EVALUATION OF HIGH-FIDELITY MANIKIN SIMULATION IN EMERGENCY MEDICAL SERVCIES EDUCATION IN SAUDI ARABIA

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Summary of Thesis

At the centre of this study are two evaluation models—Kirkpatrick's evaluation model and the context, input, process, and product (CIPP) evaluation model—to assess the efficacy of implementing high-fidelity manikin simulation in emergency medical services (EMS) education in Saudi Arabia. This thesis has produced important contributions to EMS education in Saudi Arabia, expanding upon previous studies by combining the two evaluation models to examine the programme outcomes, input, and process. The study extends the literature on outcome evaluation or programme evaluation by examining faculty's and students' perceptions of the efficacy of high-fidelity manikin simulation before or during the COVID-19 pandemic. By combining Kirkpatrick's and CIPP evaluation models, we examined faculty's and student's satisfaction, preparedness, and the challenges in implementing high-fidelity manikin simulation as stakeholders and develop evaluation tools that might help EMS institutions in terms of quality assurance within simulation laboratories and improve paramedic students technical and non-technical skills in the Saudi context. The findings of this thesis reveal that faculty and students were satisfied with the simulation design features and the best educational practices of the simulation sessions. However, based on the qualitative data, faculty and students were affected by many challenges that reduced the maximal use of the high-fidelity manikin simulation sessions. The two studies in Chapters 4 and 5 revealed that faculty and students were satisfied with simulation design features and best educational practices before and during the COVID-19 pandemic. Four themes were identified from the studies in this thesis: institutional issues, support needs, assessment and feedback, and challenges in teaching during the COVID-19 pandemic. The results from Study 3 indicated that the three translated instruments examined in the Saudi context—the simulation design scale, the educational practices questionnaire, and the student's satisfaction and self-confidence in learning scale—are reliable and valid for use in EMS institutions.

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Say, “Surely my prayer, my sacrifice, my life, and my death are all for Allah—Lord of all world

CHAPTER 1: Introduction

The utilisation of simulation has served as a crucial pedagogical approach within the educational process of healthcare education (Imbriaco et al. 2021). High-fidelity simulation (HFS) has undergone rapid development in healthcare education and massive international development (Crawford et al. 2019, p. 6). Technological progress has played a pivotal role in enabling the creation of computerised manikins, sometimes referred to as high-fidelity manikin simulators, which are used in healthcare teaching (Bingham et al. 2015). The high-fidelity manikin simulators provide a comprehensive range of realistic features, such as realistic heart, lung, and bowel movements, vocalisations, functional airway structures, palpable pulses for vital signs assessment, and a venous network that enables the simulation of IV therapy (Bingham et al. 2015). These manikin simulators possess the capability to be programmed to emulate clinical manifestations observed in patients experiencing various health issues. Moreover, it offers an interactive educational opportunity for students, as it is capable of responding to clinical interventions, including the simulated administration of medications. Therefore, these developments have increased the demand for well-prepared educators, which might have a significantly positive influence on their students' achievement (Van Vuuren et al. 2018). Emergency medical services (EMS) facilitators are challenged to prepare paramedic students in the absence of educator training, excessive educator workload, technical malfunction, and inadequate manpower to implement high-fidelity manikin simulation (Hollema 2015; Mulli et al. 2022; Mamcarz et al. 2023). Recently, high-fidelity manikin simulation has emerged as a potential solution to prepare paramedic students for improving safety and patient care, improving critical thinking skills, reducing transition time for new graduates, increasing confidence and competence of the participants, reducing and eliminating errors and near misses, improving retention rates, improving efficiency through process improvements, and encouraging interdisciplinary teamwork and applying and integrating theoretical knowledge into clinical practice (Jeffries 2022, p. 23–25). Nestel et al. (2019, p. 248) provided the rationale for effective use of HFS, including planning for facilitation, especially the realism of the simulation experience, identifying the objectives that might lead to a suitable degree of fidelity, and enabling the learners to believe that the simulation they are participating in closely resembles real life. HFS plays a crucial role in the training of EMS students, serving to enhance the current educational approach. The importance of evaluation, identification of challenges, and preparedness is emphasised in order to attain a more optimal HFS implementation (Presado et al. 2018). In the following section, I clarify the thesis context and explain the HFS used in EMS education. I then discuss the thesis aim, and the questions are summarised. Finally, I provide an overview of the thesis chapters in relation to the objectives and context of HFS.

