to suit the local students.

The internal consistency reliability for the California Critical Thinking Disposition Inventory (CCTDI) for the seven individual scales in the initial CCTDI sample was not performed but it has been reported to range from 0.71 to 0.80, with the alpha for the overall instrument reaching 0.91. Strong values have been observed consistently in samples collected over the past 15 years (ranging from 0.60 to 0.78 on the scales and 0.90 or above for the overall measure. (CCTDI User Manual, 2015; Godzyk, 2009). It has been internationally verified with strong internal consistency reliability (a minimum alpha of 0.80 for attribute measures and a minimum KR-20 of 0.72 for skills measures) and was observed to maintain this performance in all samples of adequate variance (CCTDI User Manual, 2015). CCTDI is a licensed research instrument to evaluate judgement performance in critical thinking.

3.11 Data Analysis

Data was analysed with the Statistical Package for Social Sciences program version 21 (IBM, Chicago, IL) (SPSS version 21, 2012). Descriptive statistics analysis was used to analyse range, percentage, sum, standard deviation, and mean difference for demographic characteristics of student participants. Independence t-tests were used to compare means between two levels or less and for gender, age groups and experience with HFPS with dependent variables. A one-way ANOVA was used for variables with more than two levels such as CGPA, highest level of education and role in simulation. The Tukey test for homogeneity was used to test the data in this study.

Chi square or the $\chi 2$ test was used to determine the association for categorical variables such as for demographic variables. The correct response of each subscale of the SBQ with the total of 30 questions used a paired t-test for the pre and post phase after a month of HFPS exposure. The non-parametric Wilcoxon signed rank test was used to detect a difference in results, with normality assumptions found to be met (p-value < 0.05). Odd ratios were obtained from auto calculation using the Medcals software (http://www.medcalc.org).

Table 3.8 shows summary of data analysis of the variables in this study.

Comparison between pre and post knowledge item questions for control and intervention groups

The Single Best questions consisted of 30 items with A, B, C and D response options. Student participants were required to select one answer for each item in the set of the single-best question. The model answer was coded for each question. The model answer of question recoded A = 1, B = 2, C = 3 and D = 4. Student participants who answered correctly were categorised as 1 while incorrect answers were designated as 0. For question number 3, 17 and 25, the correct answer was A; for question number 1, 2, 6, 9, 23. 26 and 30, the correct answer was B; for question number 4, 10, 11, 12, 18, 24, 27, 28 and 29 the correct answer was C; and for questions 5, 7, 8, 13, 14, 15, 16, 19, 20 , 21 and 22 it was D. The total of 30-single best questions were analysed using descriptive statistics for frequency and percentage. Pre-test answers for SBQ number 1 to number 30 were paired with post-test SBQ answers number 1 to number 30. Non-parametric test was applied for Wilcoxon signed range test to compare the difference between the pre and post-test of control and intervention groups.

MedCalc (medcalc.org), a statistical auto calculation software was used to calculate the correct response post-pre intervention between intervention and control group in odds ratio (OR) and 95% confidence interval (CI). An OR is a relative measure of effect for the comparison between the intervention group and control group. In the interpretion of diseases, if the odd ratio is OR< 1, this means there is difference between the odds of exposed if diseased and odds of exposed if not diseased. The difference in odds ratio for prediction of diseases however it is opposite and interpreted as protective if regard to disease (Rosner, 2015).

In the study with no regard to disease implication, the interpretion of the odds ratio is as the follows:

OR = 1 Intervention does not affect odds of outcome, or no association.

OR > 1 Intervention associated with the higher odds of outcome (The intervention is better than the control group).

OR< 1 Intervention associated with lower odds of outcome (The control is better than intervention group).

The confidence interval (CI) indicates the level of uncertainty around the measure of effect which is expressed as an OR. CIs are used because a study recruits only a small sample of the overall population, so by having an upper and lower confidence limit, the true population effect falls between these two points. If the CI crosses 1, this implies there is no difference between intervention and control on the effects of HFPS after exposure on knowledge item questions.

Table 3.8: Summary of data analysis of study

Variable	Descriptive	Inferential	Justification
Demographic characteristics	Range, percentage, sum, SD, mean difference	-Independence t- test	-Compare means between gender, age, experience with dependent variables (4 learning outcomes).
		-ANOVA	-CGPA, education level and role in simulation with dependent variables (4 learning outcomes). Test Null hypotheses
		-Chi square test	-Association of categorical variables in demographic variables.

Table 3.8, Continued

Dependent variables		-RM ANOVA -ANCOVA -Pearson correlation	-Total mean difference & effect between pre & post test. -To test the main effects & interactions of categorical & continuous dependent variables. Controlled of covariate variables in 7 demographic characteristics. -Association between quantitative variables (4 learning outcomes)
Knowledge		OR & CI	Effectiveness of pre-post test outcomes after 2 months.

Repeated measures was used to measure total mean and the effectiveness of the intervention groups post-exposure to HFPS overtime for dependent variables (knowledge, skill performance, critical thinking skills, level of satisfaction and self-confidence). The statistically significance was set at p-value less than 0.05. A higher Eta square, $\eta 2$ was used to determine effectiveness of a single group compared to another. Effect size on the real difference in the comparison, regardless of the sample size used is the Partial Eta square, $\eta 2$.

The observed power in the post hoc analysis is the statistical power of tests performed. Observed power is based on effect size estimated from the data.

The value of the Partial Eta square, $\eta 2$ ranges from 0-1 and a value more than 0.15 is considered sizable (Chinna & Choo, 2013). Wilks' lambda determined the interaction and main effect.

Bivariate correlation analysis using Pearson correlation was used to measure the association between quantitative variables, namely knowledge, skill performance, critical thinking skills, level of satisfaction and self-confidence. Correlation is a standardised form of covariance and its value ranges from -1 to 1.

Testing for normality of variables was presented in Table 4.1a on the summary of dependent variables at pre exposure and post exposure stage. The majority of the data from the study were normally distributed with a skewness value of ±1, thus symmetry can be assumed. Skewness is a measure of symmetry of data distribution. Symmetry means the data were normal and it is a necessary condition of normality. The kurtosis is the measurement of peakness of data distribution. The normally distributed variables were analysed using parametric tests while non-normally distributed variables were analysed using non-parametric tests.

In this study, objective no (i) is evaluate the knowledge levels of nursing students using an adult code blue drill simulated programme before and after using HFPS compared to low fidelity patient manikins.

Levels of knowledge was measured using the 30-single best questions (SBQ) covering the domain of responsiveness, airway, breathing, circulation, drugs, defibrillation and management to managing the deteriorating patient. A thirty minutes' classroom lecture with a power point presentation and video clips on code blue management was presented to both the control and intervention group after the student participants from both control and intervention group completed the pre-test of thirty (30) SBQ. The same thirty (30) SBQ questions were administered at post-test following the control and intervention sessions after the lecture presentation.

A repeated measures ANOVA test used to test for differences between pre-and post-test knowledge levels of participants exposed to simulation training. A non-parametric Wilcoxon test with two related sample for pre-test and post-test were used. The non-parametric test was used because variables were categorical and ordinal variables. An

ANCOVA was used to test the main and interaction effects of categorical variables on continuous dependent variables. The covariates are the control variables such as the characteristics of participants. A non-parametric Wilcoxon test with two related sample for pre-test and post-test were used. The non-parametric test was used because variables were categorical and ordinal variables.

As for the effects of HFPS on skill performance between the pre- and the post- skill performance between groups**,** objective no (ii) was evaluate the clinical skill performance of nursing students using an adult code blue drill simulated programme before and after using HFPS compared to low fidelity patient manikins. The level of clinical skill performance was measured using a standardised checklist consisting of 12 domains. Interrater paired assessors evaluated the student participants' skill performance in a code blue scenario for both control and intervention groups. The intervention groups were exposed to HFPS whereas the control groups were used LFPM.

The effects of HFPS on critical thinking skills was measured by examining the difference in total mean score for critical thinking skills between the two groups, as the objective no (iii) of the study is to identify the level of critical thinking skills (judgment performance) of nursing students using an adult code blue drill simulated programme before and after using HFPS compared to low fidelity patient manikin.

The critical thinking skills for nursing student participants were measured using the CCTDI. CCTDI consists of a 75-item Likert scale attitudinal survey. The 75-item Likert type was scored on a 6-point scale anchored by 'agree strongly' and 'disagree strongly'. The subscale items measure 7 attributes of critical thinking namely, truth seeking (TS), open mindedness (OM), inquisitiveness (IN), analyticity (AN), systematicity (SYS), confidence in reasoning (CR) and maturity of judgment (MJ).

The effects of HFPS on satisfaction and self- confidence was measured using the difference in total mean score for satisfaction and self-confidence between groups, with objective no (iv) & (v) designed to evaluate the satisfaction and self-confidence levels of nursing students using an adult code blue drill simulated programme before and after using HFPS compared to low fidelity patient manikins. The student participants were from the same semester of each cohort participating in this study. They were a largely homogenous group and further randomised into control and intervention groups. A total of 176 student participants answered this questionnaire. The control group comprised of 82 participants while 94 were from the intervention group. In order to evaluate the differences in mean score for knowledge, skill performance, critical thinking skills, satisfaction and self-confidence level measured at pre and post test for both groups (i.e. control and intervention), a two way repeated measure ANOVA was conducted to assess whether there were significant differences between the two groups on the outcomes of interest.

3.12 Research Grant

The researcher applied for and obtained the following research grants to conduct the study from two universities: the Universiti Postgraduate research for the sum of RM13,000 and Universiti Tunku Abdul Rahman Research Grant (UTARRF) for the sum of RM29,922.56.

3.13 Summary

This chapter presented detailed descriptions on the process and selection of research methodology used. Each explanation discussed the details of the measurement for each research question conducted in the study, with the application of research concepts and principles. Results and report of findings of the study are shown in the following chapter.

CHAPTER 4: RESULTS

4.1 Introduction

This chapter presents the results from this quantitative study and aims to evaluate the effectiveness of HFPSs as a teaching strategy for each of the four learning outcomes. Descriptive and inferential statistical results on variables are presented in figures and tables. The research questions are answered at the end of the Chapter four. Statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS) program version 21 software (IBM, Chicago, IL) (SPSS Statistics 21, 2012). Cronbach Alpha was used to test the internal consistency of the research instruments. Four (4) research instruments/assessment tools were used:

- The 30-item Single Best Answer (SBQ) Questions (Theory Assessment);
- The 12-domain Code Blue Assessment Checklist (Practical Assessment);
- The California Critical Thinking Disposition Inventory (CCTDI) for judgment performance in critical thinking will be used in the actual study;
- The 20-item Simulation Design Scale (SDS) and 16 items of Educational Practices in Simulation Scale (EPSS)

4.2 Analysis

4.2.1 Descriptive analysis

In the descriptive analysis, frequencies and percentages were used to describe demographic characteristics of the study sample. Data were summarised in table or graphical form. Besides the location and spread of the data set, researchers also need to understand the distribution of data set. Most statistical procedures require the data to have a normal distribution and thus the data must be symmetrical. Through this descriptive analysis, the assumption is based on data normality. If the normality is met, researcher may use parametric methods. Description of knowledge scores were coded as follows: 1 (No pass) = 0-12 marks; 2 (Marginal) = 13-20 marks; 3 (Proficient) = 21-26 marks and 4 (Exemplary) = 27-30 marks. The mean mark of knowledge at pre exposure phase for N = 389 students was coded as follows: 2.05 (SD = 0.58); median = 2; skewness = 0; kurtosis = -0.303 while post exposure phase as 2.43 (SD = 0.64); median = 2; skewness = 0.400; kurtosis = -0.339. The median mark was 2 for both pre-exposure phase and post-exposure stage of knowledge, this indicated that 50% of the students scored higher than Marginal scoring levels (13-20 marks). The mean, median and mode values are very close to each other, indicating data symmetry. The skewness and kurtosis value are within ±1, hence, the data can be assumed to be symmetrical.

Description of skill performance scores was coded as follows: 1 (No Pass) = 0-15 marks; 2 (Marginal) = 16-17 marks; 3 (Proficient) = 28-35 marks and 4 (Exemplary) = 36-40 marks. The mean mark of skill performance at pre exposure phase for n = 60 students is coded as 1.95 (SD = 0.77); median = 2; skewness = 0.08; kurtosis = -0.829 while post exposure phase as 1.76 (SD = 0.43); median = 2; skewness = -1.220; kurtosis = -0.789. The median mark was 2 for both pre-exposure phase and post-exposure stage of skill performance, this indicating at 50% of the students scored more than the range of marginal (16-17 marks). The mean, median and mode values are very close to each other, perhaps the data is symmetrical. The skewness and kurtosis value are within ±1, hence, the data can be assumed to be symmetrical.

Description of CCTDI total scores were coded as follows: less than 210 (Negatively disposed, weak); 210-280 (Ambivalently disposed, average); above 280 (Positively disposed, strong). The mean mark of CCTDI total scores at pre exposure phase for n = 409 students were coded as 279.88 (SD = 19.46); median = 279; skewness = 0.19;

kurtosis = 0.241 while post exposure phase as 270.99 (SD = 24.07); median = 268; skewness = 0.380; kurtosis = 0.241. The median mark was 279 for the pre-exposure phase and 268 for the post-exposure stage of the total CCTDI scores. This indicated that 50% of the students scored higher than the ambivalently disposed level, with an average range of 210-280 marks. The mean, median and mode values were very close to each other, indicating that the data was likely to be symmetrical. This was confirmed by the skewness and kurtosis values which were within ±1, hence, the data can be assumed to be symmetrical.

The levels of satisfaction and self-confidence were coded as follows: Strongly disagree; 2 = Disagree; 3 = Undecided; 4 = Agree and 5 = Strongly agree. The scores at the pre exposure phase for n = 176 students was 3.14 (SD = 0.88); median = 3; skewness = 0.77; kurtosis = -0.457, while the scores at post exposure phase for n = 389 was 4.39 (SD = 0.47); median = 4.42; skewness = -0.540; kurtosis =1.235. The mean, median and mode values were very close to each other indicating that the data was likely to be symmetrical. This was confirmed by the skewness and kurtosis values which were within ±1, hence, the data can be assumed to be symmetrical.

4.2.2 Inferential Analysis

The inferential analysis was further analysed following descriptive statistical analysis on dependent variables. The normality and distribution of continuous variable were assessed. For normally distributed data, parametric test was used. Table 4.1a shows the normality distribution of each learning outcome for both pre and post test interaction.

Table 4.1a: Normality distribution of variables and subscale in pre-exposure and post-exposure phase

	Pre Exposure phase					Post Exposure phase				
	n	Mean (SD)	Median	Skewness	Kurtosis	n	Mean (SD)	Median	Skewness	Kurtosis
Knowledge	389	2.05(0.58)	2.00	0.00	-0.303	389	2.43(0.64)	2.00	0.400	-0.339
Skills Performance	60	1.95(0.77)	2.00	0.08	-0.829	60	1.76(0.43)	2.00	-1.220	-0.798
Critical Thinking Skills	409	279.88(19.46)	279.00	0.19	0.241	409	270.99(24.07)	268.00	0.380	0.241
Level of Satisfaction and Self-Confidence	176	3.14(0.88)	3.00	0.77	-0.457	389	4.39(0.47)	4.42	-0.540	1.235

Description of Knowledge:
1(No pass)=0-12 marks; 2(Marginal)=13-20 marks; 3(Proficient)=21-26 marks and 4(Exemplary)=27-30 marks
Description on Skills performance:
1(No Pass)=0-15 marks; 2(Marginal)=16-17 marks; 3(Proficient)=28-35 marks and 4(Exemplary)=36-40 marks
CCTDI Total score:
Less than 210(Negatively disposed, weak); 210-280(Ambivalently disposed, average); Above 280(Positively disposed, strong)
Description on Level of Satisfaction and Self-Confidence:
1=Strongly disagree; 2=Disagree; 3=Undecided; 4=Agree and 5=Strongly agree

4.3 Demographic Characteristics

Three nursing school participated in this study. These were public, semi-government and private nursing schools respectively. A total of 389 students who voluntary participated in this study were from the same cohort group. Twenty nursing students were excluded from the study. The total response rate was 95%.

The demographic characteristics for all participants are displayed in Table 4.1. The age range for students was between 20-28 years old. This was recoded to the following age groups: participants who were 20 years old at recruitment (n = 259, 67%), and participants aged 21 and above (n = 130, 33%).

There were 120 participants (66.7%) in the control group and 139 participants (66.5%) in the intervention group whom were aged 20 years old. In the 21 years and above age bracket, 60 participants (33.3%) were in the control and 70 participants (33.5%) were in the intervention group. There were no significant difference between control and intervention group with regard to age ($\chi 2$=0.01 with p-value =0.973) (Table 4.2)

The gender distribution of students was predominantly female, n = 359 participants (92%) with the rest were males (n = 30, 8%) (Table 4.1). They were 180 students from the control group with 160 female participants (88.9%) and 20 male participants (11.1%); of the 209 students from the intervention group, 199 were females (95.2%) and 10 (4.8%) were males. All student participants were from the cohort year, which was year 3 of the diploma in nursing. There was a significant difference between the control and intervention group in terms of gender ($\chi 2$ = 5.438, p-value = 0.02).

In terms of the highest education level attained pre-entry into the nursing diploma programme, 384 participants (98%) enrolled with SPM qualification while 2 participants (1%) had STPM qualification, and 3 (1%) had degrees (Table 4.1). In the control group, 178 participants (98.9%) had SPM qualifications, while in the intervention group 206 participants (98.7%) had SPM qualifications. There were 2 participants (1.1%) whom were STPM holders in the control group, while in the intervention group 3 participants (1.4%) had other qualifications including a prior degree from another programme. There were no significant differences between the control and intervention group with regard to their education level ($\chi2$ = 4.907, p-value 0.086) (Table 4.2).

Student Cumulative Grade Point Average (CGPA) was recoded into 4 categories: <2.5; 2.50-2.99; 3-3.5 and >3.5 (Range= 2.00-3.95). The highest CGPA among the students was 3.95 while the lowest was 2.00. Table 4.1 shows that the overall mean score of CGPA for students was 3.03, with the majority having CGPAs ranging from 3 to 3.5. In the control group, a total of 110 participants (61.1%) had a CGPA of 3 to 3.5, while in the intervention group, 112 participants (53.6%) has a CGPA of 3 to 3.5. The next most common CGPA among participants fell within the range of 2.50 to 2.99, for which there were 43 participants (23.9%) in the control group while 70 participants (33.5%) were from the intervention group. There were an equal number of students with CGPAs of more than 3.5 CGPA, with 18 participants (10%) in the control group and 18 participants (8.6%) in the intervention group. For CGPA scores of less than 2.5, 9 participants (5%) and 9 participants (4.3%) were from the control and intervention group respectively. The majority of students from the cohort groups of three schools were average students in terms of their academic performance. There were no significant differences in CGPA between the control and intervention groups ($\chi2$ = 4.331, p-value 0.228) (Table 4.2).

There was a mixed distribution of students with and without experience using simulation in their learning at any stage in their diploma education before the participation in this research study. The number of students with prior exposure to the HFPS was as follows: 116 participants (40%) had never been exposed to simulation training, while 273 participants (60%) reported prior exposure (Table 4.1). In the control group, 119 participants (66.1%) had not been exposed to simulation education while 154 participants (73.1%) from the intervention group reported no prior HFPS exposure. Only 61 participants (33.9%) reported undergoing simulation education in the control group while 55 participants (26.3%) were from the intervention group. There were no significant differences between control and intervention group with regard to experience in simulation education ($\chi 2 = 2.650$, p-value 0.104) (Table 4.2).

The role of each student played in the code blue simulation education was categorised as either 'Nurse 1', 'Nurse 2', 'Nurse 3', doctor and relative/ confounder. They collaborated as a team in the management of the given code blue scenario. The role for each participant was as follows: 'Nurse 1', 162 participants (21%); 'Nurse 2', 160 participants (21%); 'Nurse 3', 158 participants (20%); doctor, 156 participants (20%) and relative/ confounder, 142 participants (18%) (Table 4.1). For the participant role as Nurse 1, there was 39 participants (21.7%) and 42 participants (20.1%) from control and intervention groups respectively. There were 37 participants (20.7%) in control group student participants who played Nurse 2, with 43 participants (20.6%) from intervention group in this role. The role of Nurse 3 was played by 38 participants (21.1%) from the control group and 41 participants (19.6%) from the intervention group. A total of 34 students (18%) from the control group and 44 participants (21.1%) played the doctor. In the role of the relative/ confounder, there were 32 participants (17.8%) and 39 participants (18.7%) from the control and intervention groups respectively. There were no significant differences between the control and intervention group in terms of roles assumed for the five categories as 'Nurse 1', 'Nurse 2', 'Nurse 3', doctor and relative/ confounder, as evaluated in the simulation education based on the given code blue scenario ($\chi 2$ = 0.488, p-value 0.975) (Table 4.2).

Table 4.1: Demographic characteristics of participants (N=389)

Characteristics	n (%)	Range	Mean (SD)
AGE			
20 Years	259 (67)	20-25	
21 & above	130(33)		
Gender			
Female	359(92)		
Male	30(8)		
Education Level			
SPM	384(98)		
STPM	2(1)		
Degree	3(1)		
CGPA			
<2.5	18(5)	2.00-3.95	2.71(0.70)
2.50-2.99	113(29)		
3 - 3.5	222(57)		
>3.5	36(9)		
Experience in HFPS			
Yes	116(40)		
No	273(60)		
Role			
Nurse 1	162(21)		
Nurse 2	160(21)		
Nurse 3	158(20)		
Doctor	156(20)		
Relative:Confounder	142(18)		

Note: SPM=O-Level, STPM=A-Level in Malaysia education, CGPA = Cumulative Grade Point Average and HFPS=High Fidelity Patient Simulator

Table 4.2: Demographic characteristics of participants in control and intervention Group, N=389

Characteristics	n (%)			$\chi2$ (Control vs. Intervention)	P
	Total	n=180 Control	n=209 Intervention		
Age					
20 Years	259 (67)	120(66.7)	139(66.5)	0.001	0.973
21 & above	130(33)	60(33.3)	70(33.5)		
Gender					
Female	359(92)	160(88.9)	199(95.2)	5.438	0.020
Male	30(8)	20(11.1)	10(4.8)		
CGPA					
<2.5	18(5)	9(5)	9(4.3)	4.331	0.228
2.50-2.99	113(29)	43(23.9)	70(33.5)		
3 - 3.5	222(57)	110(61.1)	112(53.6)		
>3.5	36(9)	18(10)	18(8.6)		
Experience in HFPS					
Yes	116(40)	61(33.9)	55(26.3)	2.650	0.104
No	273(60)	119(66.1)	154(73.7)		
Role					
Nurse 1	81(20.8)	39(21.7)	42(20.1)		
Nurse 2	80(20.6)	37(20.6)	43(20.6)		
Nurse 3	79(20.3)	38(21.1)	41(19.6)	0.488	0.975
Doctor	78(20.1)	34(18.9)	44(21.1)		
Relative:Confounder	71(18.3)	32(17.8)	39(18.7)		

Note: Control group = no intervention, Intervention group= exposed to HFPS
Statistically significance, *P* value <0.005

4.4 Knowledge

4.4.1. Comparison on total mean knowledge scores - correct responses for subscale knowledge questions after exposure to HFPS in 2 months

Table 4.3 showed 13 items with ORs below 1. There were for questions (q): q1 (OR 0.91, CI 0.59-1.42), q3 (OR 0.93, CI 0.64-1.34), q4 (OR 0.92, CI 0.67-1.25), q5(OR 0.92, CI 0.68-1.23), q10 (OR 0.96, CI 0.69 - 1.34), q13 (OR 0.98, CI 0.65-1.39), q14 (OR 0.92, CI 0.67-1.26), q15 (OR 0.94, CI 0.67-1.31), q17 (OR 0.97, CI 0.67-1.40), q23 (OR 0.92, CI 0.64-1.33), q24 (OR 0.74, CI 0.44-1.22), q26 (OR 0.92, CI 0.62-1.36) and 30 (OR, 0.55 CI 0.32- 0.92). The results indicated the odds of control group that been exposed to HFPS as teaching strategy on knowledge level in the items 1,3, 4, 5, 10, 13, 14, 15, 17, 23, 24, 26 and 30 were more effective than the intervention group that without exposure to HFPS. OR < 1 indicated intervention group with lower odds of outcome.

Sixteen (16) items had ORs of more than 1 : q2 (OR1.04, CI 0.75 -1.44), q6 (OR 1.05, CI 0.78-1.42), q7 (OR 1.06, CI 0.57-1.99), q8 (OR, 1.05 CI 0.48-2.24), q9 (OR, 1.32 CI 0.87-1.98), q11 (OR 1.08, CI 0.77-1.51), q12 (OR 1.49, CI 0.91-2.44), q16 (OR, 1.05 CI 0.75-1.47), q18 (OR, 1.04 CI 0.71- 1.51), q19 (OR1.01, CI 0.76 - 1.36), q20 (OR1.04, CI 0.75 - 1.42), q21 (OR 1.06, CI 0.70-1.62), q22(OR 1.02, CI 0.68 - 1.51), q25 (OR 1.15, CI 0.70-1.90), q27 (OR 1.82, CI 1.02-3.05) and q28 (OR 1.09, CI 0.72-1.65). The findings showed OR > 1 for items 2, 6,7,8,9,11,12,16,18,19,20,21,22, 25,27 and 28. These 16 items have ORs of more than 1 with a higher odds of outcome, with the intervention groups performing better in knowledge levels after exposure to HFPS compared to the control groups.

As the OR is equal to 1 for item 29, there was no difference between both intervention and control group in their knowledge level (OR1.00, CI 0.49-2.01).

Table 4.3: Comparison on Total Mean Knowledge Score between Intervention and Control Groups for Pre and Post Exposure

Correct responses for subscale knowledge question after exposure to HFPS in 2 months

Subscale knowledge question	Pre Exposure		Post Exposure		Correct response Post -Pre Exposure
Question	Control (N=180) n (%)	Intervention (N=209) n (%)	Control (N=180) n (%)	Intervention (N=209) n (%)	Odds ratio (OR)/ (95% CI)
Q1	74(41.1)	80(38.3)	81(45)	80(38.3)	0.91 (0.59 - 1.42)
Q2	128(71.1)	139(66.5)	150(83.3)	169(80.9)	1.04 (0.75 -1.44)
Q3	102(56.7)	123(58.9)	108(60)	121(57.9)	0.93 (0.64 - 1.34)
Q4	149(82.8)	177(84.7)	155(86.1)	169(80.9)	0.92 (0.67 - 1.25)
Q5	162(45.4)	195(54.6)	173(47.5)	191(52.5)	0.92 (0.68 - 1.23)
Q6	165(47.3)	184(52.7)	166(46)	195(54)	1.05 (0.78 - 1.42)
Q7	24(43.6)	31(56.4)	59(42.1)	81(57.9)	1.06 (0.57 -1.99)
Q8	20(40.8)	29(59.2)	25(39.7)	38(60.3)	1.05 (0.48 - 2.24)
Q9	84(53.5)	73(46.5)	104(46.6)	119(53.4)	1.32 (0.87 - 1.98)
Q10	126(48.3)	135(51.7)	145(49.3)	149(50.7)	0.96 (0.69 - 1.34)
Q11	112(46.1)	131(53.9)	131(44.3)	165(55.7)	1.08 (0.77 - 1.51)
Q12	55(50.9)	53(49.1)	66(41)	95(59)	1.49 (0.91 - 2.44)
Q13	102(46.2)	119(53.8)	135(46.7)	154(53.3)	0.98 (0.69 - 1.39)
Q14	135(46.2)	157(53.8)	155(48.3)	166(51.7)	0.92 (0.67 - 1.26)
Q15	129(44.8)	159(55.2)	128(46.4)	148(53.6)	0.94 (0.67 -1.31)
Q16	126(46.7)	144(53.3)	126(45.5)	151(54.5)	1.05 (0.75 -1.47)
Q17	87(43.9)	111(56.1)	121(44.8)	149(55.2)	0.97 (0.67 - 1.40)
Q18	93(48.4)	99(51.6)	123(47.5)	136(52.5)	1.04 (0.71- 1.51)
Q19	169(47.1)	190(52.9)	171(46.7)	195(53.3)	1.01 (0.76 - 1.36)

Table 4.3, Continued

Q20	147(47.3)	164(52.7)	142(46.4)	164(53.6)	1.04 (0.75 - 1.42)
Q21	79(48.8)	83(51.2)	86(47.3)	96(52.7)	1.06 (0.70 - 1.62)
Q22	113(47.7)	124(52.3)	78(47.3)	87(52.7)	1.02 (0.68 - 1.51)
Q23	119(46.1)	139(53.9)	103(48.1)	111(51.9)	0.92 (0.64 - 1.33)
Q24	39(39.8)	59(60.2)	77(47.2)	86(52.8)	0.74 (0.44 - 1.22)
Q25	61(48.8)	64(51.2)	54(45.4)	65(54.6)	1.15 (0.70 - 1.90)
Q26	91(46.9)	103(53.1)	102(49)	106(51)	0.92 (0.62 - 1.36)
Q27	37(55.2)	30(44.8)	63(40.4)	93(59.6)	1.82 (1.02 - 3.05)
Q28	74(47.4)	82(52.6)	93(45.4)	112(54.6)	1.09 (0.72 - 1.65)
Q29	19(46.3)	22(53.7)	59(46.5)	68(53.5)	1.00 (0.49 - 2.01)
Q30	42(35.9)	75(64.1)	53(51)	51(49)	0.54 (0.32 - 0.92)

4.4.2 Mean pre and post-test knowledge scores by control and intervention group

The assumption of sphericity indicated that the variance in difference scores of all possible paired levels of the repeated measures were roughly equal. An ANOVA with a Greenhouse-Geisser correction was used and showed that mean knowledge level differed statistically significantly between time points after exposure of HFPS ($F_{(1,120)}$ = 758.41, $\eta 2$ = 0.237, $p<0.001$).

There were no significant differences in groups interaction between groups ($F_{(1,120)}$ =.117, $\eta 2$ = 0.000, p = 0.892). Thus, to test the relevant hypothesis, a post hoc test (Bonferroni) was applied to contrast the mean scores. Results from the Bonferroni test showed that the total knowledge mean score between control and intervention groups at baseline was not statistically significant (p > 0.05), and that the difference between intervention and control groups was not significant (p = 0.950).

To examine the effectiveness of the intervention, the pre-and post-test scores were compared independently. The findings of the post hoc test (Bonferroni) revealed that the difference among pre-and post in knowledge score for both intervention and control groups was significantly improved ($p < 0.05$) with the eta square indicating that the improvement was greater in the intervention ($\eta 2 = 0.147$) than the control group ($\eta 2 = 0.124$).

A repeated measures ANCOVA was used to add covariates to serve as control variables for the independent factors. In this study, the ANCOVA was used to compare groups formed by participants' characteristics (categorical dependent variables) on control and intervention groups by knowledge level (a set of interval dependent variable) across time at pre and post exposure to HFPS, which controlled for age, gender and CGPA. The mean pre-test score on the level of knowledge in code blue drill was 15.91 (SE = 0.20) for the intervention group. The mean post-test score after exposure to HFPS for intervention group was 17.87 (SE = 0.23); ($F_{(1,216)} = 65.649$, $\eta 2 = 0.146$, $p < 0.001$). The mean pre-test score on the level of knowledge in code blue drill for the control group was 15.96 (SE = 0.22). The mean post-test score for the control group with no exposure to HFPS was 17.95 (SE = 0.25); ($F_{(1,216)} = 57.469$, $\eta 2 = 0.130$, $p < 0.001$). The results of the pre-and post-test differences by level of knowledge score is shown in Table 4.4. The findings of the post hoc test (Bonferroni) revealed a significant difference between pre- and post test in knowledge score for both the intervention and control groups, even when controlled by age, gender and CGPA. There was a significant improvement ($p<0.05$) considering the eta square was greater in the intervention group ($\eta 2 = 0.146$) rather than the control group ($\eta 2 = 0.130$). The power of the test = 34.5% (> 20%). Thus, there is a difference in total mean knowledge scores, when controlled by age, gender and CGPA.

Table 4.4: Comparison on Total mean Knowledge Score between Intervention and Control Groups for Pre and Post Exposure of HFPS controlled for Age, Gender and CGPA

	Pre Exposure			Post Exposure				
Group	Total mean knowledge score	Magnitude difference (Control-Intervention) Group		Total mean knowledge score	Magnitude difference (Control-Intervention) Group		Magnitude Difference (post-pre) exposure	
		Diff (95% CI)	P value		Diff (95% CI)	P value	Diff (95% CI)	P value
Intervention (n=209)	15. 91(0.20)	0.045 (-0.53, 0.62)	0.880	17.87(0.23)	0.062 (-0.60,0.73)	0.854	1.974 (-2.45, -1.50)	<0.001
Control (n=180)	15.96(0.22)			17.94(0.25)			1.991 (-2.51, -1.48)	<0.001

Note: Control group = no intervention, Intervention group= exposed to HFPS
Statistically significance, P value <0.005

4.4.3 Comparison of mean total knowledge score by demographic characteristics

Table 4.5 displays total mean knowledge scores by demographic characteristics for the intervention and control groups at pre-exposure and post-exposure phase after 2 months. There were statistically significance with p-value < 0.001 for those aged 20 year-old and 21 years and above, on both the intervention and control groups at pre and post exposure phase (Intervention pre-exposure: age 20 year-old, n = 139, 14.98 (SD = 2.64); 21 years and above, n = 70, 17.70 (SD = 3.29); p-value <0.001; intervention post-exposure: age 20 year-old, n= 139, 16.85 (SD = 3.09); 21 year and above, n = 70, 19.97 (SD = 3.36) ; p-value <0.001) (Control pre-exposure: age 20 year-old, n = 120 , 14.09 (SD = 2.51); 21 years and above, n = 60, 18.15 (SD = 3.50); p-value <0.001; control post-exposure: age 20 year-old, n = 120, 16.91 (SD = 3.50); 21 years above, n = 60, 20.00 (SD = 3.51) , p-value <0.001).

There was a statistically significant difference (p-value < 0.001) between participants with prior HFPS exposure at pre and post exposure of control groups, but this was true only for the intervention group at post-exposure phase (Intervention pre-exposure: Yes, n = 55, 16.33 (SD = 3.32); No, n = 154, 15.73 (SD = 3.07); p-value = 0.230; intervention post-exposure: Yes, n = 55, 19.65 (SD = 3.15); No, n = 154, 17.27 (SD = 3.42); p-value <0.001) (Control pre-exposure: Yes, n = 100, 16.94 (SD = 3.45); No, n = 80, 14.79 (SD = 2.54); p-value <0.001; control post-exposure: Yes, n = 100, 19.10 (SD = 3.52); No, n = 80, 16.49 (SD = 3.62); p-value <0.001). These results reveal that age and experience were significantly associated with an increase in total mean knowledge score after exposure to HFPS.

Comparing the magnitude of differences between the total mean knowledge score at pre-exposure and post-exposure 2 months after for both the intervention and control groups, no statistically significance were found in terms of characteristics and total mean knowledge score. Only participants with prior exposure to HFPS showed statistical significance in the intervention group (Yes, n = 55, mean score difference 3.33 (SD = 3.60); No, n = 154, mean score difference 1.53 (SD = 3.47); p-value < 0.001) (Table 4.6).

Table 4.5: Demographic characteristics of total mean knowledge score for intervention and control groups at pre-exposure and post-exposure phase after 2 months (N = 389)

Characteristics	Intervention (n = 209)						Control (n = 180)					
	Pre-exposure			Post exposure			Pre-exposure			Post exposure		
	n	Total mean knowledge score Mean (SD)	P value	n	Total mean knowledge score Mean (SD)	P value	n	Total mean knowledge score Mean (SD)	P value	n	Total mean knowledge score Mean (SD)	P value
Age												
20 Years	139	14.98±2.64	<0.001	139	16.85±3.09	<0.001	120	14.09±2.51	<0.001	120	16.91±3.50	<0.001
21 & above	70	17.70±3.29		70	19.97±3.36		60	18.15±3.50		60	20.00±3.51	
Gender												
Female	199	15.77±3.09	0.013	199	17.92±3.45	0.583	160	15.89±3.22	0.265	160	17.93±3.76	0.890
Male	10	18.30±3.34		10	17.30±4.65		20	16.75±3.49		20	18.05±4.08	
CGPA												
<2.5	9	14.22±2.82	0.405	9	14.44±2.51	0.010	9	17.44±1.51	0.488	9	17.56±3.58	0.643
2.50-2.99	70	15.91±3.23		70	17.60±3.49		43	15.72±2.91		43	17.37±3.27	

Table 4.5, Continued

3 - 3.5	112	15.94±3.14		112	18.36±3.45		110	15.90±3.36		110	18.22±4.10	
>3.5	18	16.33±2.93		18	17.89±3.46		18	16.39±3.94		18	17.78±3.08	
Experience in HFPS												
Yes	55	16.33±3.32	0.230	55	19.65±3.15	<0.001	100	16.94±3.45	<0.001	100	19.10±3.52	<0.001
No	154	15.73±3.07		154	17.27±3.42		80	14.79±2.54		80	16.49±3.62	
Role												
Nurse 1	42	16.10±3.53	0.898	42	17.62±3.91	0.779	39	16.13±3.43	0.516	39	18.54±3.95	0.809
Nurse 2	43	16.16±3.3		43	18.23±3.32		37	16.73±3.63		37	17.81±3.76	
Nurse 3	41	15.68±2.77		41	18.20±3.45		38	15.82±2.87		38	17.95±4.11	
Doctor	44	15.91±2.73		44	17.43±3.20		34	15.44±3.19		34	17.44±3.47	
Relative: Confounder	39	15.56±3.41		39	18.03±3.71		32	15.72±3.21		32	17.88±3.68	

Statistically significance, P value <0.001

Table 4.6: Comparison of pre-and post exposure total mean knowledge scores for each control and intervention groups after 2 months exposure to HFPS (N=389)

Characteristics	Intervention (N=209)			Control (N=180)		
	Difference (Post-Pre) Exposure			Difference (Post-Pre) Exposure		
	n	Total mean knowledge score ean (SD)	P value (2 tailed)	n	Total mean knowledge score Mean (SD)	P value (2 tailed)
Age						
20 Years	139	1.87±3.61	0.776	120	1.95±3.24	0.447
21 & above	70	2.27±3.57		60		
Gender						
Female	199	2.16±3.54	0.006	160	2.04±3.47	0.376
Male	10	-1.00±3.40		20	1.30±3.76	
CGPA						
<2.5	9	0.22±2.49	0.208	9	0.11±2.85	0.215
2.50-2.99	70	1.69±3.38		43	1.65±3.45	

Table 4.6 , Continued

3 - 3.5	112	2.42±3.78		110	2.32±3.63	
>3.5	18	1.56±3.36		18	1.39±2.81	
Experience in HFPS						
Yes	55	3.33±3.60	0.001	100	2.16±3.61	0.383
No	154	1.53±3.47		80	1.70±3.37	
Role						
Nurse 1	42	1.52±3.92	0.559	39	2.41±3.60	0.533
Nurse 2	43	2.07±3.13		37	1.08±3.54	
Nurse 3	41	2.51±3.48		38	2.13±3.79	
Doctor	44	1.52±3.56		34	2.00±3.37	
Relative: Confounder	39	2.46±3.87		32	2.16±3.14	

Statistically significance, P value <0.005

4.5 Skill Performance

4.5.1 Descriptive analysis of skills performance subscale item scores

There were 12 domains consisting of 40 items in the skill performance checklist, which gave a minimum score of 0 and a maximum total score of 30. Participant scores ranged between 0 and 5 in this. The scores for the skill performance subscale are displayed in Table 4.7a. The highest total skill performance pre-score for control group was 21 and the lowest was 9; the highest total skill performance post score highest score was 21 and lowest score was 16. The highest skill performance score in the intervention group was a pre-score of 16 and the lowest was 9; the highest post skill performance score was 24 and the lowest was 16. Among the pre-test scores for the control group, there were zero scores found for preparation of environment, oxygen administration, ECG, IVI, suctioning, assisting in intubation, administration of drugs, assisting in defibrillation and documentation while the same result was found in the intervention group, with exception to the administration of oxygen score which was 0.50 mark and IVI score was 1 mark respectively. As for post exposure to HFPS, the control group only improved on administration of oxygen and drugs; the other subscales that were zero in the pre-test remained unchanged. The intervention group saw an increase in overall subscale scores in the post-test compared to the pre-test score, however the two subscales, suctioning and documentation remained unchanged (zero score) as in post-test.