1.1 The PhD Context of Emergency Medical Services (EMS) in Saudi Arabia

EMS colleges in Saudi Arabia were founded in 2007 and have substantially increased in number since then (Alshammari et al. 2017). There are currently 13 EMS colleges that offer a bachelor of paramedic science degree (Al-Wathinani et al. 2023). Furthermore, there has been an increase in the enrolment of EMS students and a great demand for teaching staff (Alshammari et al. 2017). There has also been a significant shift in the educational system from a teacher-centred to a learner-centred model. The EMS education curriculum was changed 10 years ago to reflect this shift, moving as much as possible to use the traditional lectures aligned with the experiential model with the addition of activities such as high-fidelity manikin simulation. A total of 256 high-fidelity manikin simulation activities, such as patient assessment, medical and trauma skills, decision-making, and first aid, are delivered during the academic year for all paramedic students from the first year to the third year. The study guide for EMS simulation activities includes general learning objectives for all simulation educators at the beginning of the academic year; however, no specific standards or approaches for HFS activities are mentioned. Although there is no clear structure or guide for HFS activities, the general agreement is to provide the simulation activities at the beginning of the semester, to identify a topic a few days before the scheduled HFS activities, and to instruct the students to participate and give them feedback at the end of the simulation activities. As a simulation educator in one of the medical education departments in Saudi Arabia, I have observed several reports from the faculty about issues with student engagement with HFS activities, and the faculty is not prepared or lacks the necessary simulation lab equipment.

1.2 The Thesis Rationale

Different challenges in EMS education have led to renewed attempts to find the best ways to develop paramedics' skills. In particular, patients are at risk when used in education in pre-hospital environments (Tippayanate et al. 2020). As a result, EMS education providers have concentrated on innovative and technical EMS care methods that minimise patients' exposure to preventable errors (MacQuarrie et al. 2022). Hunter et al. (2021) noted a lack of clinical experience in paramedic students' education in practice because of the small number of patients. Therefore, students are not able to practice critical skills and are trained without patients. Flott and Linden (2016) added that clinical sites can be too busy, and that students cannot take the opportunity to improve their basic clinical skills related to EMS in such places. Thus, students who need to become clinically successful or competent paramedics might have no practical contact with patients in the real world during their education (Lucas 2014). EMS institutions and organisations have been urged to invest in simulation creation and use while educating their inexperienced practitioners as the easiest and most effective way to minimise medical errors (Sanko 2017).

Van Beek (2019) confirmed that HFS learning improves both technical skills, such as the efficiency of injections, dressing, and flushing nasogastric tubes, and non-technical skills, such as interpersonal communications, decision-making, leadership, and teamwork. Evidence suggests that as a teaching approach, HFS increases self-efficacy and strengthens the effectiveness of paramedic students and professionals in their clinical skills and capabilities. Therefore, attraction was likely to have been an encouraging factor for the participants in the simulation labs. The growth of HFS is based on addressing the issues and concerns of students, such as critical care, and helping bridge deficiencies in knowledge and clinical skills (Volante et al. 2016; Valentin et al. 2015).

EMS colleges in Saudi Arabia recruit newly qualified paramedics each year to serve as EMS simulation educators. EMS simulation educator's duties include teaching, assessing students' work, and giving feedback in laboratories and clinics; however, they enter their jobs with little support. Specifically, recent graduates of EMS colleges generally have scant experience in both working as paramedics and teaching as academics. Meanwhile, although lecturers and professors may be good clinicians and experts in their specialties, most EMS simulation educators enter academies with expertise in a particular clinical area but have little to no experience teaching in simulation labs. A master's degree, and preferably one in the EMS field, is the required educational level to teach EMS at the baccalaureate level. These advanced degrees provide theory and enhance teaching ability (Caputi 2010), but they do not prepare the teaching faculty with the teaching skills required for high-fidelity manikin simulation. This situation leads to difficulties in teaching and learning in a complex technical setting that requires a specific skill set (Ahmed et al. 2016). According to Wilson and Wittmann-Price (2018) (p. 28–30), simulation educators should be proficient and have the skills to effectively teach HFS, such as demonstrating effective debriefing techniques, promoting support environments for the learners, controlling the technical aspects of high-fidelity simulators, developing scenarios, and facilitating the simulation activity.