Table 4.7a: Skill performance subscale item scores for control and intervention group at pre and post exposure phase to HFPS

Group		N	Minimum	Maximum
Control	Pre Activation	30	0.50	3.50
	Pre Environment	30	0.00	1.50
	Pre Patient	30	2.00	3.00
	Pre Crash Cart	30	0.50	1.00
	Pre Oxygen	30	0.00	1.50
	Pre ECG	30	0.00	2.00
	Pre IVI	30	0.00	2.00
	Pre Suction	30	0.00	2.50
	Pre Intubation	30	0.00	1.50
	Pre Drugs	30	0.00	1.50
	Pre Defibrillation	30	0.00	2.00
	Pre Documentation	30	0.00	2.50
	Post Activation	30	2.00	3.50
	Post Environment	30	1.50	3.00
	Post Patient	30	1.00	4.00
	Post Crash Cart	30	0.75	1.00
	Post Oxygen	30	0.50	3.00
	Post ECG	30	0.00	1.50
	Post IVI	30	0.50	3.00
	Post Suction	30	0.00	1.50
	Post Intubation	30	0.00	1.50
	Post Drug	30	0.50	2.00
	Post Defibrillation	30	0.00	3.50

Table 4.7a, Continued

	Post Documentation	30	0.00	1.50
Intervention	Pre Activation	30	1.00	3.00
	Pre Environment	30	0.00	1.50
	Pre Patient	30	2.00	3.00
	Pre Crash Cart	30	0.50	1.50
	Pre Oxygen	30	0.50	3.00
	Pre ECG	30	0.00	1.00
	Pre IVI	30	1.00	2.00
	Pre Suction	30	0.00	1.50
	Pre Intubation	30	0.00	0.50
	Pre Drugs	30	0.00	1.50
	Pre Defibrillation	30	0.00	1.50
	Pre Documentation	30	0.00	1.00
	Post Activation	30	2.50	3.50
	Post Environment	30	1.50	2.00
	Post Patient	30	3.00	4.00
	Post Crash Cart	30	0.75	1.50
	Post Oxygen	30	0.50	3.00
	Post ECG	30	0.00	1.00
	Post IVI	30	0.50	2.00
	Post Suction	30	0.00	2.00
	Post Intubation	30	1.00	2.00
	Post Drug	30	0.50	2.00
	Post Defibrillation	30	1.50	4.00
	Post Documentation	30	0.00	2.00

4.5.2 Total mean skill performance scores of control and intervention group at pre- and post exposure to HFPS

Table 4.7b presents the mean score and standard deviation for the skill performance subscale and the magnitude of difference for (post-pre) test score. In the control group, results of the total subscale mean difference score (post-pre exposure) were statistically significant, p-value 2 tailed ($p < 0.001$) on activation of code blue 0.70 (SD = 0.96), preparation of environment 0.88 (SD = 0.65), arrival of crash cart 0.29 (SD = 0.23), oxygen administration 1.30 (SD = 1.05), drug administration 0.92 (SD = 0.80), assistance in defibrillation 1.53 (SD = 0.85) and documentation (-0.67 (SD = 0.81). There was an overall increment on the total mean score for each subscale for the control group. However, for two subscales, administration of suction apparatus -0.13 (SD = 0.85) and documentation -0.67 (SD = 0.81) in the control group indicated a decrease at post exposure. Results for the preparation of patient, ECG administration, setting up of infusion, administration of suction apparatus and assistance in intubation showed no statistically significant difference.

Results from the intervention group showed that the total subscale mean difference score (post-pre exposure) were statistically significant, p-value 2 tailed ($p < 0.001$) on activation of code blue 1.42 (SD = 0.74), preparation of environment 1.08 (SD=0.74), preparation of patient 1.25 (SD = 0.64), arrival of crash cart 0.04 (SD = 0.31), assistance in intubation 1.08 (SD = 0.19), drug administration 0.42 (SD = 0.35), assistance in defibrillation 1.58 (SD = 1.15) and documentation 0.92 (SD = 0.70). There was decrease in score for the administration of suction apparatus -0.08 (SD = 0.43) for the intervention group, similar to the control group -0.13 (SD = 0.85). Findings for the arrival of crash cart, oxygen administration, ECG administration, setting up of infusion, administration of suction apparatus show there was no statistically significant difference in the intervention group.

Pre-test total mean score on skill performance for the control group was 12.00 (SD = 4.15); for the intervention group it was 11.50 (SD = 2.67). Post-test total mean score on skill performance for the control group was 18.33 (SD = 1.73) and 20.17 (SD = 2.65) for the intervention group.

The change in total mean score from pre-test to post-test for the control and intervention groups was found to show a statistically significant difference in skill performance between the groups (control, 6.33 (SD = 4.46); intervention, 8.67 (SD = 2.54) and $p < 0.001$).

Table 4.7b: Total mean skill performance scores of control and intervention group before and after exposure to HFPS

		Pre Exposure		Post Exposure			Mean±SD (Difference post-pre) exposure	95% CI		t	P value Sig. (2-tailed)
Group	Subscale	n	Mean±SD	n	Mean±SD	n					
Control	Activation of Code Blue	30	1.83±0.91	30	2.53±0.61	30	0.70±0.96	0.341	1.059	3.988	<0.001
(n=30)	Preparation of Environment	30	1.04±0.59	30	1.93±0.54	30	0.88±0.65	0.642	1.124	7.493	<0.001
	Preparation of Patient	30	2.67±0.38	30	2.87±0.89	30	0.20±1.13	-0.223	0.623	0.966	0.340
	Arrival of Crash Cart	30	0.67±0.25	30	0.96±0.09	30	0.29±0.23	0.206	0.377	7.000	<0.001
	Oxygen Administration	30	0.67±0.56	30	1.97±0.99	30	1.30±1.05	0.909	1.691	6.800	<0.001
	ECG Administration	30	0.83±0.63	30	0.88±0.39	30	0.05±0.91	-0.291	0.391	0.300	0.770
	Setting up of Infusion	30	0.96±0.86	30	1.73±0.76	30	0.78±1.40	0.252	1.298	3.033	0.010
	Suction Apparatus	30	0.67±0.91	30	0.53±0.60	30	-0.13±0.85	-0.451	0.184	-0.859	0.400
	Assist in Intubation	30	0.58±0.46	30	0.87±0.45	30	0.28±0.28	-0.022	0.588	1.900	0.070
	Drugs Administration	30	0.25±0.57	30	1.17±0.48	30	0.92±0.80	0.618	1.215	6.279	<0.001
	Assist in Defibrillation	30	0.50±0.72	30	2.03±1.12	30	1.53±0.85	1.216	1.851	9.877	<0.001

Table 4.7b, Continued

	Documentation	30	1.33±0.76	30	0.67±0.56	30	-0.67±0.81	-0.970	-0.363	-4.492	<0.001
Intervention	Activation of Code Blue	30	1.75±0.64	30	3.17±0.38	30	1.42±0.74	1.139	1.694	10.433	<0.001
(n=30)	Preparation of Environment	30	0.79±0.63	30	1.88±0.19	30	1.08±0.74	0.806	1.361	7.978	<0.001
	Preparation of Patient	30	2.17±0.38	30	3.42±0.35	30	1.25±0.64	1.011	1.489	10.699	<0.001
	Arrival of Crash Cart	30	1.00±0.29	30	1.04±0.23	30	0.04±0.31	-0.074	0.157	0.740	0.465
	Oxygen Administration	30	1.42±0.99	30	1.70±0.91	30	0.28±0.61	0.055	0.512	2.538	0.017
	ECG Administration	30	0.58±0.35	30	0.67±0.38	30	0.08±0.54	-0.119	0.286	0.841	0.407
	Setting up of Infusion	30	1.42±0.46	30	1.58±0.54	30	0.17±0.56	-0.043	0.377	1.624	0.115
	Suction Apparatus	30	0.67±0.56	30	0.58±0.76	30	-0.08±0.43	-0.245	0.078	-1.056	0.300
	Assist in Intubation	30	0.25±0.25	30	1.33±0.38	30	1.08±0.19	1.013	1.154	31.308	<0.001
	Drugs Administration	30	0.75±0.57	30	1.17±0.48	30	0.42±0.35	0.286	0.547	6.530	<0.001
	Assist in Defibrillation	30	0.67±0.56	30	2.25±0.82	30	1.58±1.15	1.153	2.014	7.523	<0.001
	Documentation	30	0.17±0.38	30	1.08±0.70	30	0.92±0.70	0.127	0.657	7.215	<0.001

Statistically significance, P value <0.005

4.5.3 Correlations of subscale item scores of skill performance

Table 4.8 shows the correlation coefficient, r for the control group on preparation on environment ($r = 0.354$, $p = 0.055$), arrival of crash cart ($r = 0.316$, $p = 0.089$), administration of suction apparatus ($r = 0.430$, $p = 0.018$) and assistance in defibrillation ($r = 0.652$, $p < 0.001$) which showed a positive correlation. Scores for the preparation of patient ($r = -0.520$, $p = 0.003$), ECG administration($r = -0.574$, $p < 0.001$), setting up infusion ($r = -0.483$, $p = 0.007$), assistance in intubation ($r = -0.611$, $p < 0.001$) indicated a negative correlation.

In the intervention group, there was a positive correlation coefficient or r for the arrival of crash cart ($r = 0.322$, $p = 0.083$), oxygen administration ($r = 0.796$, $p < 0.001$), setting up infusion ($r = 0.377$, $p = 0.040$), administration of suction apparatus ($r = 0.826$, $p < 0.001$), assistance in intubation ($r = 0.894$, $p < 0.001$) and drugs administration ($r = 0.791$, $p < 0.001$). There was negatively correlation coefficient, r found in preparation of environment ($r = -0.484$, $p = 0.007$), preparation of patient ($r = -0.542$, $p = 0.002$) and assistance in defibrillation ($r = -0.375$, $p = 0.041$).

The clinical skill performance was conducted for 60 student participants in one school. This cohort group was evenly divided into two groups: 30 in the control group and 30 in the intervention group respectively. Descriptive statistics for skills for both groups are shown in Table 4.7. The mean pre-test score on clinical skills performance in managing deteriorating condition was 11.46 (SD = 2.51) for the intervention group.

The mean post-test score after exposure to HFPS for the intervention group was 20.00 (SD = 2.68). The mean pre-test score on clinical skills performance in managing patient deterioration for the control group was 11.68 (SD = 4.30). The mean post-test score for the control group with no exposure to HFPS was 18.17 (SD = 1.83).

Table 4.8: Correlations of subscale score of skill performance between pre and post exposure to HFPS for both control and intervention groups

Group	Subscale (Post-Pre score)	N	Correlation	Sig.
Control (n=30)	Activation of Code Blue	30	0.256	0.172
	Preparation of Environment	30	0.354	0.055
	Preparation of Patient	30	-0.520	0.003
	Arrival of Crash Cart	30	0.316	0.089
	Oxygen Administration	30	0.181	0.340
	ECG Administration	30	-0.574	<0.001
	Setting up of Infusion	30	-0.483	0.007
	Suction Apparatus	30	0.430	0.018
	Assist in Intubation	30	-0.611	<0.001
	Drugs Administration	30	-0.158	0.404
	Assist in Defibrillation	30	0.652	<0.001
	Documentation	30	0.270	0.150
Intervention (n=30)	Activation of Code Blue	30	0.000	1.000
	Preparation of Environment	30	-0.484	0.007
	Preparation of Patient	30	-0.542	0.002
	Arrival of Crash Cart	30	0.322	0.083
	Oxygen Administration	30	0.796	<0.001
	ECG Administration	30	-0.108	0.568
	Setting up of Infusion	30	0.377	0.040
	Suction Apparatus	30	0.826	<0.001
	Assist in Intubation	30	0.894	<0.001
	Drugs Administration	30	0.791	<0.001

Table 4.8, Continued

	Assist in Defibrillation	30	-0.375	0.041
	Documentation	30	0.272	0.145

Statistically significance, P value <0.005

4.5.4 Mean pre and post-test of skill performance scores by control and intervention groups

The assumption of sphericity indicated that the variance in difference scores of all possible paired levels of the repeated measures were roughly equal. A repeated measures ANOVA with a Greenhouse-Geisser correction indicated that mean skills performance level differed significantly between time points after exposure of HFPS ($F_{(1,125)} = 257.218$, $p < 0.001$, $\eta 2 = 0.816$).

There was no significant difference in interaction between groups ($F_{(1,257)} = 4.739$, $p = 0.0344$, $\eta 2 = 0.076$). To test the hypothesis, a post hoc test (Bonferroni) was applied to contrast the mean scores. The Bonferroni test showed that the total skills performance mean score between the control and intervention groups at baseline was not statistically significant ($p > 0.05$), although the difference between intervention and control groups was significant ($p = 0.003$).

To examine the effectiveness of the intervention, the pre-and post-test in both groups were compared independently. The findings of post hoc test (Bonferroni) revealed that the difference in pre-and post in skill performance score for both intervention and control groups was significantly improved ($p<0.05$) considering the eta square was higher in the intervention ($\eta 2 = 0.741$) than the control group ($\eta 2 = 0.624$).

A repeated measures ANCOVA was used to add covariates to serve as control variables for the independent factors. In this study, the use of ANCOVA test to compare groups categorised by participant characteristics (categorical dependent variables) in the control and intervention groups on skill performance level (a set of interval dependent variable) across time at pre and post exposure to HFPS, was controlled for by age. The mean pre-test score on the level of skill performance on the code blue drill was 11.50 (SE = 2.68) for the intervention group. The mean post-test score after exposure to HFPS for the intervention group was 20.17 (SE = 2.65); ($F_{(1,214)} = 165.502$, $\eta2 = 0.744$, $p < 0.001$). The mean pre-test score on the level of knowledge in the code blue drill for the control group was 12.00 (SE = 4.15). The mean post-test score for the control group with no exposure to HFPS was 18.33 (SE = 1.73); ($F_{(1,214)} = 89.997$, $\eta2 = 0.612$, $p < 0.001$). The results of the pre-and post-test differences on the level of skill performance score are displayed in Table 4.9. The findings of the post hoc test (Bonferroni) revealed differences between the pre-and post in skill performance score for both intervention and control groups, even when controlled by age as there was a significant improvement ($p < 0.05$) considering the eta square was higher in the intervention ($\eta2 = 0.744$) compared to the control group ($\eta2 = 0.612$). The power of test = 99.7% (>80%).

Thus, there is a difference in total mean skill performance scores when controlled by age.

Table 4.9: Comparison on Total mean Skill performance Score between Intervention and Control Groups for Pre and Post Exposure controlled by Age

	Pre Exposure			**Post Exposure**			Magnitude Difference (post-pre) exposure	
		Magnitude difference (Control-Intervention) Group			Magnitude difference (Control-Intervention) Group			
Group	Total mean skills score	Difference (95% CI)	P value	Total mean skills score	Difference (95% CI)	P value	Different (95% CI)	P value
Intervention (n = 30)	11.50 (2.68)	0.517 (-1.33,2.36)	0.577	20.17 (2.65)	1.750 (-2.93, -0.58)	0.004	8.63 (-9.98, -7.29)	<0.001
Control (n = 30)	12.00 (4.15)			18.33 (1.73)			6.37 (-7.71, -5.02)	<0.001

Statistically significance, P value <0.005

4.5.5 Total Skill Performance Scores by Demographic Characteristics

The total mean skill performance scores for intervention and control groups at pre-exposure and post-exposure phase are presented in Table 4.10 by demographic characteristics. The scores were statistically significant with p-value < 0.001 for participants aged 20 years, compared to those aged 21 year and above, pre exposure on the interventions and control groups. The total mean skills performance score was not significantly different between the intervention and control groups at post-exposure score (intervention pre-exposure: age 20 years, n = 28, 19.36 (SD = 6.27); 21 years and above, n = 2, 24.77 (SD = 6.06); p-value = < 0.001; intervention post-exposure: age 20 years, n = 28, 20.04 (SD = 2.65); 21 years and above, n = 2, 22.00 (SD = 2.83); p-value = 0.320) (Control pre-exposure: age 20 years, n = 25, 16.25 (SD = 5.22); 21 years and above, n = 5, 22.05 (SD = 5.60); p-value < 0.001; control post-exposure: age 20 years, n = 25, 18.68 (SD = 1.65); 21 years and above, n = 5, 16.60 (SD = 0.89); p-value = 0.011).

The magnitude of differences in total means skill performance score at pre-exposure and post-exposure phase for both intervention and control group showed no statistical difference (Table 4.11).

Table 4.10: Total mean level of skill performance score for intervention and control groups during pre-exposure and post-exposure phase by demographic characteristic (N = 60)

Characteristics	Intervention (n = 30)						Control (n = 30)					
	Pre-exposure			Post exposure			Pre-exposure			Post exposure		
	n	Total mean skill performance score Mean (SD)	P value	n	Total mean skill performance score Mean (SD)	P value	n	Total mean skill performance score Mean (SD)	P value	n	Total mean skill performance score Mean (SD)	P value
AGE												
20 years	28	19.36±6.27	<0.001	28	20.04±2.65	0.320	25	16.65±5.22	<0.001	25	18.68±1.65	0.011
21 & above	2	24.77±6.06		2	22.00±2.83		5	22.05±5.60		5	16.60±0.89	

Table 4.10, Continued

Gender												
Female	28	21.01±6.66	0.115	28	19.96±2.62	0.120	29	18.17±5.95	0.074	29	18.34±1.76	0.848
Male	2	24.43±6.85		2	23.00±1.41		1	20.68±5.24		1	18.00±0	
CGPA												
<2.5	3	18.39±6.33	0.385	3	20.00±2.00	0.480	1	19.50±6.77	0.770	1	1800±0	0.480
2.50-2.99	12	20.53±7.37		12	19.75±2.26		12	17.80±6.17		12	17.58±1.62	
3 - 3.5	13	21.68±6.40		13	20.15±3.16		12	18.48±5.68		12	18.75±1.54	
>3.5	2	21.90±5.79		2	23.00±1.41		5	19.25±6.62		5	19.20±2.17	
Role												
Nurse 1	6	20.95±6.55	0.980	6	20.17±2.86	1.000	6	18.66±5.90	0.921	6	18.33±1.86	1.000
Nurse 2	6	21.66±7.02		6	20.17±2.87		6	18.93±5.88		6	18.33±1.86	
Nurse 3	6	21.00±6.71		6	20.17±2.88		6	17.76±5.51		6	18.33±1.86	
Doctor	6	20.86±6.53		6	20.17±2.89		6	18.20±6.36		6	18.33±1.86	
Relative: Confounder	6	21.40±6.95		6	2017±2.65		6	18.71±6.23		6	18.33±1.86	

Statistically significance, P value <0.005

Table 4.11: Post versus pre intervention for intervention and control groups on differences in total mean skill performance score at pre-exposure and post-exposure phase (N = 60)

Characteristics	Intervention (N=30)			Control (N=30)		
	Difference (Post-Pre) Exposure			Difference (Post-Pre) Exposure		
	n	Total mean skill performance score Mean (SD)	P value (2 tailed)	n	Total mean skill performance score Mean (SD)	P value (2 tailed)
Age						
20 Years	28	8.46±2.47	0.103	25	6.72±4.50	0.296
21 & above	2	11.50±2.12		5	4.40±4.16	
Gender						
Female	28	8.54±2.49	0.298	29	6.24±4.51	0.552
Male	2	10.50±3.54		1	9.00±0.00	
CGPA						
<2.5	3	9.00±1.00	0.613	1	9.00±0.00	0.879
2.50-2.99	12	8.92±1.93		12	6.75±3.41	

Table 4.11, Continued

3 - 3.5	13	8.08±3.15		12	5.67±5.33	
>3.5	2	10.50±3.54		5	6.40±5.50	
Role						
Nurse 1	6	8.67±2.73	1.000	6	6.33±4.80	1.000
Nurse 2	6	8.67±2.73		6	6.33±4.80	
Nurse 3	6	8.67±2.73		6	6.33±4.80	
Doctor	6	8.67±2.73		6	6.33±4.80	
Relative: Confounder	6	8.67±2.73		6	6.33±4.80	

Statistically significant, p value <0.005

4.5.6 Association between total mean scores of knowledge and skill performance

A Pearson correlation coefficient was computed to assess the relationship between level of knowledge and skill performance for the intervention group at pre-exposure. There was a non-significant correlation between the two variables, $r = 0.419$, $p = 0.021$. Overall, there was a non-significant correlation between the level of knowledge and skill performance for the intervention group at pre-exposure. Increases in the level of knowledge were not correlated with increases in the level of skill performance at pre-exposure to HFPS. Likewise, at the post exposure stage to HFPS, the two variables showed $r = -0.081$, $p = 0.671$. Overall, there was a non-significant correlation between the level of knowledge and skill performance for the intervention group at post exposure. Increases in the level of knowledge were not correlated with increases in the level of skill performance, post exposure to HFPS.

4.6 Critical Thinking

4.6.1 Comparison of means on subscale California critical thinking disposition skills

The CCTDI comprises of seven attributes of critical thinking namely truth seeking (TS), open mindedness (OM), inquisitiveness (IN), analyticity (AN), systematicity (SYS), confidence in reasoning (CR) and maturity of judgment (MJ). There were a total of 409 nursing students whom participated in this test. The CCTDI subscale attribute for TS has less than 30 scores (Negatively disposed, weak); None of attributes scored between 30-40 score (ambivalently disposed, average) while attributes of OM, IN, AN, SYS, CR and MJ scored above 40 (Positively disposed, strong) for both pre and post-test (Table 4.12).

Table 4.12: Critical thinking skills scores for control and intervention groups, pre and post exposure to HFPS

Group		N	Minimum	Maximum
Control	CCTDI Overall Pre Test	187	237	329
	TSPretest	187	14	42
	OMPretest	187	21	49
	INPretest	187	36	60
	ANPretest	187	33	59
	SYSPretest	187	29	54
	CRPretest	187	26	57
	MJPretest	187	17	52
	CCTDI Overall Post Test	187	221	336
	TSPosttest	187	10	48
	OMPosttest	187	25	48
	INPosttest	187	32	60
	ANPosttest	187	26	58
	SYSPosttest	187	26	57
	CRPosttest	187	19	60
	MJPosttest	187	10	52
Intervention	CCTDI Overall PreTest	222	229	341
	TSPretest	222	10	48
	OMPretest	222	27	50
	INPretest	222	32	60
	ANPretest	222	30	60
	SYSPretest	222	26	54

Table 4.12, Continued

CRPretest	222	24	60
MJPretest	222	13	51
CCTDI Overall Post Test	222	221	341
TSPosttest	222	13	43
OMPosttest	222	25	51
INPosttest	222	29	60
ANPosttest	222	25	60
SYSPosttest	222	25	54
CRPosttest	222	26	60
MJPosttest	222	15	50

SD=Standard deviation; SE=Standard Error
Description on CCTDI Subscale score: Less than 30 (Negatively disposed, weak); 30-40 (ambivalently disposed, average) and Above 40 (Positively disposed, strong).
CCTDI Total score: Less than 210 (Negatively disposed, weak); 210-280 (Ambivalently disposed, average); Above 280 (Positively disposed, strong).

Table 4.12 shows the maximum and minimum score for each subscale in critical thinking skills. The highest pre-test score for control were IN (60), AN (59) and CR (57) while the lowest were for TS (14), MJ (17) and OM (21). The intervention group highest pre-test score were for IN (60), AN (60) and SYS (60) while the lowest pre-test score were for TS (10), MJ (13) and CR (24). Post-test scores for the control group were highest for IN (60), CR (60), AN (58) and SYS (57) while the lowest was for TS (10), MJ (10) and CR (19). In the intervention group, the highest post-test scores were for IN (60), AN (60), CR (60) while lowest post-test score were for TS (13), MJ (15). The total mean score CCTDI for pre-test in control group was 283.64 (SD = 18.91) and post-test 274.77 (SD = 26.63) while the total mean score CCTDI for pre-test in the intervention group was 276.73 (SD = 19.40) and post-test 267.80 (SD = 21.22). Both groups were in the score range of 210-280 (Ambivalently disposed, average) and stated lower post-test scores, with the control group scoring higher on the mean score compared to the intervention group.

4.6.2 Total mean difference of critical thinking scores

Table 4.13 displays the total mean difference (post-pre) exposure between control and intervention group. Scores were found to be decreased in OM, IN, AN, SYS, CR and MJ for both control and intervention group. The summary of results for control and intervention groups are as follows: OM (control -0.379 (SD = 5.35), t = -0.97, p = 0.333, 95% CI for mean difference was [-1.152,0.392]; intervention -0.333 (SD = 4.38), t = -1.133, p = 0.258, 95% CI for mean difference was [-0.913,0.246], IN (control -2.620 (SD = 6.53), t = -5.488, p < 0.001, 95% CI for mean difference was [-3.562,-1.679]; intervention -2.229 (SD = 6.44), t = -5.159, p < 0.001, 95% CI for mean difference was [-3.082,-1.378], AN (control -2.235 (SD = 5.50), t = 5.851, p < 0.001, 95% CI for mean difference was [-3.146,-1.560]; intervention -2.703 (SD = 5.86), t = -6.875, p < 0.001, 95% CI for mean difference was [-3.478,-1.928]), SYS (control -1.059 (SD = 5.34), t = -2.712, p = 0.007, 95% CI for mean difference was [-1.829,-0.289]; intervention -1.139 (SD = 5.68), t = -2.99, p = 0.003, 95% CI for mean difference was [-1.891,-0.388], CR (control -0.711 (SD = 7.12), t = -1.365, p = 0.174, 95% CI for mean difference was [-1.739,0.316] ; intervention -0.707 (SD = 6.49), t = -1.623, p = 0.106, 95% CI for mean difference was [-1.566,0.152] and MJ (control -2.177 (SD = 6.72), t = -4.431, p < 0.001, 95% CI for mean difference was [-3.146,-1.208]; intervention -2.703 (SD = 6.81), t = -5.912, p < 0.001, 95% CI for mean difference was [-3.604, -1.802]. There was a statistically significant difference with a p-value (2-tailed) of less than 0.005 (post-test and pre-test difference) for both control and intervention group on IN (p < 0.001), AN (p < 0.001) and MJ (p < 0.001). In addition, there was a statistically significant difference p-value (2-tailed) = 0.005 (post-test and pre-test difference) on SYS ($p < 0.001$) which was found to be increased in the intervention group.

The CCTDI subscale attribute for TS has less than 30 scores (Negatively disposed, weak); None of attributed has 30-40 scores (ambivalently disposed, average) while attributes of OM, IN, AN, SYS, CR and MJ scored above 40 (Positively disposed, strong) for both pre and post-test. The CCTDI subscale attributes were decreased after post-test for all attributes except for the TS scores which saw an increase.

Table 4.13: Total mean score for critical thinking skills in control and intervention group pre and post exposure to HFPS

Group	Scale	Pre Exposure		Post Exposure			Mean±SD (Difference post-pre) exposure	t	CI 95%		P-value Sig. (2-tailed)
		n	Mean±SD	n	Mean±SD	n			Lower	Upper	
Control (n=187)	Overall score	187	283.64±18.91	187	274.77±26.63	187	-8.8717±22.23	-5.458	-12.078	-5.665	<0.001
	Truth Seeking	187	29.20±5.73	187	29.65±6.66	187	0.4492±6.61	0.929	-0.505	1.403	0.354
	Open-mindedness	187	36.65±4.65	187	36.27±4.76	187	-0.3797±5.35	-0.97	-1.152	0.392	0.333
	Inquisitiveness	187	50.39±4.99	187	47.77±7.14	187	-2.6203±6.53	-5.488	-3.562	-1.679	<0.001
	Analyticity	187	45.38±4.64	187	43.03±5.92	187	-2.3529±5.50	-5.851	-3.146	-1.560	<0.001
	Systematicity	187	41.63±5.10	187	40.57±5.84	187	-1.0588±5.34	-2.712	-1.829	-0.289	0.007
	Confidence in Reasoning	187	43.55±6.17	187	42.83±7.11	187	-0.7112±7.12	-1.365	-1.739	0.316	0.174
	Maturity of Judgment	187	37.03±5.75	187	34.86±7.80	187	-2.1765±6.72	-4.431	-3.146	-1.208	<0.001
Interve-ntion (n=222)	Overall score	222	276.73±19.40	222	267.80±21.22	222	-8.9279±20.21	-6.582	-11.601	-6.255	<0.001
	Truth Seeking	222	28.37±5.83	222	29.23±5.94	222	0.8559±6.71	1.9	-0.032	1.744	0.059
	Open-mindedness	222	36.74±4.26	222	36.41±4.01	222	-0.3333±4.38	-1.133	-0.913	0.246	0.258

Table 4.13, Continued

	Inquisitiveness	222	49.07±5.59	222	46.84±6.88	222	-2.2297±6.44	-5.159	-3.082	-1.378	<0.001
	Analyticity	222	44.01±4.98	222	41.31±5.46	222	-2.7027±5.86	-6.875	-3.478	-1.928	<0.001
	Systematicity	222	39.45±5.20	222	38.31±5.23	222	-1.1396±5.68	-2.99	-1.891	-0.388	0.003
	Confidence in Reasoning	222	42.70±6.67	222	41.99±6.37	222	-0.7072±6.49	-1.623	-1.566	0.152	0.106
	Maturity of Judgment	222	36.67±5.83	222	33.96±6.92	222	-2.7027±6.81	-5.912	-3.604	-1.802	<0.001

Statistically significant, p value < 0.005

4.6.3 Association of critical thinking skills subscale scores

Table 4.14 shows the correlations of overall and subscale score for the California Critical Thinking Disposition for the control and intervention group after exposure to HFPS. The correlation coefficient, r for control group and intervention group indicated a similar trend involving a positive correlation for the post-pre score. The correlation results were between r = 0.350 to r = 0.568. There were changes observed in pre-and post exposure of HFPS for both groups with a statistically significant p-value of < 0.05, with overall and subscale scores revealing a p-value <0.001.

The total CCTDI scores ranged from 70 to 420. There are seven attributes in the CCTDI. Students who scored less than 210 are defined as negatively disposed toward critical thinking (weak), students with scores between 210 and 280 defined as ambivalently disposed (average) and students with the scores above 280 are defined as positively disposed. The score range for each of the seven sub-scales is from 10-40, and students can be considered negatively disposed (scores less than 30), ambivalently (scores between 30 and 40), or positively (scores greater than 40) disposed to each of the characteristics (Fero et al, 2010 & California Critical Thinking User Manual, 2015).

Pre-post answer script papers containing the 76 items Likert scale response were collected from three schools. The total number of participants was 409; student participants answered the computerised format of pre and post answer scripts. These answer scripts were then compiled and sent to Insight Assessment, California for scoring analysis. The researcher used the computer generated raw data received from Insight Assessment Universal Press, USA and transformed it into SPSS format for the analyses that measured study objective no (3).

A paired t-test was used to test if there is a difference between pre-and post-test to determine the level of critical thinking skills among student participants who had been exposed to simulation training. The mean pre-test score on the critical thinking in managing deteriorating condition was 276.73 (SD = 19.40) for intervention group. The mean post-test score after exposure to HFPS for intervention group was 267.80 (SD = 21.22).

The mean pre-test score on critical thinking in managing a deteriorating patient for the control group was 283.64 (SD = 18.91). The mean post-test score for the control group with no exposure to HFPS was 274.73 (SD = 26.62).

Table 4.14: Correlations of subscale score of critical thinking skills between pre and post exposure to HFPS for both control and intervention group

Group	Scale (Post -Pre)	N	Correlation	Sig.
Control	Total critical thinking score	187	0.568	<0.001
	Truth seeking	187	0.438	<0.001
	Open-mindedness	187	0.354	<0.001
	Inquisitiveness	187	0.466	<0.001
	Analyticity	187	0.479	<0.001
	Systematicity	187	0.531	<0.001
	Confidence in reasoning	187	0.431	<0.001
	Maturity judgement	187	0.544	<0.001
Intervention	Total critical thinking score	222	0.508	<0.001
	Truth seeking	222	0.350	<0.001
	Open-mindedness	222	0.440	<0.001
	Inquisitiveness	222	0.482	<0.001
	Analyticity	222	0.373	<0.001
	Systematicity	222	0.407	<0.001

Table 4.14, Continued

	Confidence in reasoning	222	0.505	<0.001
	Maturity judgement	222	0.439	<0.001

Statistically significance, P value <0.005

4.6.4 Mean pre and post critical thinking scores by control and intervention groups

The assumption of sphericity was met, indicating a roughly equal population variance for all possible paired levels. A repeated measures ANOVA with a Greenhouse-Geisser correction determined that mean critical thinking significantly differed between the time points after exposure to HFPS ($F_{(1, 72)} = 71.852$, $p < 0.001$). There were no significant differences in between-group interactions ($F_{(1,72)} = 0.001$, $p = 0.979$). To test the relevant hypothesis, a post hoc test (Bonferroni) was applied to contrast the mean scores. The Bonferroni test showed that the total critical thinking skills mean score between control and intervention groups at baseline was statistically significant ($p < 0.001$) and that there was a difference between the intervention and control groups for critical thinking after the intervention ($p = 0.003$).

To examine the effectiveness of the intervention, the pre-and post-test in both groups were compared independently. The findings of post hoc test (Bonferroni) revealed that the difference between pre-and post in critical thinking score for both intervention and control groups was significantly decreased ($p < 0.05$).

The mean score for critical thinking skills between the control and intervention groups at baseline was not statistically significant ($p > 0.05$), whereas the difference between the intervention and control groups were significant for critical thinking skills immediately after the intervention ($p = 0.003$). The difference between pre-and post-test in critical thinking skill scores for both the intervention and control groups was significantly improved ($p < 0.05$) considering the eta square for the improvement was greater in the intervention ($\eta 2 = 0.089$) compared to the control group ($\eta 2 = 0.075$).

A repeated measures ANCOVA was used to add covariates to serve as control variables for the independent factors. In this study, the ANCOVA was used to compare the groups by participants' characteristics (categorical dependent variables) on the control and intervention groups in critical thinking level (a set of interval dependent variable) across time at pre and post exposure to HFPS, which was controlled for by age, gender and education. The mean pre-test score on the level of critical thinking skill in code blue drill was 278.73 (SE = 18.77) for intervention group. The mean post-test score after exposure to HFPS for the intervention group was 268.38 (SE = 22.63); ($F_{(1,1519)} = 300.686$, $\eta 2 = 0.636$, $p < 0.001$). The mean pre-test score on the level of critical thinking for the code blue drill was 281.22 (SE = 20.47) for the control group. The mean post-test score for the control group with no exposure to HFPS was 272.87 (SE = 25.20); ($F_{(1,1519)} = 233.928$, $\eta 2 = 0.576$, $p < 0.001$). The results of the pre-and post-test differences on the level of critical thinking scores are shown in Table 4.15. The findings on the post hoc test (Bonferroni) show that there was a difference in pre-and post critical thinking scores for both intervention and control groups, even when controlled by age, gender and education as there was a significant improved ($p < 0.05$), with a higher eta square in the intervention group ($\eta 2 = 0.119$) compared to the control group ($\eta 2 = 0.066$). The power of test = 85.5% (>80%). Thus, there is a difference in total mean critical thinking skills scores, when controlled by age, gender and education.

Table 4.15: Comparison on total mean California Critical Thinking Disposition (CCTDI) score between intervention and control groups for pre and post exposure of HFPS controlled by Age, Gender and Education

Group	Pre Exposure: Total mean CCTDI score	Pre Exposure: Magnitude difference (Control-Intervention) Group: Diff (95% CI)	Pre Exposure: Magnitude difference (Control-Intervention) Group: P value	Post Exposure: Total mean CCTDI score	Post Exposure: Magnitude difference (Control-Intervention) Group: Diff (95% CI)	Post Exposure: Magnitude difference (Control-Intervention) Group: P value	Magnitude difference (post-pre) exposure: Diff (95% CI)	Magnitude difference (post-pre) exposure: P value
Intervention (n=222)	278.73 (18.77)	2.04 (-1.99, -6.07)	0.321	268.38 (22.63)	3.83(-1.04,8.71)	0.123	10.26(7.38, 13.13)	<0.001
Control (n=187)	281.22 (20.47)			272.87 (25.20)			8.46(5.18, 11.75)	<0.001

Statistically significant, p value <0.001

Table 4.16: Total mean critical thinking skills score for intervention and control groups at pre-exposure and post-exposure phase (N = 409)

Characteristics	Intervention (n = 222)						Control (n = 187)					
	Pre-exposure			Post -exposure			Pre-exposure			Post exposure		
	n	Total mean critical thinking skills score Mean (SD)	P value	n	Total mean critical thinking skills score Mean (SD)	P value	n	Total mean critical thinking skills score Mean (SD)	P value	n	Total mean critical thinking skills score Mean (SD)	P value
Age												
20 years	142	274.67±20.17	0.037	142	266.52±21.40	0.237	118	282.36±19.57	0.228	118	270.60±26.47	0.005
21 & above	80	280.31±17.52		80	270.03±20.86		69	285.83±17.64		69	281.90±25.53	
CGPA												
<2.5	11	275.36±26.51	0.326	11	270.64±33.35	0.954	13	277.46±23.47	0.092	13	255.92±21.69	<0.001
2.50-2.99	120	274.82±18.40		120	267.46±19.72		89	281.38±18.14		89	267.42±25.01	
3 - 3.5	74	280.11±19.68		74	268.24±21.54		69	285.90±18.72		69	284.57±25.25	
>3.5	17	276.35±19.79		17	266.41±22.58		16	291.50±17.93		16	288.75±24.00	

Table 4.16, Continued

Experience HFPS												
Yes	64	275.52±17.27	0.556	64	266.23±20.96	0.486	111	287.19±18.50	0.002	111	279.76±26.60	0.002
No	158	277.22±20.23		158	268.43±21.36		76	278.46±18.41		76	267.49±25.10	
Role												
Nurse 1	44	275.80±19.65	0.269	44	265.89±22.14	0.477	38	282.24±19.85	0.735	38	270.79±26.30	0.835
Nurse 2	45	276.84±19.26		45	267.67±20.28		36	287.28±17.95		36	276.42±25.63	
Nurse 3	44	276.02±18.56		44	269.36±21.18		40	281.73±18.75		40	274.05±29.04	
Doctor	47	281.55±21.62		47	271.68±24.41		36	283.03±17.31		36	275.11±27.85	
Relative: Confounder	42	272.29±16.98		42	264.46±17.04		37	284.22±20.89		37	277.70±24.84	

Statistically significant, p value < 0.005

4.6.5 Demographic characteristics for total mean critical thinking scores

The total mean score for intervention and control groups at pre-exposure and post-exposure phase are presented by demographic characteristics in Table 4.16. There was no significant difference at the pre and post exposure phase for control and intervention groups except for the overall total mean level difference by CGPA. In the control group, this was significant with a p-value < 0.001, n = 187; CGPA < 2.5, n=13, 255.92 (SD = 21.69); CGPA 2.50-2.99, n = 89, 267.42 (SD = 25.01); CGPA 3-3.5, n = 69, 284.75 (SD = 25.25); CGPA >3.5, n = 16, 288.75 (SD = 24.00).

Table 4.17 presents the differences (post-pre) in total mean critical thinking score at pre-post exposure for both intervention and control groups on demographic characteristics. The magnitude differences (post-pre exposure) for both intervention and control groups on demographic characteristics shows no statistically significant difference with a p-value>0.005.

Table 4.17: Post versus pre intervention scores for intervention and control groups on differences in total mean critical thinking score at pre-exposure and post-exposure phase (N = 369)

Characteristics	Intervention (n=209)			Control (n=160)		
	Difference (Post-Pre) Exposure			Difference (Post-Pre) Exposure		
	n	Total mean critical thinking skills score Mean(SD)	P value (2 tailed)	n	Total mean critical thinking skills score Mean (SD)	P value (2 tailed)
Age						
20 years	139	-11.24±22.39	0.394	106	-11.38±21.12	0.010
21 & above	70	-8.56±19.56		54	-2.41±19.02	
CGPA						
<2.5	9	-18.33±23.53	0.361	9	-10.22±18.69	0.800
2.50-2.99	70	-7.56±22.27		38	-5.95±18.41	
3 - 3.5	112	-11.85±21.44		97	-9.46±22.36	
>3.5	18	-7.83±16.65		16	-6.25±18.44	
Experience in HFPS						
Yes	55	-12.38±21.70	0.414	86	-7.22±21.56	0.463
No	154	-9.62±21.41		74	-9.66±19.98	
Role						
Nurse 1	42	-10.29±22.88	0.927	35	-7.86±15.26	0.213
Nurse 2	43	-12.49±22.29		34	-1.56±20.57	
Nurse 3	41	-11.07±20.76		34	-11.91±22.37	
Doctor	44	-8.45±21.17		28	-8.35±25.19	
Relative: Confounder	39	-9.41±20.92		29	-12.55±19.67	

Statistically significance, P value <0.005

4.6.6 Association between total mean scores of knowledge, skill performance and critical thinking

Association between Total Mean Scores for Knowledge and Critical Thinking Skills

A Pearson correlation coefficient was computed to assess the relationship between total mean scores for knowledge and critical thinking skills for the intervention group at pre-exposure phase. There was no correlation between the two variables, r = 0.111, p = 0.111. Overall, there was no correlation between total mean scores on knowledge and critical thinking skills for the intervention group at the pre-exposure phase. Increases in the level of knowledge were not correlated with increases in the level of critical thinking skills at the pre-exposure phase to HFPS. Likewise, at the post exposure phase to HFPS, the two variables were not significant, with r = 0.091, p = 0.189. Overall, there was no association between the total mean scores for knowledge and critical thinking skills for the intervention group at the post exposure phase. Increases in the level of knowledge were not correlated with increases in the level of critical thinking skills at the post exposure phase to HFPS.