Evidence suggests that teaching staff members at healthcare colleges in Saudi Arabia in general and EMS colleges in particular start their jobs without any foundational training or courses on HFS (Ahmed et al. 2016). Nielsen and Harder (2013) described teachers feeling uncomfortable and unqualified to use simulation as obstacles to its implementation. Moreover, Jeffries et al. (2015) argued that there seems to be a disconnection between teachers and learners, which frustrates both sides and leads to claims that new teaching techniques simply do not work or are not worth their time. Well-prepared facilitators might have a significantly positive influence on their students' achievement (Wilson and Wittmann-Price, 2018 p. 29). Teachers may embrace new teaching methods and technologies in their desire to develop qualities in learners that prepare them for the EMS field they will enter, but this does not mean that they have had experience with best practices for using these methods (Billings and Halsted 2005). Moreover, Richardson and Claman (2014) pointed out that HFS is extremely important for EMS students, as it exposes them to the real emergency practices that they will encounter after graduation. While good HFS practice is multifactorial, EMS simulation educators play a central role in the HFS process. Thus, it is critical to focus on the development of such teachers' teaching skills and to support them in developing the competencies and knowledge required for the effective implementation of HFS (Jeffries et al. 2015).

The principles of implementing HFS are learned through experience; new faculty members do not undergo training in HFS. Rather, EMS teachers are expected to possess teaching skills (Foronda et al. 2013). This inconsistency in how simulation is delivered throughout EMS institutions can have a negative impact on student experiences, with inconsistencies between students who are receiving simulation and those who are not. However, implementing HFS, as with any other skill, must be learned, and EMS faculty members need to be prepared to understand their tasks, duties, and responsibilities (Ramani 2008). Furthermore, in the quest to overcome barriers such as realism, the quality of the scenario, familiarity with the equipment, and the student's preparedness, simulation facilitators need support and an environment in which their skills and qualities can be developed.

Recognising the above-mentioned problem, EMS colleges have recently started to establish medical education departments to improve health education. However, despite this effort, the medical education departments in EMS institutions neither provide EMS faculty members with training in HFS nor evaluate this teaching method. While the departments' efforts represent an improvement over the system that was previously in place, they have focused on revising all exam questions and assessment methods and have paid practically no attention to HFS. However, evidence suggests that many challenges still exist in EMS colleges regarding teaching in HFS settings. Ahmed et al. (2016) conducted an exploration of Saudi teaching staff members' experiences with simulation in the field of medical education and found that medical teachers faced many challenges and struggled to fulfil their teaching roles and responsibilities in implementing HFS. Given the importance of this teaching method, addressing this gap is crucial to EMS education. According to Meling and Meling (2021) there is a significant effect of simulation training on patient outcomes. Furthermore, Au et al. (2016) noted that nursing students value HFS activities over actual clinical placements when they execute them effectively. Therefore, it is critical to examine EMS faculty members' and students' satisfaction, preparedness, and challenges when providing appropriate support for HFS implementation.

It is also important to recognise that HFS involves significant investments in space, costs, and faculty time. The significant costs of HFS manikins, such as SimMan® ($30,000 for SimMan® vs. $1,000 for a static manikin), make it reasonable to ensure the return on investment. In addition, HFS involves a significant amount of space and faculty training time, in addition to the purchasing and maintenance of the simulators. The literature mentions that the cost associated with simulation can be a barrier; however, “the major barrier to adopting simulation is the lack of trainers experienced to use it” (Munangatire and Naidoo 2017). Many EMS institutions were elated to have HFS equipment only to find that they struggled with the application and implementation processes. Many manikins stayed in boxes, unused because of a lack of application knowledge. These issues raise concerns about the processes involved in incorporating successful programmes. The simulation packages are expensive, and purchasing equipment that would not be used is a waste of funding. Furthermore, Maloney and Haines (2016) and Nestel et al. (2019) posited that despite the educational effectiveness and high-level impact on the health outcomes of HFS, it is necessary to evaluate its cost effectiveness, training needs, and engagement at the operational, administrative, and technical levels. Hence, collaboration with key stakeholders, including deans, heads of department, educators, students, and special simulation technicians, is crucial to improving the implementation of HFS and making effective use of the resources (Hellaby 2013, p. 8).