Association between Total Mean Scores on Skill performance and Critical Thinking Skills

A Pearson correlation was run to determine the association between the total mean scores for skill performance and critical thinking skills at the pre- exposure phase for HFPS (r = 0.212, p = 0.262). There was a no correlation between total mean scores for skill performance and critical thinking skills in intervention group at the pre-exposure phase. Increases in the level of skill performance were not correlated with increases in the level of critical thinking skills at the pre-exposure phase to HFPS. Similarly, at the post exposure phase to HFPS, the two variables were not correlated (r = 0.090, p = 0.639). Overall, there was no association between total mean scores on skill performance and critical thinking skills for the intervention group at the post exposure phase. Increases in the level of skill performance were not associated with increases in the level of critical thinking skills at the post exposure phase to HFPS.

4.7 Satisfaction and Self-Confidence

4.7.1 Mean scores of satisfaction and self-confidence levels pre and post exposure to HFPS

The mean scores on satisfaction and self-confidence level are reported in Table 4.18. All subscale items saw an increase in mean scores except for information (control pre min=1.6, post min=1.4); (intervention pre min = 1.6, post min = 1). Stable subscale mean scores in the control group were for support, fidelity, collaboration and high expectation while for the intervention group, this were for support, problem solving, debriefing, fidelity, collaboration, a diverse way of learning and high expectation. There was an increment for all subscale items in the intervention groups from a scale of 3 (pre-exposure) to 5 (post-exposure). The control group rated the same scale at 5, pre- and post-exposure phase.

The overall highest and lowest mean scores reported for satisfaction and self-confidence were (control pre min = 1.6, post min = 1.64; pre max = 5; post max = 5) and (intervention pre min = 2, post min = 1.22; pre max = 4; post max = 5). Findings revealed an increased overall mean score for the control and intervention group. Pre-test overall mean scores was 3.09 (SD = 0.83) and the post-test score was 4.38 (SD = 0.50) for the intervention group. The pre-test overall mean scores for the control group was 3.18 (SD = 0.93) while the overall mean post-test score for the control group was 4.40 (SD = 0.42). This result was revealed at pre exposure phase for intervention groups, indicating students were uncertain of the HFPS as the new method of their learning experience and they rated the overall subscale items as 3; however, at post exposure phase, this rating increased to 5.

Table 4.18: Total mean scores for satisfaction and self-confidence

Group		Overall Sat. Pre	Overall Sat. Post	Sat. Info. Pre	Sat Info. Post	Sat. Support. Pre	Sat. Support. Post	Sat. Prosolv. Pre	Sat. Prosolv. Post	Sat. Debrief. Pre	Sat. Debrief. Post	Sat. Fidelity. Pre	Sat Fidelity. Post
Control	N	112	210	112	210	112	210	112	210	112	210	112	210
	Range	3.4	3.36	3.4	3.6	4	4	4	3.2	4	3.75	4	4
	Min	1.6	1.64	1.6	1.4	1	1	1	1.8	1	1.25	1	1
	Max	5	5	5	5	5	5	5	5	5	5	5	5
Intervention	N	64	179	64	179	64	179	64	179	64	179	64	179
	Range	2	3.78	1.4	4	1.5	4	2	4	2	4	2	4
	Min	2	1.22	1.6	1	1.5	1	1	1	1	1	1	1
	Max	4	5	3	5	3	5	3	5	3	5	3	5

Table 4.18, **Continued**

Group		Sat. Active Learning Pre	Sat. Active Learning Post	Sat. Collaboration Pre	Sat. Collaboration Post	Sat. Diverse Way. Pre	Sat. Diverse Way. Post	Sat. H Expectation. Pre	Sat. H Expectation. Post
Control	N	112	210	112	210	112	210	112	210
	Range	4	3.6	4	4	4	3.5	4	4
	Min	1	1.4	1	1	1	1.5	1	1
	Max	5	5	5	5	5	5	5	5
Intervention	N	64	179	64	179	64	179	64	179
	Range	1.9	3.6	2	4	2	4	2	4
	Min	1.1	1.4	1	1	1	1	1	1
	Max	3	5	3	5	3	5	3	5

4.7.2 Mean pre and post-test satisfaction and self-confidence scores by control and intervention group

The sphericity assumption was met indicating a roughly equal population variance for all possible paired levels. A repeated measures ANOVA with a Greenhouse-Geisser correction determined that mean critical thinking differed significantly between the time points after exposure to HFPS ($F_{(1, 414)} = 414.088$, $p < 0.001$). There were no significant differences in group interaction between-groups ($F_{(1,414)} = 0.315$, $p = 0.575$). To test the relevant hypothesis, a post hoc test (Bonferroni) was applied to contrast the mean scores. The Bonferroni test showed that the total satisfaction and self-confidence level mean score between the control and intervention groups at baseline was not statistically significant ($p = 0.575$) and that there was a significant difference between the intervention and control groups for satisfaction and self-confidence levels after the intervention ($p = 0.001$).

To examine the effectiveness of the intervention, the pre-and post-test in both groups were compared independently. The findings of the post hoc test (Bonferroni) revealed that a significant improvement in pre-and post scores in satisfaction and self-confidence level for both the intervention ($p < 0.001$) and control ($p < 0.001$) groups ($p < 0.05$). The intervention groups at baseline were not statistically significant ($p > 0.05$), whereas the difference between intervention and control groups was significant after the intervention ($p < 0.001$). The difference between pre-and post-test in satisfaction and self-confidence level scores for both intervention and control groups was significant ($p < 0.05$) considering the eta square showed a greater improvement in the intervention group ($\eta 2 = 0.574$) compared to the control group ($\eta 2 = 0.513$).

A repeated measures ANCOVA was used to add covariates to serve as control variables when examining the factors. The ANCOVA was used to compare groups by participants' characteristics (categorical dependent variables) between control and intervention groups on total satisfaction and self-confidence levels (a set of interval dependent variables) across time at pre and post exposure to HFPS, which was controlled for by age and education. The mean pre-test score on the level of total satisfaction and self-confidence level in a code blue drill was 3.08 (SE = 0.84) for the intervention group. The mean post-test score after exposure to HFPS for the intervention group was 4.37 (SE = 0.50); ($F_{(1,1454)} = 300.686$, $\eta2 = 0.636$, $p < 0.001$). The mean pre-test score on the level of total satisfaction and self-confidence level in code blue drill for the control group was 3.18 (SE = 0.93). The mean post-test score for the control group with no exposure to HFPS was 4.39 (SE = 0.42); ($F_{(1,1454)} = 233.928$, $\eta2 = 0.576$, $p < 0.001$). The results of the pre-and post-test differences on the level of total satisfaction and self-confidence score are displayed in Table 4.19. The findings of the post hoc test (Bonferroni) revealed an improvement ($p<0.05$) from pre- to post scores for total satisfaction and self-confidence in both intervention and control groups, even when controlled by age and education. The eta square for improvement was higher in the intervention group ($\eta2 = 0.636$) compared to the control group ($\eta2 = 0.576$). The power of test = 38.8% (>20%). Thus, there is a difference in total mean satisfaction and self-confidence scores, when controlled by age, gender and education.

Table 4.19: Comparison on Total mean Satisfaction (SAT) and Self-confidence (SC) Score between Intervention and Control Groups for Pre and Post Exposure of HFPS controlled of Age and Education

	Pre Exposure			Post Exposure				
Group	Total mean SAT&SC score	Magnitude difference (Control-Intervention) Group		Total mean SAT&SC score	Magnitude difference (Control-Intervention) Group		Magnitude difference (post-pre) exposure	
		Diff (95% CI)	P value		Diff (95% CI)	P value	Diff (95% CI)	P value
Intervention (n=94)	3.08(0.84)	1.10(-0.11,-0.33)	0.366	4.37(0.50)	0.02 (-0.11, -0.17)	0.713	1.29(-1.54, -1.22)	<0.001
Control (n=82)	3.18(0.93)			4.39 (0.42)			1.22(-1.47, -1.13)	<0.001

Statistically significance, P value <0.005

4.7.3 Total mean scores for satisfaction and self-confidence by demographic characteristics

Total mean scores for satisfaction and self-confidence for intervention and control groups are presented by demographic characteristics at pre-exposure and post-exposure phase (Table 4.20). There was a statistically significant difference for age by pre-exposure for both intervention and control groups. The age characteristic of participants was as follows: (Intervention pre-exposure: aged 20 years, n = 37, 3.58 (SD = 0.77); 21 years and above, n = 57, 2.63 (SD = 0.47); p-value < 0.001; intervention post-exposure: aged 20 years, n = 139, 4.22 (SD = 0.66); 21 years and above, n = 70, 4.21 (SD = 0.57); p-value = 0.904). (Control pre-exposure: age 20 years, n = 32, 3.75, (SD = 0.93); 21 years and above, n = 50, 2.75 (SD = 0.87); p-value <0.001; control post-exposure: aged 20 years, n = 120, 4.00 (SD = 0.76); 21 years and above, n = 59, 4.28 (SD = 0.51); p-value = 0.010). For prior HFPS exposure: intervention pre-exposure: Yes, n = 34, 2.66 (SD = 0.39); No, n = 60, 3.33 (SD = 0.93); p-value < 0.001; intervention post-exposure: Yes, n = 55, 4.23 (SD = 0.58); No, n = 154, 4.14 (SD = 0.68); p-value = 0.370); Control pre-exposure: Yes, n = 41, 2.57 (SD = 0.41); No, n = 41, 3.79 (SD = 0.91); p-value < 0.001; control post-exposure: Yes, n = 100, 3.91 (SD = 0.65); No, n = 79, 4.14 (SD = 0.70); p-value = 0.027). The results showed characteristics of age and experience in HFPS was statistically significant at pre-exposure for both the intervention and control groups but was not significant at post-exposure phase.

The magnitude differences in total mean satisfaction and self-confidence (program) score at pre-exposure and post-exposure phase were statistically significant for age group and prior exposure to HFPS. The total mean difference results by age group are as follows: (Intervention: aged 20 years, n = 37, 0.98 (SD = 0.83); 21 years and above, n =

57, 1.64 (SD = 0.69); p-value < 0.001; Control: aged 20 years, n = 32, 0.81 (SD = 0.93); 21 years and above, n = 50, 1.58 (SD = 0.78); p-value < 0.001).

The total mean difference for prior exposure to HFPS was: (Intervention: Yes, n = 34, total mean difference 1.92 (SD = 0.58); No, n = 154; total mean difference 1.07 (SD = 0.76); p-value < 0.001) and Control group (Yes, n = 41, total mean difference 1.83 (SD = 0.60); No, n = 41; total mean difference 0.72 (SD = 0.84); p-value < 0.001 (Table 4.21). The findings for total mean difference for age and prior exposure to HFPS revealed that both intervention and control groups had statistically significant differences on participant levels of satisfaction and self-confidence.

Table 4.20: Total mean level of satisfaction and self-confidence score for intervention and control groups at pre-exposure and post-exposure phase by demographic characteristics (N = 389)

Characteristics	Intervention (n = 209)						Control (n = 180)					
	Pre-exposure			Post -exposure			Pre-exposure			Post exposure		
	n	Total mean satisfaction and self confidence Mean (SD)	P value	n	Total mean satisfaction and self confidence Mean (SD)	P value	n	Total mean satisfaction and self confidence Mean (SD)	P value	n	Total mean satisfaction and self confidence Mean (SD)	P value
Age												
20 years	37	3.58±0.77	<0.001	139	4.22±0.66	0.904	32	3.75±0.93	<0.001	120	4.00±0.76	0.010
21 &above	57	2.63±0.47		70	4.21±0.57		50	2.75±0.87		59	4.28±0.51	
Gender												
Female	86	3.07±0.84	0.632	199	4.15±0.66	0.277	72	3.26±0.94	0.035	160	4.02±0.70	0.559
Male	8	3.23±0.90		10	4.38±0.54		10	2.60±0.60		20	3.93±0.58	
CGPA												
<2.5	6	3.33±1.10	0.904	9	4.24±1.17	0.704	5	3.20±0.79	0.163	9	4.24±0.61	0.068

Table 4.20, Continued

2.50-2.99	39	3.06±0.83		70	4.23±0.55		27	3.38±1.09		43	4.21±0.60	
3 - 3.5	44	3.09±0.83		112	4.12±0.68		41	2.96±0.79		110	3.91±0.68	
>3.5	5	3.04±0.92		18	4.13±0.64		9	3.58±1.00		18	4.08±0.83	
Experience in HFPS												
Yes	34	2.66±0.39	<0.001	55	4.23±0.58	0.370	41	2.57±0.41	<0.001	100	3.912±0.65	0.027
No	60	3.33±0.93		154	4.14±0.68		41	3.79±0.91		79	4.14±0.70	
Role												
Nurse 1	18	3.03±0.94	0.839	42	4.05±0.77	0.422	18	3.24±0.91	0.988	39	4.12±0.69	0.504
Nurse 2	21	3.01±0.80		43	4.28±0.58		18	3.22±0.89		37	4.12±0.52	
Nurse 3	18	3.30±0.91		41	4.12±0.75		17	3.12±0.82		38	3.93±0.74	
Doctor	20	3.04±0.89		44	4.24±0.45		16	3.10±1.02		34	3.98±0.72	
Relative: Confounder	17	3.07±0.72		39	4.09±0.71		13	3.22±1.17		32	3.91±0.73	

Statistically significance, P value <0.005

Table 4.21: Post versus pre intervention for intervention and control groups on differences in total mean satisfaction and self-confidence level score at pre-exposure and post-exposure phase

Characteristics	Intervention (n=94)			Control (n=82)		
	Difference (Post-Pre) Exposure			Difference (Post-Pre) Exposure		
	n	Total mean Satisfaction & Self-Confidence score Mean (SD)	P value (2 tailed)	n	Total mean Satisfaction & Self-Confidence score Mean (SD)	P value (2 tailed)
Age						
20 years	37	0.98±0.83	<0.001	32	0.81±0.93	<0.001
21 & above	57	1.64±0.69		50	1.58±0.78	
Gender						
Female	86	1.37±0.83	0.669	72	1.26±0.94	0.606
Male	8	1.50±0.55		10	1.42±0.78	
CGPA						
<2.5	6	1.34±0.78	0.726	5	1.52±1.01	0.118

Table 4.21, Continued

2.50-2.99	39	1.36±0.81		27	1.02±0.89	
3 - 3.5	44	1.78±1.17		41	1.49±0.90	
>3.5	5	1.38±0.81		9	0.96±0.87	
Experience in HFPS						
Yes	34	1.92±0.58	<0.001	41	1.83±0.60	<0.001
No	60	1.07±0.76		41	0.72±0.84	
Role						
Nurse 1	18	1.44±0.73	0.645	18	1.17±0.74	0.234
Nurse 2	21	1.59±0.71		18	1.28±1.02	
Nurse 3	18	1.13±0.76		17	1.27±0.82	
Doctor	20	1.45±0.81		16	1.48±1.03	
Relative: Confounder	17	1.24±1.02		13	1.19±1.06	

Statistically significance, P value <0.005

4.7.4 Association between Knowledge, Skill Performance, Critical Thinking Skills with Level of Satisfaction and Self-Confidence

Association between Level of Knowledge and Satisfaction and Self-Confidence

A Pearson correlation coefficient was computed to assess the relationship between the level of knowledge and level of satisfaction and self-confidence for the intervention group at pre-exposure phase. There was a significant correlation between the two variables, $r = -0.386$, $p < 0.001$ (Table 4.22). Overall, there was a weak negative correlation between the level of knowledge and satisfaction and self-confidence in the intervention group at the pre-exposure phase. Increases in the level of knowledge were correlated with decreases in the level of satisfaction and self-confidence at pre-exposure phase to HFPS.

There was no relationship between the level of knowledge, satisfaction and self-confidence for the intervention group at post exposure phase to HFPS, $r = 0.012$, $p = 0.865$ (Table 4.23). Overall, there was no correlation between the level of knowledge and satisfaction and self-confidence for the intervention group at the post exposure phase. Increases in the level of knowledge were not associated with increases in the level of satisfaction and self-confidence at the post exposure phase to HFPS.

Association between Level of Skill Performance, Satisfaction and Self-Confidence

A Pearson correlation was used to determine the correlation between the level of skill performance, satisfaction and self-confidence at the HFPS pre-exposure phase, $r = 0.314$, $p = 0.091$ as presented in Table 4.22. Overall, there was a non-significant correlation between the level of skill performance and satisfaction and self-confidence for the intervention group at the pre-exposure phase. Increases in the level of skill performance were not correlated with increases in the level of satisfaction and self-confidence at pre-exposure phase to HFPS. Equally, at the post exposure phase to HFPS, the two variables were r = 0.218, p = 0.248 (Table 4.23). Overall, there was no association between the level of skill performance and satisfaction and self-confidence for the intervention group at the post exposure phase. Increases in the level of skills performance were not correlated with the increases in level of satisfaction and self-confidence at post exposure phase to HFPS.

Association between Level of Critical Thinking Skills, Satisfaction and Self-Confidence

The Pearson correlation between level of critical thinking skills, satisfaction and self-confidence at the pre-exposure phase of HFPS were r = 0.004, p = 0.972 (Table 4.22). Overall, there was no correlation between the level of critical thinking skills, satisfaction and self-confidence for the intervention group at pre-exposure phase. Increases in the level of critical thinking skills were not correlated with increases in the level of satisfaction and self-confidence at pre-exposure phase to HFPS. Similarly, at the post exposure phase to HFPS, the two variables were r = -0.135, p = 0.051 (Table 4.23). Overall, there was no correlation between the level of critical thinking skills, satisfaction and self-confidence in the intervention group at post exposure phase. Increases in the level of critical thinking skills were not correlated with increases in the level of satisfaction and self-confidence at post exposure phase to HFPS.

Table 4.22: Correlation between knowledge, skill performance, critical thinking skills, level of satisfaction and self-confidence in the intervention group, pre HFPS exposure

Group	Dependent Variable	Pre Knowledge Scores	Pre Skill performance Scores	Pre Critical Thinking Scores	Pre Level of Satisfaction and Self-Confidence
Intervention	Knowledge (n = 209)				
	r				
	Skill performance (n = 30)	.419*			
	r	0.021			
	Critical Thinking Skills (n=209)	0.111	0.212		
	r	0.111	0.262		
	Level of Satisfaction and Self-Confidence (n = 94)	-.386**	0.314	0.004	
	p	<0.001	0.091	0.972	

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 4.23: Correlation between knowledge, skill performance, critical thinking skills, level of satisfaction and self-confidence in intervention group, post HFPS exposure

Group	Dependent Variable	Post Knowledge Scores	Post Skill performance Scores	Post Critical Thinking Scores	Post Level of Satisfaction and Self-Confidence
Intervention	Knowledge (n = 209)				
	r				
	Skill performance (n = 30)	-0.081			
	r	0.671			
	Critical Thinking Skills (n=209)	0.091	0.09		
	r	0.189	0.636		
	Level of Satisfaction and Self-Confidence (n=209)	0.012	0.218	-0.135	
	p	0.865	0.248	0.051	

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

4.8 Summary

This chapter is important as it presents findings that offer both a descriptive and analytical account of the student nurses who participated in this study. The majority of the students, 259 participants (66%) were from the younger age group (20 years old). The students were predominantly female (92%). Most entered the diploma in nursing programme using SPM qualifications (98%). The majority of the students had a CGPA of 3 to 3.5 in the control (61.1%) and intervention group (53.6%). Roughly 60% of participants had never been exposed to simulation training. Use of simulation training appeared to increase participant knowledge, skill performance, critical thinking, level of satisfaction and self-confidence even when controlled for demographic characteristics as covariates such as age, gender and CGPA. The results presented in this chapter provide answer to the research questions. The findings carry important ramifications for the use of HFPSs in nursing education.

CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter presents a comprehensive discussion of the key findings of this study. The discussion outlines the study objectives and expounds the outcomes of the study which assessed the effects of HFPS as a learning strategy among diploma level nursing students using a quasi-experimental design. Firstly, the discussions are described participant characteristics, followed by the description of each of the independent variables namely the levels of knowledge, skill performance, critical thinking, satisfaction and self-confidence. Subsequently, the discussion explores the strengths and limitations of this research. Implications for clinical nursing practice, education, management, training and research development and professional advancement are also expounded. Finally, the general conclusions are drawn with recommendations for further studies.

5.2 Participant Characteristics

5.2.1 Overview

A total of 409 students were recruited in this study. The overall participant response rate was 94% (N = 389). Most students were female (n = 359, 92%) and only 30 participants (8%) were male. The age group for the students in year 3 was categorised to 20 years old (n = 259, 67%) and more than 20 years old (n = 130, 33%). The highest education level was SPM with n = 384 (98%) for the majority of participants. One possible reason for this was due to SPM being the minimal requirement for entry into any diploma in nursing programme in Malaysia. The majority (n = 335, 86%) had a CGPA ranging from 2.5-3.5. There were n = 116 (40%) participants who had prior exposure to HFPS while n = 273 participants (60%) had no prior exposure to HFPS.

Male nurses comprised only 8% of participants in this study, which is reflective of the current situation in Malaysia. In overseas, it is in line with statistics reported by Tanner (2013) that of more than 2 million registered nurses in the United States, approximately 10 percent were men based on 2013 data. Vere-Jones (2008) reported that based on the figures obtained from the Nursing and Midwifery Council (NMC) only one in ten registered nurses were male, a figure that has remained static for the past four years. There is currently no published data reported in Malaysia. The public perception towards nursing has not changed and nursing remains perceived as a pink-collar job, subjects of erotic fantasy of an individual with uniform and a stethoscope around the neck. Nursing specialty areas that attract a lot of men include intensive care, the operating theatre, mental health and accident and emergency, which are seen as more musculine than other specialties within the profession (Zamanzadeh et al., 2013 and Tanner, 2013).

In this study, students who participated were homogeneous groups. They were all at the same level in their respective diploma-nursing programme (Nursing Board Malaysia, 2015). Setting this as the baseline aimed to reduce bias in terms of personal ability in learning and attributes that might influence the response and feedback provided by participants. A chi square test was used to detect any confounders that may have interfered with the accuracy of the findings. The distribution of control and intervention groups were evenly distributed as the chi square test showed non-significant p-value for all demographic characteristics.

5.2.2 Participant Characteristics compared on Knowledge, Skill performance, Critical Thinking and Satisfaction and Self-Confidence

Knowledge

There were a statistically significant difference with a p-value < 0.001 for participants aged 20 years and those 21 years and above on both intervention and control groups at pre and post exposure phase.

Experience in HFPS was also statistically significant with a p-value < 0.001 for pre and post exposure for the control groups but this was only significant for intervention groups at post-exposure phase. These results are likely due to participant age and experience in using HFPS which led to better knowledge test scores in this study. It is noteworthy that student factors of age and experience in using HFPS played a role in the level of knowledge performance in this study.

Research found that students with more experience were better prepared generally for simulations, integrating their clinical experience, past simulation, and their ability to work in teams to readily manage a given scenario (Najar et al., 2015).

There were no statistically significant differences found between participant characteristics and mean total knowledge in the intervention and control groups based on the magnitude of difference in mean total knowledge score at pre-exposure and post-exposure phase after 2 months. One possible explanation may be due to memory decay after 2 months post intervention leading to the lack of difference in the mean total knowledge score in the intervention group (Hoadley, 2010; Akhu-Zaheya et al., 2013 cited in Tawelbeh, 2013).

Skill performance

There was a significant difference in terms of demographic characteristics for the mean total skill performance score in both intervention and control groups at pre-exposure and post-exposure phase, specifically with regard to age. At pre-exposure, the 20 years and 21 years and above age groups for both the interventions and control groups were not statistically significance for post-exposure. The difference between pre and post skill performance score for both intervention and control groups was significantly improved. The skill performance showed a greater improvement for the intervention group ($\eta 2$ = 0.741) compared to the control group ($\eta 2$ = 0.624). Simulation education for the year-3 diploma nursing students was objectively measured by skill performance of the students' responses for code blue management in a team for both intervention and control group.

The intervention group achieved better scores ($\eta 2$ = 0.741) compared to the control group ($\eta 2$ = 0.624). This study was in line with other studies conducted in China, Korea, Australia and the United States. The literature review reported that simulation education improved skills (Yuen et al., 2011; Fisher & King, 2013; Richardson & Claman, 2014; Oermann et al., 2014; Kaddoura et al., 2016 and Lee & Oh, 2015 cited in in Cant & Cooper, 2017) with simulation improving skills in preparation for clinical management with actual patients (Lewis et al., 2012 and Ricketts et al., 2013; Laue et al., 2015 cited in Cant & Cooper, 2017).

The magnitude of difference in mean total skill performance score at pre-exposure and post-exposure phase for both intervention and control group showed no statistical significance. This could be due to the small size sample of this study.

Critical Thinking

The demographic characteristics for critical thinking at pre-post exposure for both intervention and control groups and its magnitude of differences respectively showed no statistical significance. This was congruent with prior studies that found no difference in total dispositional score between genders in past study (Facione et al., 1993; Ip et al., 2000 cited in Dunn et al., 2002). This finding is consistent with Dunn et al. (2002), who found the genders, age, and race showed no association with critical thinking disposition. These findings reinforce the concept that critical thinking disposition is a trait that does not depend on general personal characteristics.

At least one past study (Ip et al., 2000 cited in Dunn et al., 2002) reported work experience bearing no relationship between nursing students' mean score or subscale scores. In previous research using the CCTDI, significant correlations between grade point average (GPA) and mean total score and the mean scores was found for OM, AN, SYS, INS, CR and MJ (Dunn et al., 2002).

Satisfaction and self-confidence

The demographic characteristics for the mean total level of satisfaction and self-confidence (program) score for intervention and control groups at pre-exposure and post-exposure phase were statistically significant for age and exposure to HFPS, but this was limited to the pre-exposure level for both groups. The results showed characteristics of age and experience in HFPS was statistically significant at the pre-exposure phase for both intervention and control groups but not at post-exposure phase.

The magnitude of difference in mean total satisfaction and self-confidence (program) score at pre-exposure and post-exposure phase was statistically significant for age group and prior experience using the HFPS. This result revealed that the age group of participants and their prior experience in HFPS influenced their level of satisfaction and self-confidence in the program. Participants in the 21 years and above age group with prior exposure to HFPS had higher mean scores for mean total satisfaction and self-confidence (program) score at pre-exposure and post-exposure phase on the code blue scenario program.

5.3 Level of Knowledge

The single best answer items consisting of 30 items with the distractors of A, B, C and D was used to measure the level of knowledge. Comparison between pre and post knowledge item questions were made. The control group had 13 items (1, 3, 4, 5, 10, 13, 14, 15, 17, 23, 24, 26 and 30) that were scored higher on average, indicating greater effectiveness compared to the intervention group. An OR < 1 indicated that the intervention group had a lower odds of outcome.

A total of 16 items for q2, 6, 7, 8, 9, 11, 12, 16, 18, 19, 20, 21,22, 25,27 and 28 indicated an OR > 1. These 16 questions show that the intervention group demonstrated better knowledge retention after 2 months compared to control group. There were no differences for both the control and intervention on only one item which is q29 where the OR = 1.

This finding reflected the effect of retention in knowledge with use of the HFPS and is in line with results from past studies (Hoffman, O'Donnell, & Kim, 2007; Ackermann, 2009 and Kim & Jang, 2011 cited in Tawalbeh, 2013), where there was a significant improvement on knowledge items as indicated by the OR on post test scores after 2 months of exposure to the HFPS based on the 16 items in the intervention group, compared to 13 items in control group, which was 55.2% in intervention group compared to 44.5% in the control group. The intervention group demonstrated better knowledge retention for the 16 items question tested. These 16 items consisted of questions stipulated at higher Bloom taxonomy levels and reflected the participants learned through experiential learning. These were items q2, 7, 8, 9, 20, 25, 27 and 28. Items that measured experiential learning and strengthened the retention of memory were q6, 8, 11, 12, 16, 18, 19, 21, 22.

Items q3, 4, 5, 10, 13, 17, 23, 24, 26 and 30, which were mostly questions from lower Bloom's taxonomy levels were scored higher by the control group compared to the intervention group, indicating better knowledge. Only items q1, 14 and 15 tested knowledge on an application level. Items q1, 4, 5 ,13, 23, 24 and 26 were related to experiential learning and retention of memory.

Objective no. i in this research study was to assess the knowledge level of nursing students using an adult code blue drill simulated programme before and after using the HFPS compared to low fidelity patient manikins. The post hoc test (Bonferroni) revealed that the difference between pre-and post in knowledge scores for both intervention and control groups was significantly improved ($p < 0.05$) considering the eta square for improvement was higher in the intervention group ($\eta 2 = 0.146$) compared to the control group ($\eta 2 = 0.130$) controlled by age, gender and CGPA.

The study reported knowledge gains among participants using the HFPS consistent with the studies reported by Alinier, Hunt, Gordon, and Collin, 2006; Jeffries, Rizzolo, 2006; Hoffmann, O'Donnell, Kim, 2007; Howard, 2007; Cooper, Kinsman, Buykx & et al., 2010; Buykx et al., 2011 cited in Fisher & King, 2013; Gate, Par & Hughen, 2012;

Shinnick, & Woo, 2013. In these past studies, knowledge gained and retained was tested using the same questions at post-test among intervention group participants that had been exposed to the HFPS. Stroup (2014), cited in Cant & Cooper (2017), reported that participant knowledge was improved through the interactive simulation experience, although there was little evidence that the knowledge gain was greater compared to controls using other instructional methods.

5.4 Level of Skill performance

The skill performance checklist was used to measure the level of skill performance in nursing students. The total number of nursing students who participated in this test was 60. The skill performance checklist consisted of 12 domains with a total of 40 items. The 12 (twelve) domains were the activation of Code Blue (3 items), preparation of the environment (2 items), and preparation of the patient (4 items).

The intervention group improved in overall subscale minimum scores in post-test compared to pre-test score. Two other subscales, namely suctioning and documentation remained the same (zero scores) in post-test.

The results of the intervention group showed that total subscale mean difference score (post-pre exposure) was statistically significant, with a p-value (2 tailed) of less than 0.001 on the activation of code blue 1.42 (SD = 0.74), preparation of the environment 1.08 (SD = 0.74), preparation of the patient 1.25 (SD = 0.64), arrival of crash cart 0.04 (SD = 0.31), assistance in intubation 1.08 (SD = 0.19), drug administration 0.42 (SD = 0.35), assistance in defibrillation 1.58 (SD = 1.15) and documentation 0.92 (SD = 0.70). There was a decrease in administration of suction apparatus 0.08 (SD = 0.43) for the intervention group similar to the control group -0.13 (SD = 0.85). Scores for the arrival of crash cart, oxygen administration, ECG administration, setting up of infusion, administration of suction apparatus were not statistically significant in terms of difference between the intervention and control group. There was an overall increase for the total mean score of each subscale for the control group. Conversely, two subscales for the administration of suction apparatus -0.13 (SD = 0.85) and documentation 0.67 (SD = 0.81) in the control group indicated a decrease in scores at post-test. Results for the preparation of the patient, ECG administration, setting up of infusion, administration of suction apparatus and assistance in intubation showed no statistically significant difference.

The control group did not show any improvement on the domain of documentation as there were no changes at pre-and post-test (scores remained at zero). Both intervention and control group did not perform well on the domain of suction apparatus administration. The lack of skills in administration of the suction apparatus for both intervention and control groups requires attention. For the control group, poor documentation was another issue which may be attributable to the educational approach. Pre-test total mean score on skill performance were: control, 12.00 (SD = 4.15); intervention, 11.50 (SD = 2.67). The post-test total mean score on skill performance were as follows: control, 18.33 (SD = 1.73); intervention, 20.17 (SD = 2.65). The change in total mean score from pre-test to post test scores for control and intervention groups was found to be statistically significant in terms of difference in skill performance between the groups (control, 6.33 (SD = 4.46); intervention, 8.67 (SD = 2.54), with $p < 0.001$.

These results suggest the HFPS had an effect on the intervention group participants as evidenced by the higher post score in this group compared to the control group that was not exposed to the HFPS. The HFPS is a teaching-learning strategy with debriefing session that has the potential to measure and increase psychomotor mastery in an objective manner for the 12 domains of code blue situation in this study and subjectively measures the competency of professional traits such as communication, delegation, and teamwork (Chunta & Taylor, 2013).

Objective no. ii of the research study was to evaluate the skill performance level of nursing students using an adult code blue drill simulated programme before and after using HFPS compared to low fidelity patient manikins. The post hoc test (Bonferroni) indicated a difference between pre-and post in skill score for both intervention and control groups which was significantly improved ($p<0.05$) considering the greater eta square for the intervention group ($\eta2 = 0.744$) compared to the control group ($\eta2 = 0.612$) controlled by age. The findings of this study are consistent with past studies by Alinier et al., 2004; Radhakrishnan et al., 2007 and Sportsman, Schumacker & Hamilton, 2011 cited in Richardson & Claman (2014) on clinical performance using simulation education on nursing students.

The HFPS uses a structured teaching method, which provides students feedback on actions, questions and decision through debriefing sessions. The debriefing sessions were video recorded for the opportunity to learn from one's mistake and collaboratively analyse the issues raised with suggestions and appropriate actions (Dreifuerst, 2009; Schultz, Shinnick & Judson, 2012). The intervention group performed better overall and documented better skill performance scores suggesting the approach successfully integrates technical and non-technical skills. Significantly, the students in HFPS performed better with the use of simulation. One possible reason for this was perhaps the opportunities offered through experiential learning facilitated the expression of emotion and this learning experience helped embed it in the learner's memory (Dreifuerst, 2009).

Expression of emotion refers to the response of the participants reacting to the given scenario and this has an impact on stimulating learner's memory through experiential learning using the HFPS teaching strategy. Prioritising the time frame and delegation of work (Chunta & Taylor, 2013) is essential for completion of the entire code blue simulation from initiation of code blue to documentation. Moreover, the effective delegation provided an organised workflow in the intervention groups, which was achieved through implementation of the SBAR in reporting and documentation (Kuehster & Hall, 2010). Simulation replicates key aspects of a clinical situation to facilitate student learning, and this included the assessment of clinical competencies and exposed students to clinical complex situations such as code blue in a controlled environment to teach clinical quality and patient safety (Jeffries, 2012; Shearer, 2013; Richardson, 2014).

5.5 Level of Critical Thinking Skills

The CCTDI comprised of seven attributes of critical thinking namely truth seeking (TS), open mindedness (OM), inquisitiveness (IN), analyticity (AN), systematicity (SYS), confidence in reasoning (CR) and maturity of judgment (MJ). There were a total of 409 student nurse participants in this test.

There was a statistically significant difference with a p-value (2-tailed) of less than 0.005 (post-test and pre-test difference) for both control and intervention group on IN (p-value < 0.001), AN (p-value < 0.001) and MJ (p-value < 0.001). In addition, there was a statistically significant difference with a p-value (2-tailed) of 0.005 (post-test and pre-test difference) for SYS (p-value < 0.001) in the intervention group.

The CCTDI subscale attribute for TS was less than 30 (negatively disposed, weak). None of attributes exceeded the score of 30-40 (ambivalently disposed, average) while attributes of OM, IN, AN, SYS, CR and MJ scored above 40 (positively disposed, strong) for both pre- and post-test. The CCTDI subscale attributes decreased after post-test for all attributes except TS, which showed an increment.

The pre-test score was 276.73 (SD = 19.40) for the intervention group. The post-test score after exposure to HFPS for the intervention group was 267.80 (SD = 21.22). The pre-test score for the control group was 283.64 (SD = 18.91). The post-test score for the control group with no exposure to the HFPS was 274.73 (SD = 26.62).

Except for participant confidence, where awareness of weakness can result in a lower post-test score after an effective training program, it is unusual to see dropped scores at post-test scores for the CCTDI. This finding was at odds with other studies conducted that revealed more positive outcomes for critical thinking post simulation education (Schumacher, 2004; Howard, 2007; Ravert, 2008; Hwang, et al., 2010; Wangensteen, et al., 2010; Fero, 2010; Chiang & Chan, 2013; Weatherspoon et al., 2015). However, in a study conducted by Wood & Toronto (2012) in the US, the use of the CCTDI instrument indicated no significant difference between the post-test scores of the experiment and control groups in that study. Another study in Hong Kong conducted by Shinnick & Woo (2013) also revealed no statistically significant gains on CT in the pre-post study.

Researchers from Asian countries (Ip et al., 2000; Yeh 2002; Tiwari et al., 2003; Pang et al., 2004 cited in Hwang et al., 2010) reported lower scores from nursing students in Taiwan and Hong Kong compared to nursing students from English-speaking countries. This was similar to findings by Hwang et al. (2010), those in Japan (Kawashima & Petrini, 2004) and Korea (Shin et al., 2006) for their nursing students. One possible reason for the differences in the findings between these eastern and western countries on CCTDI scores could be attributed to the mode of thinking, social customs and beliefs (Pang et al., 2004 and Hwang et al., 2010). In addition, this disparity most likely lies in the educational system in Malaysia, where the education system and the culture factors result in generally passive learners. This is supported by the differences pointed out between the methods of education in other countries as reported by Ip et al. (2000) cited in Dunn et al. (2002).

In this study, the pre- and post-test critical thinking skills were assessed within 24 hours post exposure to HFPS education. Critical thinking skills require personal awareness, willingness to accept challenges, personal traits and can be conceptualised as moving through five stages to develop greater critical thinking ability. These five stages comprise of stage 1: the unreflective thinker, stage 2: the challenged thinker, stage 3: the beginning thinker, stage 4: the practicing thinker, stage 5: the advanced thinker and stage 6: the accomplished thinker (Elder & Paul, 2010). Therefore, a significant reduction in critical thinking skills for this study suggests the need for further research and a longer follow-up period before post-test assessment. According to Ip et al., 2000 cited in Dunn, Harrelson, Martin & Wyatt, 2002), there was an increase in CCTDI scores from sophomore to junior years of baccalaureate nursing program, but significant decreases were seen from junior to senior year. However, Facione (1990) and Facione et al. (1998) suggested that increases in subscale scores and total score are possible but that overall disposition toward critical thinking appears to be stable over a period of years. Critical thinking is best developed through repeated exposure to practice where learners' thinking processes are supported by integrated contextual knowledge, skills and behaviours (Helsdingenet et al., 2011 cited in Park et al., 2012).

The correlation coefficient, r for control group and intervention group indicated a similar trend of positive correlation in post-pre score. The correlation results were between $r = 0.350$ to $r = 0.568$. There were changes observed pre-and post-exposure of the HFPS for both groups with a statistically significant p-value < 0.05, with all overall and subscale scores at a p-value < 0.001. This study showed a positive moderate correlation on total critical thinking score for both control and intervention groups on critical thinking. This result was similar to past studies by Schumacher (2004); Howard (2007); Ravert (2008); Hwang, et al. (2010); Wangensteen, et al. (2010) and Fero (2010).

However, the finding of this study did not show strong correlation between both groups on pre and post-test of simulation education with HFPS. This could be because of the background of the students on the experience of learning using the HFPS and the method of learning in the education system. According to Trishman and Andrade (2012), models of good thinkers include thinking skills and which can be taught by helping students to identify reasoning behaviour in everyday situations, provision of opportunities for peer interactions around reasoning and also with formal and informal feedback around thinking dispositions by teachers. Students should learn how to express their strengths and weaknesses of their reasoning behaviour as feedback could inculcate a culture of teaching by expressing values.

Objective no. iii of the research study was to evaluate the critical thinking level of nursing students using an adult code blue drill simulated programme before and after using the HFPS compared to low fidelity patient manikins.

The post hoc test (Bonferroni) indicated a difference (significant improvement) between the pre and post-test in critical thinking skill scores for both intervention and control groups ($p < 0.05$). The eta square showed a greater improvement in the intervention group ($\eta 2 = 0.119$) compared to the control group ($\eta 2 = 0.066$) controlled by age, gender and education. Therefore, the HFPS was effective in improving the level of critical thinking for the intervention group compared to the control group.