Although a body of literature exists on the barriers and challenges of implementing HFS education, most of the research has been conducted outside of Saudi Arabia (Rachel, 2013; Hober and Bonnel 2014; Kaddoura et al. 2016). This body of literature can inform the Saudi Arabian context to some extent, but due to cultural differences, such as gender segregation and language barriers because the teaching language in EMS education is English there may be other challenges and barriers that remain unexplored. As it appears there is a lack of HFS in Saudi colleges and universities, it may be prudent to evaluate programme outcomes, input, and process of high-fidelity manikin simulation by examining the faculty and students' perceptions in terms of their satisfaction, preparedness, and the challenges they face during their high-fidelity manikin simulation sessions. Training needs standards that are more appropriate for the country may reflect the needs of Saudi EMS colleges.

1.3 Thesis Questions and Objectives

The overall aim of the thesis is to propose an evaluation framework for High Fidelity manikin Simulation in EMS education in Saudi Arabia: Therefore, the thesis objectives are to examine faculty and student's' perceptions regarding the following:

1. What are faculty and paramedic student's' perceptions of high- fidelity manikin simulation in EMS education in Saudi Arabia?

2. What are faculty and paramedic students' perceptions of preparation, implementation and challenges to identify learning needs in EMS education in Saudi Arabia?

3. Develop a psychometrically sound tool to evaluate High Fidelity manikin Simulation in Arabic.

1.4 Overview of Thesis Chapters

This PhD thesis consists of three studies to meet the primary aims and objectives. Chapter 1 explains the thesis' significance, aims, and questions and provides an overview of the thesis chapters.

Chapter 2 summarises the existing literature on simulation in healthcare education. The chapter explores the history of the healthcare simulation context, HFS definitions, types of fidelity manikin simulation, the educational learning theories related to simulation, evaluation of HFS in healthcare education, models of evaluation in healthcare education, key aspects of embedding simulation in the programme, HFS simulation phases, and participants in the HFS activity.

Chapter 3 presents a literature review that summarises the existing literature about faculty's and student's perceptions regarding HFS in health care education, identifies gaps in the literature, and highlights relevant needs for further studies.

Chapter 4 summarises in general the thesis design, thesis instruments, and the ethics for further studies.

Chapters 5, 6, and 7 are the main prospective studies of this thesis. Chapter 5 presents a study examining the views of EMS students and educators in Saudi Arabia about their HFS experience (pilot study). Students and faculty at the College of Emergency Medical Services at King Saud University, Riyadh, were invited to participate in the study. In total, 32 faculty members and 57 students completed the questionnaires, and 9 faculty members and 16 students volunteered to take part in the semi-structured interview. The findings indicate that both faculty and students were satisfied with their simulation activities. However, participants faced many challenges from organisational, support, and assessment and feedback issues to lack of preparation for the implementation of high-fidelity manikin simulation and equipment malfunction. The study was conducted in one cultural context with male EMS students and a faculty member of one EMS school; thus, it had limited gender validity. Therefore, to generalise the findings of the study in Chapter 5, the study in Chapter 6 was conducted with Saudi female and male paramedics and in 11 EMS schools in Saudi Arabia.

Chapter 6 explores the perceptions of Saudi female and male faculty and students in terms of HFS before and during the COVID-19 pandemic. A questionnaire and semi-structured interviews were designed to tap into the views of faculty and students with respect to satisfaction, preparedness, and barriers to implementing HFS in EMS education before and during the COVID-19 pandemic. A total of 210 students and 40 faculty members completed the questionnaires, and 10 faculty members and 17 students volunteered to take part in the interviews. Participants completed a questionnaire, which included the educational practices questionnaires (EPQ) and the simulation design scale (SDS), before and during the COVID-19 pandemic.

Chapter 7 presents a cross-sectional questionnaire study that developed an Arabic version of the simulation design scale (SDS), the educational practices questionnaire (EPQ), and students satisfactions and self-confidence in learning (SSCL) and the perceptions of paramedic students in 11 EMS institutions in Saudi Arabia about the evaluation of the effectiveness of simulation as a pedagogical tool in EMS education post the COVID-19 pandemic. A total of 258 students took part in the study. Overall, the study shows that the Arabic versions of these scales are valid and reliable and can be used in EMS colleges in Saudi Arabia and other Arabic-speaking countries. Moreover, the students were satisfied with the simulation session after the COVID-19 pandemic.

Chapter 8 concludes this thesis. It provides an overview of the work, a summary of the discussion, implications of HFS, and recommendations for future development.