The strength of this study was that truth-seeking scores showed an increase for both control and intervention group. The studies by Colucciello (1997); Leppa (1997); Ip et al. (2000) cited in Dunn, Harrelson, Martin & Wyatt (2002) indicated that truth-seeking (TS) is often the most difficult to improve in CCTDI. Despite the reduction in the mean score of overall disposition and subscale scores, the study further reported an improvement in the truth seeking subscale of CCTDI. This study was similar to findings from Weatherspoon et al. (2015). Truth-seeking is the student's desire to achieve the best knowledge even if such knowledge fails to support or undermines his or her own beliefs, preconceptions, or self-interests. The possible reason as to why the truth-seeking scores were higher than other CCTDI subscales in this study may be due to the nature of the learning environment in most nursing schools, which is very much theory-based (at least 50% of the nursing curriculum) in accordance with the Nursing Board Malaysia guideline. Another possible explanation could boil down to the inherent culture and personality of the students whom are mostly passive learners who use route learning, and the lack of exposure to active participants and more complex scenarios requiring higher order reasoning. Based on the researcher's experience, many nursing students would rather seek answers to questions they have by themselves or consult their peers, rather than ask their teachers and risk an open discussion in the classroom for the answers or solutions.

After the theory intensive phase in their training, students are routinely placed on clinical postings, where the knowledge learned in classrooms may not be directly related to practice and the complexity and acuity of patient conditions is seldom assessed. Therefore, simulation education is a platform that helps prepare students to anticipate and care for the most common patient conditions before their clinical postings.

In regard to this, educators need to facilitate this attribute with role modelling and must also be willing to seek the truth. Truth-seeking demands self-examination on the part of the educator to open discussions when challenged by information that is inconsistent with personal values or previous knowledge. This situation is applicable to nursing profession that practices are possibly challenged by recent research findings, and these existing practices require change.

5.6 Level of Satisfaction and Self-Confidence

The 20 items of Simulation Design Scale (SDS) and 16 items of Educational Practices in Simulation Scale (EPSS) were answered in Likert scale responses (1-5). This research tool was designed to measure the level of satisfaction and self-confidence with HFPS exposure in a pre and post-test survey questionnaire. A total of 389 nursing students participated in this survey.

The mean pre-test score on overall satisfaction and self-confidence levels in managing deteriorating conditions across time on the program was 3.09 (SD = 0.83) for the intervention group. The mean post-test score after exposure to HFPS for the intervention group was 4.38 (SD = 0.50). The mean pre-test score on the overall satisfaction and self-confidence on program in managing deteriorating conditions for the control group was 3.18 (SD = 0.93). The mean post-test score for the control group with no exposure to HFPS was 4.40 (SD = 0.42). Overall, the total mean score for satisfaction and self-confidence for the intervention groups was higher compared to the control group. Similar results were found by Jeffries and Rizzolo (2006); Mills et al. (2013) and Tosterud, Hedelin & Hall-Lord (2013).

The minimum mean scores for both intervention and control groups did not demonstrate a significant difference. The maximum mean scores between pre and post exposure phase indicated the same average score for all items in control group, which remained at 5 (pre and post exposure) whereas there was an increment for all items in the intervention group (increase in mean from 3 to 5). This result for intervention group demonstrates an important study finding. The intervention group had a lower average score at the pre-exposure phase compared to the control group. This indicated that students were uncertain with regard to the use of HFPS in their learning when beginning a new learning strategy that was introduced to them. Rating at pre-exposure phase was low on average, however, at post exposure phase, it was rated an average of 5. These results reflected a remarkable change in the mind-set of nursing students in the intervention groups using the new teaching method, particularly as they had never handled a code blue situation with the use of HFPS. At the end of the simulation programme, the nursing students were aware of the benefit of this simulation education teaching method. All students (intervention and control groups) were familiar with the traditional teaching method using the LFPM in their practical and were happy with

LFPM as it was the only option they had, and had been using since the first day of their practical session in their respective nursing programs. Awareness in the acceptance of this teaching and learning method was evident in this study. Nevertheless, when the HFPS was introduced and programmed with a code blue situation to the intervention groups, student nurses favoured the new simulation education.

Objective no (iv) was evaluate the satisfaction and self-confidence levels of nursing students using an adult code blue drill simulation programme before and after using HFPS compared to low fidelity patient manikins.

The post hoc test (Bonferroni) revealed a difference between pre and post in satisfaction level and self-confidence on program scores for both intervention ($p < 0.001$) and control groups ($p < 0.001$). There was a significant improvement ($p < 0.05$) considering the eta square was more in intervention ($\eta 2 = 0.636$) than control group ($\eta 2 = 0.576$) controlled by age and education. Findings for both the satisfaction and self-confidence levels were reflected with the use of HFPS linked to higher levels of satisfaction and self-confidence in the intervention groups compared to the control groups that used the LFPM. This study is consistent with other studies conducted that used the same questionnaires created by Jeffries in other countries (Jeffries & Rizzolo, 2006; Maas & Flood, 2010; Mills. et al., 2013 and Tosterud, Hedelin & Hall-Lord, 2013; Baptista et al., 2016; Williams et al., 2016) and other studies using simulation education to evaluate the level of satisfaction in nursing (Alinier et al., 2006; Prescott & Garside, 2009; McCaughey & Traynor, 2010; Najar, Lyman & Miehl, 2015; Rushton, 2015 and Baptista, et al., 2016).

This study offers insight for educators and nursing schools or universities on the use of simulation education with HFPS in managing code blue situations, as it appeared to be the first choice among student nurses for their learning. At the pre-test level for both control and intervention groups, students rated their current education at 3.00-3.09 as they were uncertain of the new simulation education compared to traditional teaching methods that they have been exposed since the beginning at their respective schools. Post-test scores indicated a remarkable increased among the intervention groups compared to the control groups. It is recommended that Schools of Nursing involved in this study implement and support the use of HFPS.

It is noteworthy that use of HFPS in simulation education enables the learner to engage in experiential learning. The technical skills and the use of high fidelity manikins can demonstrate value in nursing. For example, when the student speaks to the patient in a calming manner or uses therapeutic touch, the blood pressure and heart rate can be displayed on the monitor. Student can learn to respond promptly to complaints and clinical features exhibited by the patient such as pain, coughing, confusion and lack of responsiveness. Appropriate responses were expected at each stage in managing deteriorating patient conditions. For example, a certain set of actions were required if the patient was not responsive and should the monitor indicate asystole, the student's next action would be to contact the appropriate person. In cases where the student may hesitate in making a decision, the use of such a simulation education platform will help train the nurse to communicate with the team through practical assistance to manage the critical patient condition and prompt action that could save the patient's life. Each student played a role and concurrently collaborated with other team members to achieve the same common goal, which maximises the patient's outcomes and can help potentially save a life.

Chunta & Taylor (2013) and Baptista et al. (2016) posited that students communicating and engaging in collaboration with one another encourages each task to be prioritised, while delegating roles enhanced leadership in teams through the simulation learning experience. Good team communication and collaboration in nursing is key to motivating students in learning and subsequently achieving the level of satisfaction and self-confidence required of them in their future practice as licensed staff nurses. The nursing students felt that HFPS improved their communication skills in practice (Stirling, Smith & Hogg, 2012 and Aebersold et al., 2012 cited in Aebersold & Tschannen 2013). The most exciting experience was that the HFPS had feature of realism that were not expected. The debriefing and feedback from the simulation learning that was facilitated by the paired assessors was able to help students make sense of the clinical scenario and their actions. Key concepts were identified with the realism that mimicked actual clinical scenarios helping build confidence by integrating theory into practice in a safe learning environment. Discussions held during the debriefing session also helped bring the theory learned closer to practice (Jeffries & Rizzolo, 2006; Robert & Greene, 2010; Brannan et al., 2008 cited in Lapkin et., al 2010 and Baptista, et al., 2016). Students reported that use of the HFPS enhanced their levels of satisfaction and self-confidence.

The overall results for knowledge, skill performance, critical thinking skills and satisfaction and self-confidence were statistically significant (p-value < 0.005), with higher eta square results in the intervention groups as well as observed power. The null hypothesis was rejected and in favour of the alternate hypothesis. Therefore, knowledge, skill performance, critical thinking skills, satisfaction and self-confidence were found improved following an exposure to HFPS in intervention groups compared to control groups that were not exposed to HFPS.

5.7 Association between total mean scores level of knowledge, skill performance, critical thinking skills and satisfaction and self-confidence

Association between knowledge and skill performance

On the whole, there was a non-significant correlation between the two variables on the level of knowledge and skill performance for the intervention group at pre- and post-exposure phase. Increases in the level of knowledge were not correlated with increases in the level of skill performance at both pre- and post-exposure phase to the HFPS. Richardson & Clamen (2014) reported in a systematic review paper that the findings revealed by Hauber, Cormier & Whyte (2010) on psychomotor testing and knowledge-related measures ($r = 0.542$, $p < 0.05$ & $r = -0.540$, $p < 0.05$) after high fidelity simulation showed an increased positive correlation between these variables. The result showed no association between knowledge and skill performance of the students. The likelihood could be that students had not attained sufficient maturity in relating theory to practice in the evaluation process for code blue management. Students had learned from theoretical instruction on how to manage deteriorating patients in this programme and also from their teachers collectively through integrated nursing subjects taught during their undergraduate course since the first year of enrolment to the current semester.

It is interesting to explore in-depth to uncover reasons why learned knowledge may not always successfully translate to clinical acumen. In this regard, student may simply lack the opportunity to practice the situation tested in this study. Students are not always given the opportunity to play a part in managing deteriorating patients in wards. In most cases, they may be told to observe staff nurses and doctors performing appropriate actions to care for patients in deteriorating situations. Students may only be instructed to stand behind to observe when a resuscitation situation occurs, as ward staff may worry that students may cause a delay in the provision of care that could endanger patient safety and result in poorer patient outcomes. The aims of the researcher in selecting this code blue management was to increase student exposure to an important practical scenario where these students would need to think and carefully consider their actions in a situation they would very likely encounter in future, by having to respond to and be to provide care for a patient or rather manikin who is deteriorating rapidly.

Association between level of knowledge and critical thinking skills

There was a non-significant correlation between the two variables on level of knowledge and critical skills for intervention group at pre-and post exposure phase. A study conducted by Schubert (2012) in a reported systematic reviewe by Aebersold & Tschannen (2013) assessing nurses' performance in failure to rescue events using knowledge assessment test showed a significant increase in knowledge mean score and critical thinking (pre and immediate post-test). However, at two-weeks post-test in this study, improvement was not found to be sustainable.

Association between level of skill performance and critical thinking skills

With regard to the level of skill performance and critical thinking skills, there was a non-significant correlation between the two variables for the intervention group at pre- and post-exposure phase. A study conducted by Fero et al. (2010) reported that critical thinking scores were significantly correlated with simulation performance scores ($r = 0.413$, $p = 0.047$). Fero et al. (2010) found an association between the level of skill performance and critical thinking skills. Critical thinking scores however have been found to be significantly correlated with simulation performance scores (Richardson & Clamen,2014), although it must be stated that the sample size was small ($n = 36$) and was a convenience sample. The findings from this study were contrary to the study conducted by Fero et al. (2010) and the reason for this result could be that critical thinking skills for students are limited and lack maturity as reflected in their skill performance in the management of code blue situations. It should be noted that the students in this study were managing code blue situations for the first time. Further study is recommended to determine whether there is an improvement on critical thinking scores following consistent exposure to HFPS use among student nurses.

Association between level of knowledge and satisfaction and self-confidence

Overall, there was a weak negative correlation between level of knowledge and satisfaction and self-confidence $r = -0.386$, $p < 0.001$. At the pre-test phase, students who scored higher on knowledge had lower satisfaction in response to traditional teaching methods received. The result showed that students who possessed higher levels of knowledge reported lower levels of satisfaction and self-confidence at pre exposure to HFPS. Conversely, the post-test phase revealed a non-significant difference between the level of knowledge and satisfaction and self-confidence. This means that neither knowledge and satisfaction and self-confidence showed an association. The reason for this may be due to the adjustment shift during the transition period from traditional learning method to the new learning strategy method introduced to students in this study. Students may require an adjustment period to acquire familiarisation toward the new learning method using simulation education for code blue management. Furthermore, sufficient time is necessary to build satisfaction and self-confidence and for students to make their own adjustment in their learning process. The adjustment is based on the duration and quality of exposure in managing the complex code blue management as a team. This finding demonstrated that the level of satisfaction and self-confidence was a drawback when nursing students were undertaking complex clinical scenarios that challenged their knowledge levels in terms of managing code blue situations. Rhodes and Curran (2005) cited in the systematic review conducted by Fisher & King (2013) demonstrated similar findings in their study on lower levels of confidence were seen as detrimental when nursing students were undertaking complex skills.

Association between level of skill performance and satisfaction and self-confidence

Overall, there was a non-significant correlation between the level of skill performance and satisfaction and self-confidence for the intervention group at pre- and post-exposure phase. Increases in the level of skill performance was not correlated with an increase in the level of satisfaction and self-confidence of student nurse participants, post exposure to the HFPS.

Mould, White & Gallagher (2011) cited in Richardson & Clamen (2014) found a positive correlation between competence and confidence ($r = 0.68$, $p < 0.05$), which improved after simulation experience ($r = 0.78$, $p < 0.05$). In contrast, another systematic review by Fisher & King (2013) reported no significance in the study conducted by Alinier et al. (2006) for confidence and performance levels for the experimental group in Objective Structured Clinical Examinations (OSCE). Baillie and Curzio (2009) also found no significant difference on confidence in skills and subjective reports of preparedness for practical examinations.

Association between level of critical thinking skills and satisfaction and self-confidence

Overall, there was a non-significant correlation between the level of critical thinking skills and satisfaction and self-confidence for the intervention group at pre-and post-exposure phase. Increases in the level of critical thinking skills was not correlated with increases in the level of satisfaction and self-confidence at pre-and post-exposure phase to HFPS. To the researcher’s best knowledge, there are limited studies specifically examining the association between levels of critical thinking skills and satisfaction and self-confidence. It is argued that there are two possible explanations for this outcome: critical thinkers may be expected to be better satisfied and self confident in themselves if they could perform a clinical simulation well. Conversely, if these critical thinkers could not perform a clinical simulation well nor fulfil desired learning outcomes, their levels of satisfaction and self-confidence could be negatively affected. Additional investigations are needed to assess the association between level of critical thinking skills and satisfaction and self-confidence in clinical simulation education among this population.

5.8 Summary

This study assessed the impact of simulation education with the use of HFPS in the management of a deteriorating patient in a code blue situation. The framework of this study was adopted for the modified Jeffries & Rizzolo (2006) Simulation Model. The evaluation of effectiveness for the HFPS were on these four learning outcomes: the level of knowledge, level of skill performance, level of critical thinking, level of satisfaction and self-confidence.

There were statistically significant improvements for knowledge levels, skill performance levels and the level of satisfaction and self-confidence at post-exposure stage to HFPS in a code blue scenario for intervention groups. Nonetheless, critical thinking skills reduced significantly as seen in decreased mean scores for overall disposition and subscale scores, post HFPS exposure. Despite a reduction in the mean score for overall disposition and subscale scores, this study reported an improvement in scores for the truth seeking subscale of the CCTDI. According to previous research studies, it is uncommon to achieve higher score in post-test for truth seeking. Further comparison between intervention and control group indicated a higher eta square for the intervention group, indicating promise for the effectiveness of HFPS as a teaching strategy.

The present findings in terms of demographic characteristics demonstrated that age and experience in HFPS significantly influenced the four learning outcomes. Nonetheless gender, highest education level, CGPA and role in simulation were not found to be significant as independent predictors. This finding implied that the age and experience in HFPS likely play a role in preparedness and readiness to achieve higher scores for the learning outcomes.

Results examining the association between the learning outcomes of this study showed there was a strong positive correlation between student nurse participants' level of satisfaction and self-confidence. Conversely, there was no significant correlation between the level of knowledge, level of skill performance, level of critical thinking, level of satisfaction and self-confidence.

CHAPTER 6: CONCLUSION

6.1 Introduction

The use of HFPS as an effective educational strategy to instruct nursing students in code blue management was examined using a quasi-experimental design method with two-arms using a pre-test, post-test design. This study presented the evaluation of effectiveness in four learning outcomes using HFPS: the level of knowledge, level of skill performance, level of critical thinking, and lastly, the level of satisfaction and self-confidence based on the conceptual framework created by Jeffries & Rizzolo (2006). The participants were from three nursing schools and the participating nursing students randomised into control and treatment arms. The sample consisted entirely of final year-3 diploma student nurses from three participating nursing schools. Universal sampling was used in this study. At the pre-test phase, both control and intervention groups used traditional teaching methods with the LFPM. A code blue management scenario was chosen with the new teaching strategy to be introduced at the post-test phase level using HFPS as the simulation education. Once assigned into either control or intervention group, each student was then given a role where the individual was assigned a task to play in the code blue management scenario such as nurse 1, nurse 2, nurse 3, a doctor or relative which formed a group.

Pre-test for the 30 items knowledge of single best questions was given both control and intervention groups. Subsequently, a lecture was given on the code blue management to both control and intervention groups, with a briefing on simulation education and tasks during the simulation education by the researcher prior to the practical sessions in the assigned groups. Students and paired assessors were both double blinded as they did not know at pre-test phase to whom they would be assigned to either assess or be assessed by. The researcher notified students of assignation to either control or intervention groups at the beginning of the post-test phase for the code blue management practical session.

The effectiveness of the four learning outcomes for knowledge increased and the implementation of HFPS simulated education proved effective for the intervention group after two months of training. Based on the eta square results, the improvement for intervention ($\eta 2 = 0.146$) compared to the control ($\eta 2 = 0.130$), demonstrated a weak evidence of increment in level of knowledge. Participant skill performance was found to be significantly different between the intervention and control groups ($p = 0.003$). Skill performance on learning outcomes showed both intervention and control groups improved in the post-test, with the eta square showing a greater improvement for the intervention group ($\eta 2 = 0.744$) compared to the control group ($\eta 2 = 0.612$).

The critical thinking learning outcome for the subscale attributes decreased after post-test for the control and intervention groups, but truth-seeking scores showed an increase. Both groups scored between 210-280 scores (Ambivalently disposed, average) and showed decreased scores at post-test with the control group demonstrating a higher mean score compared to the intervention group. The learning outcome on satisfaction and self-confidence levels was significant for both the control and intervention groups. The satisfaction and self-confidence levels showed an improvement for both groups but favoured the intervention ($\eta 2 = 0.636$) compared to the control group ($\eta 2 = 0.576$). The learning outcomes showed that the HFPS served as an effective tool for teaching and learning for the management of code blue situations, except that the critical thinking skills anticipated appositionally on the overall scores. These results provide useful information into the impact of exposure to HFPS for student nurses learning to manage code blue situations for the first time, as compared to current traditional teaching methods. The results for critical thinking skills were found to be of benefit to those using the HFPS, taking into account other possible variables that could have influenced these results including these students' backgrounds and their past experience with the current education system.

This study also explored and analysed the influence of demographic characteristics of participants in the evaluation of the four learning outcomes. This included age, gender, education level, result of current CGPA, prior HFPS experience and the participatory role played by students during the intervention sessions. The demographic characteristics of participants in the evaluation of the four learning outcomes were found to be statistically significant in terms of age and prior experience using the HFPS. The association between the four learning outcomes on the effectiveness of HFPS in the code blue management were assessed. All of the learning outcomes were found to have no association.

6.2 Implication in Nursing Practice

6.2.1 Clinical practice

This study raises awareness of the value of changing current nursing educational practice to include HFPS. Use of the HFPS could serve to enhance learning outcomes and make learning more interesting for nursing students. This educational strategy can be tailored to different styles of learning among students and educational backgrounds. In addition it can help integrate various subject to help ensure and develop nursing student that are well-prepared students to enter their profession as qualified and safe clinical practitioners with an emphasis on lifelong learning.

As the student nurses in this study were all from year 3, it is expected that this cohort will soon graduate as novice nurses. These students are expected to be well prepared in the required clinical areas to practice in complex health care settings. Besides the routine nursing responsibilities, the future must be able to manage high acuity patients, multiple admissions and discharges, frequent unscheduled procedures and deteriorating patient condition such as in the event of a cardiac arrest.