CHAPTER 2: Simulation in Healthcare Education: Definitions and Theories

This chapter provides an overview of the history of healthcare simulation and its modalities. Furthermore, it presents the different types of high-fidelity manikin simulation, simulation learning theories, evaluations of simulation in healthcare education, models of evaluation in healthcare education, main simulation characteristics, and participants' roles in these simulation processes.

2.1 History of Simulation in Healthcare Education

Simulation has had a long and varied history in many different fields, including aviation and the military. A look into the past to briefly touch on some of the major historical aspects of simulation in health care will give us a broader understanding of simulation's historical roots and the relationship to patient safety and its different modality. Simulation is not a new concept in healthcare education and has a long history, from ancient periods to the modern era (Owen 2016, p. 17). However, simulation has evolved significantly over the years, with the emergence of different simulation modalities in healthcare. Simulation refers to the type of equipment and methodology used in a simulation, such as manikin and screen-based simulation (Alfes and Elizabeth 2020, p. 31). When researchers or educators discuss the history of simulation, they usually differentiate between two periods that emerged in the sixteenth and twentieth centuries. Owen (2016) explored the brief history of simulation in healthcare by dividing it into two main periods. The first simulation emerged before 1500 years, and the later simulation was catalysed around the sixteenth century as a doctrine in France. The latter includes the prevailing system of medicine and observation for both surgeons and physicians to develop effective interventions for medical situations, such as during labour and vaccination. The first use of simulation procedures to prepare students was known as simulation-based training for midwifery courses, which were established in 1740 in the London Evening Post. However, Nestel et al. (2019, p. 9) asserted that the appearance of simulation more recently started in 1902 with the determination of the role of advanced educational techniques, such as the use of simulators in bronchoscopy procedures. Owen (2016, p. 18) indicated that the beginning of the twentieth century was considered the dark age in healthcare simulation and that it was not until the latter half of the twentieth century that simulation was rediscovered in healthcare.

According to Forrest and McKimm (2019, p. 53), the simulated patient concept was pioneered by Howard Barrows (a neurologist and academic) in the 1960s in the USA. Barrow (1993) defined this concept into two terms: simulated patients and standardised patients. These two simulated learning modalities provide an assessment of practical skills that can be considered supplementary to some teaching of technical skills in clinical procedures, such as communications skills, touch, and pressure that help learners obtain instant feedback or support the formative and summative assessment, for example, the Objectives Structured Clinical Examination (Forrest and McKimm, 2019, p. 54). In 1960, a Norwegian-based Laerdal company proposed a CPR trainer called *the Resusci®-Anne* as a new method of training for mouth-to-mouth ventilation (Crawford et al. 2019, p. 5). The manikin was developed by Dr. Bjorn and Dr. Peter Safars through the Norwegian manufacturer of play toys, and it is widely used for cardiopulmonary resuscitation (CPR) around the world (Cooper and Taqueti 2008, p. 12). Although this CPR manual provides the possibility of training for the airway, breathing, and circulation, it lacks heartbeat and programmed breathing.

Crawford et al. (2019, p. 5) believed that the first simulation manikin called 'Sim One' emerged from the advanced computer technology and electronic engineering industry in 1967 and offers palpable pulses, eye movement, breathing lungs, and blood pressure indicators that are useful for teaching and learning purposes. The term 'Sim One' manikin was ignored by the slow-moving medical community, and at the end, the project was broken and lost (Levine et al. 2013, p. 17; Cooper and Taqueti 2008, p. 8). In 1968, the American Heart Association began the initiative by announcing the Harvey Cardiology Manikin project, which led to the modern concept of a part-task trainer. This fully sized manikin can stimulate 27 heart conditions (Boulet et al. 2010). Twenty years later, Harvey's manikin's effectiveness in teaching was reported (Cooper and Taqueti, 2008, p. 13). The report recommends using Harvey's manikin with cardiological examination skills. For example, improving heart sound auscultation encourages the development of a smaller cardiology patient simulator called Simulator K (Takashina et al. 1997, cited in Cooper and Taqueti, 2008, p. 14). Ward and Wattier (2011, p. 836) claimed that although Harvey's manikin did succeed as an auscultation task trainer, it has not expanded because the manikin's torso is not compact, as the mechanical control and the computer are not separated from the exam table. In addition, there was no range of cardiac disease scenarios, an electrocardiogram (ECG), or internal or external speaker for heart sounds.