Nurses often report feeling relatively incompetent in performing basic life support and advanced resuscitation skills. When the rare code blue occurs, bedside nurses are at best anxious and in the worst cases unable to manage such a scenario (O'Donnell, 1990; Keys et al., 2009 cited in Huseman, 2012). The skills learned in basic code blue management classes are likely to be forgotten without frequent practice and reinforcement. Therefore, the use of simulation for repeated practice is one means to improve performance (Abe et al., 2013; Oermann, 2014). Retention of skills is the result of performance persistance over time, and it requires practice to improve performance competency (Ericsson et al., 1993; Ericsson 2008; McGaghie et al., 2010 cited in Alinier & Platt, 2013; Abe et al., 2013; Oermann, Kardong-Edgren, Odom-Maryon & Roberts, 2014). It has also been found that repeating simulation scenarios improves not only the nurses' technical skills but also their non-technical skills (Alinier & Platt, 2013; Abe et al., 2013). The clinical skills in simulation education are flexible to replay, modify, or reprogram to single or combination domains of cognitive, psychomotor and affective from beginner to advanced levels according the learning needs of nursing students before actual clinical placements.

6.2.2 Education

Simulation education does not provide merely opportunities to practice skills without causing harm to patients but also offers a safe learning environment for all levels of learners. The highlight on cognitive, psychomotor and affective domains in the learning process enables the right objectives to be achieved and evaluated. In addition, it enables nursing students to be trained in a safe and supportive learning environment in managing complex clinical situations such as code blue situations. Simulation education provides motivation for learners without pressurise to learn beyond their own boundaries. Passive students and slow learners do need high motivation from educators to protect their well-being, as a sense of self-worth has been identified to be positively correlated to the well-being of students (Seifert, 2003 cited in Tosterud et al., 2013). This simultaneously safeguards the obligation of patient safety and professional ramifications. The issue of poor competency and low soft skills among newly graduate nurses in Malaysia leading to unemployment of these newly graduated nurses has been a subject of intense debate (Star Newspaper, 2012). One solution to this may be the use of HFPS, with such simulation education integrated from the beginning by nursing institutions to solve this problem in addition to evaluating the various other obstacles that contribute to this issue.

The researcher suggests the implementation of simulation education starting from year 1 in nursing undergraduate programmes. This is in accordance with the level of learning from each subject/ module prior to the student nurses' clinical posting on this discipline. For example, in year 1 nursing students could be provided with a scenario focused on health assessment with a client upon admission to the ward, communication skills for interviewing the client and family, administration of medication and identification of medication errors, managing elderly nursing patients at high risk of falls. Year 2 scenarios could focus on medical-surgical nursing such as wound care management and nursing post-operative patient with anesthesia and pain management. Year 3 scenarios could prioritise post-partum and newborn nursing, medical emergency care, near-misses and error reporting.

Provision of exposure on simulation education from nursing students should start gradually from the early years of the programme to inculcate a culture of reasoning and understanding of the learner's self-strengths and weaknesses, consequently seeking to remedy actions to improve the teaching and learning tailored to each student's needs. In order to motivate students to excel in academically and maintain engagement in simulation education with full accountability, assessment on the simulation education is essential to set each simulation education scenario to mimic the realism of any given clinical situation. Students will thus acquire confidence and clinical preparedness. Nevertheless, nursing faculty and academic staff need to continuously re-evaluate the learning outcomes of teaching and learning for each scenario on different cohort groups of students. It is also equally pivotal to obtain feedback from students involved in simulation education for development of further learning improvement.

6.2.3 Institution Management

The cost to implement and maintain simulation laboratories in nursing institutions represent a great challenge. The cost of simulation education requires significant investment in preparation of simulated environments that include a spacious physical layout for HFPS placement and accessories, in addition to the need for a control room, debriefing room, and internet-computerised-telecommunication facility for simulation education, high-cost technical software for simulation education cases of programming, cameras, recording devices, sophisticated gadgets to support visual and sound and most importantly trained faculty staffing to conduct simulation education. While simulation education is a teaching technique, it remains highly dependent on technology to run the simulation process. Where software applications are involved, there is always a need to continuously adapt and update software versions and renew its license, and these are factors that should be carefully considered when negotiating the terms and conditions with the distributing company. Moreover, institutions that are equipped with simulation facilities need to do advance planning for faculty development in terms of staffing to properly optimise the time and resources allocated.

The management team of nursing institutions should recognise the strengths and shortcomings of its own faculty staffing and available resources to maximize the benefits of simulation education for students, which can be of practical benefit not just for nursing students but also for the training of other health care professionals. This is highlighted as most institutions utilise a shared facility approach and combine existing resources with other non-nursing programmes. Mutual understanding and cooperation from all levels is relatively important to deliver more cost-effective simulation education and create a satisfactory working environment among the academic staff members. With appropriate planning and support from management, simulation education promises to deliver more positive outcomes and prove more cost effective when compared to traditional instructional methods. Planning and support can maximise available resources and reduce the cost of simulation education implementation and maintenance but allow the provision of benefit across all programmes (nursing or health sciences such as medicine, physiotherapy, radiology) in a given institution of learning. Recognition, reinforcement and motivation offered to academic staff members with the adoption of simulation education in teaching from management team of the institutions are likely to also be key factors for success in this context.

6.2.4 Training, research and development

Qualified faculty staffing has been identified as one of the barriers for the implementation of simulation education. Some educators feel that it is not feasible to run effective simulation with large student numbers given the time commitment required in the facilitation process. Some educators remain accustomed to the traditional way of teaching and are unwilling to learn new and different teaching approaches. Institutions ought to provide guidance and training to academic staff on how to teach clinical scenarios using simulation that align with the theory taught in classrooms at different levels for nursing students. Institutions have an obligation to provide training to academic staff members by encouraging attendance at workshops and seminars pertaining to simulation education.

A written guideline for simulation education is recommended for reference and a team or committee comprising simulation education experts is necessary in institutions applying HFPS. Simulation education committees need to plan and conduct oversight of the process of simulation education. The pedagogy on the use of HFPS is a teaching strategy rather than technology. The technological aspects can be managed with assistance from technical support staff. Ideally technical support personnel need to be present at initial simulation teaching sessions when implementing simulation education. Subsequently, when simulation is in place, the assigned staff will need to learn to troubleshoot simulation operations while the distributors' technical support staff need to remain contactable for further assistance without being present in the actual sessions. Innovation for academic staff to design and development individual and team approach efforts using the HFPS needs to be encouraged and supported by the management, including through recognition for excellent teaching. Hence, the success of the new teaching strategy will continue to excel for the benefit of all learners.

Simulation education can provide opportunities in research and continuing education among academic staff. Past research studies show that academic staff learned the best traits and pitfalls of simulation education by sharing these experiences academically. There are associations or societies which focus on specific specialties such as paediatrics or nursing in simulation education and research where association meetings and conferences are often good platforms to exchange key information and experience. Academic staff members that are interested could join these associations or societies for memberships. Information pertaining to simulation education and updates on education simulation are frequently disseminated through such online newsletters and web-based learning platforms. Frequently asked questions and questions from senders are also typically responded to promptly if the academic staff and clinician wish to explore further.

The research studies shared by the interest groups also are also often presented in seminars, conferences and meetings such as from the Society of Simulation in Healthcare which is US based, and the Association for Simulation Practice in Healthcare which is UK-based. These associations or societies for simulation will send updates through notifications through their website to members on upcoming seminars, conferences or meeting. The reports following these activities will be also uploaded for members unable to attend the activities, allowing them to obtain the key information of the activities held. This is a new specialty in simulation-based education that benefits academic staff who are interested in simulation education.

6.2.5 Recognition and professionalism

Nurses are accountable for the care needs of patients who require resuscitation. Thus it is important for qualified nursing personnel to acquire competency skills in the management of code blue situations with a different task played each time. Mastery of each role (nurse 1, nurse 2, nurse 3 or even as the assisting junior doctor) helps extend the role of nurses outside of the job description in cases of emergency. Greater understanding of the latest techniques in continuing education is the key to recognition of a profession with its own body of knowledge. It is vital to facilitate the learning experience of nursing students to the best it can be by taking into account limitations and shortcomings, with a view to addressing their problem-solving abilities in simulation training.

Patient safety and quality of care remain important issues where it comes to the evaluation of skills among nurses, which is why this needs to be consistently measured for the credentialing process and to maintain professionalism in nursing. According to Terry Ken (December, 2015) from Medscape, '758 hospitals in US are losing 1% of their Medicare reimbursement in fiscal year (FY) 2016 because they are in the worst performing quartile in the hospital-acquired condition (HAC) reduction program, source from the Centers for Medicare and Medicaid Services (CMS)'. There were a total of 3308 hospitals subject to the HAC program from 2015-2016. HAC remains a main issue in patient safety and nurses play an important part in caring for patients during hospitalisation, particularly with regard to reducing risk of infection, morbidity and mortality in their patients. Caring is fundamental to the practice of nursing; it is a professional value for nursing that requires competency in delivering good quality, well understood knowledge with humanistic implications. Nursing students in simulation education could experience inter-professional collaboration with other professions such as doctors that encourage the development of effective inter-professional collaboration practice in real clinical areas. Therefore, simulation education is a teaching strategy that facilitates students’ being able to develop sustainable competency in dynamic clinical nursing areas.

6.3 Strengths

6.3.1 The scope of this study

This study covered five domains of learning outcomes (the level of knowledge, level of skill performance, level of critical thinking, level of satisfaction and self-confidence) of simulation utilising the framework from Jeffries and Rizzoli (2006). These five learning outcomes are essential and holistic in evaluating simulation education on a clinical code blue situation. The knowledge component, clinical skills interpretation and soft skills in communication and critical thinking were imparted and assessed in this study. Nursing students that had learned their basic theory based on classroom learning were given the opportunity to transfer their knowledge into applied clinical skills. The complexity of the code blue situation in simulation education provided a platform to integrate knowledge and the experiences from year 1 to year 3 into a single clinical scenario. Besides the focus on research, this exposure to simulation education also function as an eye opener to students on the new leaning strategy. Students were able to capture the fundamental key points, revise and review their learning requirements before their licensure examination to help them prepare to join the nursing work force upon graduation. It is vital to evaluate the learner's expectation and satisfaction levels following the teaching, which is why level of satisfaction and self-confidence were additionally explored in this study.

6.3.2 Pioneering in the local context

This study is the first study in Malaysia to assess the five specific learning outcomes detailed prior to this chapter. Furthermore, to the researcher’s knowledge, there has been limited research conducted locally that included all five learning outcomes, particularly where it came to examining this in the context of a code blue management situation. Previous research studies were conducted using an average of two to three learning outcomes with small scale studies on nursing, with exception to the study conducted by Jeffries (2006) which was a national level study conducted across northern America. This same conclusion was obtained based on reports of systematic reviews compiled by notable researchers in this area (Mantzoukas & Watkinson, 2006; Lapkin el al., 2010; Nestel et al., 2011; Murdoch, Bottorff & McCullough, 2013; Fisher & King, 2013; Cant, McKenna & Cooper, 2013; Richardson & Claman, 2014; Aebersold & Tschannen, 2014; Shearer, 2013; Boellaard, Brandt, Johnson & Zom, 2014 and Adamson, 2015).

6.3.3 Credibility of the study

This study was conducted in Malaysia and involved participants from both private and public nursing institutions at the college to university level. A single public nursing college; a public university and a private university voluntarily participated in this study. This provided ample information and merit to this study. In general, these institutions recruit nursing students from different background across the country and can be considered representative of nursing students in Malaysia. Furthermore, nursing institutions from both public and private sectors participating in this study were excluded on the basis of non-comparable levels of academic ranking (college vs. university), which adds to the strength of this study. The nursing institutions participating in this study were assured by the researcher that findings would not reveal nor compare school performance, and that no school would be identified by or mentioned in neither the presentation nor publications. While there is ongoing debate on the evaluation and ranking of public and private nursing institutions in terms of its academic performance in this country, the different styles of these institutions in managing the nursing program holds both pros and cons. It should be noted however that the nursing curriculum is fairly standard and is adherent to a similar syllabus and clinical setting requirement. This is owing to the fact that nursing institutions in Malaysia are closely monitored and governed by the nursing board of Malaysia.

6.3.4 Focus on year-3 diploma nursing students

Even though this study involved only three nursing institutions in the Federal territories and Klang, the results of this study may not be representative of those of other nursing programs elsewhere in Malaysia. Universal sampling was selected in this study to counter this. All year-3 diploma-nursing students were invited to participate in this study from the three nursing institutions. Year 3 diploma nursing students are likely to have learned the most essential knowledge and skills in nursing and prepared to join the nursing workforce as newly graduate nurses. The code blue clinical simulation scenario selected as the topic to enable nursing students in year 3 aimed to generate greater awareness, help nursing students assess their decision, and thereby improve patient safety with prompt initiation of quality cardiopulmonary resuscitation and communication skills in the team.

6.3.5 Fair distribution of simulators in Institutions

Additionally, this study involves two main distributor companies for simulators in Malaysia. These two companies supply high fidelity patient simulators in this country.

The clinical simulation education utilised two simulator brands, which was the SimMan 3G and Meti Man from these two companies. It is urged that to reduce biases, selection should focus on a single company. Both companies had equal opportunities in introducing the best of their simulators that could contribute to the simulation education in nursing. The participation and assistance provided by these two companies were sorely academic, and strictly for research purposes with no monetary involvement.

6.4 Limitations

6.4.1 Restricted geographical area

The data collected was restricted to a single geographical area and may not be generalisable to other nursing students in other parts of the country. Moreover, it does not explore the use of simulation education in other professional healthcare programmes such as medicine and physiotherapy. Both of these programmes do require knowledge and skills for its trainees in the management of patient care. Inclusion of other types of students would have allowed the researcher to draw comparisons on the effectiveness of simulation education among healthcare professionals.

6.4.2 Limited to diploma programme

The study was limited to students undertaking the Year-3 Diploma in Nursing Degree programme, while students from the Master in Nursing were not included in this study. This is essential to explore the use of simulation education among nursing students in Malaysia and draw stronger evidence with regard to its use in nursing methods and development in Malaysia.

6.4.3 Limited nursing institutions participating in this study

This study was conducted in three nursing schools, which were a public, a semi government and a private university/ institution. The invitation to participants in this study from other schools were not granted and supported with the reason given that it was due to scheduling issues. Some school reported that their existing HFPS were not functioning, while another school mentioned that the use of simulation education was not a requirement. Another university reported that they had no year-3 diploma nursing students in the school that fulfilled the study requirements.

6.4.4 Diffusion effects for homogeneity

There was a possible participant bias in answering the pre and post research questions. The intervention and control group participants may have the interacted between groups in such a way that might have affected the results of the study. According to Craven et al. (2015), within-class experimental designs with experimental and control groups in the same class are subject to diffusion effects, whereby both experimental and control students could potentially benefit from the intervention. This in effect could contaminate the control group and bias evaluations of the intervention effects. The diffusion effects occur when interventions involve informational programs and the various intervention and control groups could communicate with each other, participants in one intervention group may learn the information intended for others. Cook & Campbell (cited in Craven et al., 2001) revealed the concern of 'resentful demoralisation'. Resentful demoralisation in control group was another limitation in the same domain of internal validity threats for control group participants giving up or not trying as hard because they were demoralised about not receiving the benefits of the intervention group. A clustering effect, or the lack of independence among student within the same class may have also occurred because student participants are likely to be more similar to each other.

6.4.5 Schools schedule for research activities

The skill performance should have been conducted in a smaller group. Due to the limitations of time, participating schools could accommodate no more than the five main objectives of this study. The schools only permitted a day of study using the students' personal time and the scheduled of the study given by these three schools was either a day before the students' semester break, during the fasting month for Muslim students or on a Saturday where there were no official classes in one particular school. There were differences in sample size for knowledge, skill performance, critical thinking skills and satisfaction and self-confidence in the actual study as not all students completed answering the questions. This led to a reduced completion rate where it came to evaluating the effect of HFPS on the learning outcomes of this study. This issue was further challenged by time constraints and unforeseen circumstances such as when students came late for the research study due to a delay in the arranged transportation from hostel to the rented simulation center, which was located in another institution. One school was unable to accommodate 189 students in their practical room and there was a day where the practical room could not be used as it was being prepared for the OSCE for junior students.

6.4.6 Possibility of teacher bias

There were two paired assessors for each cohort group for their practical session. The researcher gave two hours training to each assessor via online conversation, face-to-face conversation or both. Materials of reference such as the flow of simulation, standard questions for the debriefing session, the role of each participant including expectation of his or her role-play in the scenario were noted. The setting of the simulation on-site was also explained. A chat group was created for assessors for any doubt or questions raised. On the day of research study, another briefing was conducted with the assessors. Assessors marked the total score of observational practical session in this study individually for each student. 'Teacher bias' for assessors could have occurred for student's gender, ethnicity, and ability in communicating and from behaviour such as initiative and enthusiasm in the lesson. Moreover, the assessor’s personality is another factor in teacher's bias. Some assessor may be more lenient while in contrast some assessors could have high expectation of their students. Another reasonable explanation is that teachers could have different facilitating styles on the same simulation method which is supported by Tosterud et al. (2013). Larger samples which explore the association between methods in facilitating style and simulation education is recommended. Discrepancy in mark scores could occur between two assessors in allocating their marks even if based on a standardised checklist and rubric score system. Rubric scores remain one of the most widely used solutions to reduce bias in scoring system. Abe et al. (2013) stated that a rubric is defined as an explicit set of criteria and standards used to assessing a learner's competence, skills, abilities, and assignments. In medical and nursing education, growing interest has recently been placed on using a rubric because rubrics help learners become thoughtful evaluators of their own (self-reflection) and others' work (feedback) and rubrics reduce the educational load of instructors.

6.4.7 Further research study on the level of satisfaction and self-confidence and retention

Further research is needed to obtain an in-depth analysis of the study using qualitative research methods on the level of satisfaction and self-confidence pertaining to simulation education. A longitudinal study is suggested to follow up on student retention of knowledge and practical clinical competency and on how simulation education can help transform and achieve positive patient outcomes.

6.4.8 Fatigue among nursing students

This was a quasi-experimental study that required the completion of a pre- and post-test questionnaire and test questions for nursing students to answer within 24 hours. Only post knowledge questions were tested after 2 months. Besides answering the research questionnaire and test question, a lecture and practical session in a clinical scenario was concurrently arranged to evaluate skill performance in students who actively participated in the role-play. There was a high possibility of fatigue among students participating in this research despite the fact that a break was provided in between sessions. If fatigue did occur, both physically and mentally, concentrations on the tasks assigned could be diluted and this might have influenced the outcomes of the research study.

6.4.9 Marginal increase in effectiveness of simulation education

Overall, findings of this study showed statistical significance for four learning outcomes that was measured by eta square value and displayed improvement in overall mean scores. However, the increase in mean scores between intervention and control groups was small in terms of difference. Further research is suggested to determine the consistency of this effectiveness in simulation education with a larger margin of difference between the intervention and control groups. Although simulation education holds great potential in teaching, learning and evaluating specific competencies related to patient safety, simulation always mimic reality and thus it does not replace real clinical experience.

6.5 Suggestions and recommendations for future research study

The researcher recommends that a longitudinal study is necessary to explore the how clinical skills of nursing students can be improved using simulation education and to determine if the gains acquired from simulation education translate into positive patient outcomes. This study has its limitation in the evaluation of its outcomes. Though simulation education is an effective learning tool for facilitating learning in a safe environment, it is questionable whether the nursing students in this study are able to transfer the knowledge learned in lectures to the bedsides of their patients. It also remains to be seen whether long term retention of the code blue prompt responses can help to ultimately increase the survival rates and save lives of patients with cardiac arrest in clinical practice.

6.6 Summary

Simulation education using HFPS has been demonstrated to show benefits in clinical practice through this innovative and effective teaching approach in nursing education. Simulation education showed improvement in the level of knowledge, skills performance, self-confidence and satisfaction in this study. However, critical thinking level had decreased in both intervention and control groups at post-test. Subscale of truth seeking increased in post-test. The level of knowledge and self-confidence & satisfaction level were both found associated with age and previous experience of simulation education.

Support and expertise are challenges to both institution and educators with already heavy workloads, but not impossible for those whom desire to achieve the best educational outcomes with limited financial constraints and resources. Future studies should compare simulation education against traditional clinical approaches for cost efficacy. Despite the benefits of simulation education in fostering more positive learning outcomes, it should be emphasised that this strategy serves as an adjunct to clinical experience and not a replacement to the acquisition of experience in managing real patients in hospital and clinical settings.

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