Crawford et al. (2019, p. 6) described three human patient simulators that came after the success of Harvey's manikin simulator. The first human patient simulator was the *Prototype Manikin* with breathing, pulses, and cardiorespiratory in 1986, sponsored by Medical Educational Technologies Incorporated at Florida University, Canada. This manikin was developed by Dr. Gaba to investigate human performance in anaesthesia. Cooper and Taqueti (2008, p. 14) argued that although the first Prototype Manikins were unique to healthcare and have been used widely, they lack realism. The second manikin called Sim Man was developed in 2001 by the Laerdal Company, which continued to release this manikin because of its massive international growth (Crawford et al. 2019, p. 6). The third human patient simulator was produced by Gaumard, including the high-fidelity simulation manikin, the paediatric simulator, and the obstetrics simulator. All of these human patient simulators are similar to each other in many respects, such as chests that breathe, variable tones and heart rates, measurable blood pressure, palpable pulses, ECG displays, artery wave forms, and pulse oximeters. A number of clinical procedures can be performed. These include auscultation of heart and lung sounds, chest tube placement, opening airway manually, defibrillator, cricothyrotomy, and most manikins can be articulated, speak and cry, change colour, and experience seizures. In addition, some of the manikins can be used for special consideration. These include trauma manikins with bleeding, severe injury, or missing limbs, paediatric manikins, and birth manikins for labour and delivery.

According to Gupta et al. (2019, pp. 144-145), besides human patient simulators and the conventional simulation method, there are other distance simulation modalities that also emerged during the beginning of the 1990s, such as virtual reality (VR) and augmented reality (AR). These recent simulation modalities provide learners with observation and interaction with 3D models. Learners can also manipulate certain aspects of the environment and observe reactions, which can be considered an entertaining experience for the learners and contribute to active participation in the learning process. Boulos et al. (2007) stated that the term VR has recently been extended to include 'Second Life (SL)', in which learners select a pseudonym and can create their own selves, such as an avatar, so they can navigate, communicate, and hear other avatars depending on their physical location using three-dimensional graphical representations. Furthermore, Kuo and Balakrishnan (2013) said that this virtual reality world presented a new project called Second Health that built on the high technology of healthcare that focuses on communicating complex healthcare messages such as simulating diseases such as anaphylactic shock through animations. However, Hansen (2008, p. 3) indicated that this project was not the first virtual reality project offered for the virtual world; for example, in 2008, the University of Southern Queensland introduced a massive multiplayer online game platform and a virtual world online simulation titled *Advanced Learning and Immersive Virtual Environment* (ALIVE). Hansen (2008, p. 4) pointed out that the unique features that make ALIVE different are the combination of the following four elements: provides educators with the opportunity to develop learning contents, provides YouTube video clips on how to use ALIVE, supports an online virtual classroom, and allows learners to drag and drop 3-D scenes and distribute them via the web.

Delp and Loan (1995, p. 22) noted that the first AR in the medical education field is called 'Software for Interactive Musculoskeletal Modelling', which emerged from the biomedical engineering, physical medicine, and rehabilitation industries in 1994 and offers learners the opportunity to develop and evaluate many different musculoskeletal structures, such as muscle-tendon joints and joint kinematics. The second AR in medical education was the Virtual Reality Dynamic Anatomy (VRDA) in 1999, organised by the School of Computer Science and Division of Radiological Science at the University of North Carolina in Chapel Hill, USA (Baillot et al. 2000). However, Blum et al. (2012) presented an AR in situ visualisation of human anatomy titled *Magic Mirror,* which displays anatomical structures on the learner's body. In 2016, Pennsylvania University announced that it had implemented a new AR application in medical education titles called Gunner Googles, which is an attempt to enhance textbook learning in shelf exam preparatory review AR (Wang et al. 2016, cited in Westwood et al. 2016, p. 446). Nee and Ong (2023, p. 723) pointed out that the unique educational values of the Magic Mirror and the Gunner Googles have a positive impact on the learning outcomes of the vast majority of medical students.

Balian et al. (2019) conducted a study that focused on the use of AR in the training of healthcare providers on how to perform CPR, advancing the understanding of the potential of AR in CPR. The authors enrolled 51 healthcare providers in this trial, which contained a CPR training manikin integrated with an AR device (Microsoft HoloLens) from October 2018 to November 2018. They found that the trial was favourable to the student participants and that it was feasible to conduct CPR training with AR technology. Pantelidis et al. (2018) added that it would be useful to implement AR training programmes for basic life support, advanced cardiac life support, and paediatric life support. Hence, these programmes might provide exposure for learners to prepare them for emergency situations in realistic settings (Nee and Ong 2023, p. 723).

In 2008, the first mixed reality simulation in the medical education field arose with the launch of the mixed reality human, which was developed by the Medical College of Georgia, USA (Nee and Ong 2023, p. 118). Mixed reality humans provide learners with a physical representation of a human that they can touch in addition to a virtual visual representation. Although the first AR was a mixed reality human model, Nee and Ong (2023, p. 109) confirmed the popularity gained by mixed reality in 2018 with the appearance of the first Microsoft HoloLense, which was called the True Scale Anatomy Model and was developed by Case Western Reserve University in Cleveland. Mixed reality anatomy technology can help learners explore the gross anatomy of the human body (Maniam et al. 2020). However, this AR was considered useful for medical students' training, such as exploring the anatomy of the human, patient interaction, laparoscopic surgery, neurosurgery, and cardiology (Campisi et al. 2020). Thus, many experts believe that simulation technology remains in the early adopter phase of Rogers' diffusion of innovations curve (Crawford et al. 2019, p. 8). The emergence of healthcare simulation continues to be driven by its rapid global expansion, which has received widespread attention and popularity in the medical education field. Moreover, there are many different modality options that we could potentially use. Thus, a crucial question is: What informs the choice of which simulation modality to use? According to Forrest and McKimm (2019, p. 5), the selection has to be led by learning outcomes and not by the technology of interest. It is also important to consider how the simulation will be delivered, whether face-to-face or remotely. Stakeholders should also consider the level of the learners and their exposure, because often the learners need to familiarise themselves with the simulator to be able to flourish and develop those skills and competencies effectively (Forrest and McKimm 2019, p. 43).

In summary, this review has provided details about international simulation areas that, to my knowledge, have been under-researched (Aebersold 2016). Examining the major historical aspects of simulation in healthcare offers insights into a better understanding of the different simulation methodologies that have been used in high-fidelity simulations and how to differentiate between them. For example, a high-fidelity simulation could be virtual reality, AR, or a high-fidelity Manikin simulation. Thus, this review is very important in demonstrating the current status of the high-fidelity manikin simulation movement, particularly in this study's context of Saudi Arabia. In addition, understanding the length of time since the first appearance of the high-fidelity manikin simulation internationally provides a clear indication of the importance of this modality for medical education, which also helps in understanding the common objectives that stimulated the emergence of high-fidelity simulation internationally. Given the paucity of the history of simulation in Saudi Arabia, no additional information could be acquired in the context, thus emphasising the value of the historical review of the international advent of simulations. The review also enhances the understanding of the main motivations for creating simulation modalities, providing information about the learning theories on which they were based and whether or not they are mentioned explicitly in the literature. For example, reviewing AR modalities, such as Magic Mirror and Gunner Google, shows that they were designed to provide digital information in addition to a physical environment, according to experts. From this, it can be deduced that this modality focuses on providing learning in the constructivist approach by positioning the learner in a real-world physical environment and social context rather than paying more attention to providing learning in the instructivist approach and how to blend it into the curriculum as a teaching and learning tool. Further details about the learning theories of simulation are discussed in the following sections.

2.2 What is a High-Fidelity Simulation?

There has been extensive discussion regarding the comprehensive definition of HFS in healthcare education; the terms already in existence have been inclined to convey the objectives of simulation or the way in which it has been utilised. Hanshaw and Dickerson (2020) argued that defining HFS in the context of EMS education, the concept of fidelity pertains to the degree of realism achieved in a simulated environment. I discuss the nuanced differences these terms encapsulate, noting first that there has been much debate regarding HFS definitions and distinctions.

Hellaby (2013) argued that participants cannot be funded, evaluated, or trained to use simulation without first defining what simulation is. High-fidelity simulation can be defined as recreating a real-life task, event, or experience, providing a safe learning environment for the acquisition of skills, knowledge, attitudes, and behaviours (Gough et al. 2012). Moreover, a high-fidelity simulation has been defined as a dress rehearsal for a real event where mistakes can be made and lessons learned but no one comes to harm. Simulations include activities such as role play or team-working tasks, the use of manikins for life support training, and the use of computer-based simulators (Forrest and Mckimm 2019, p. 5). Gaba (2004) opposed the assumption that simulation is a technology, because he identified simulation as a technique to replace real situations with guided experiences that replicate aspects of the real world. However, the above definitions demonstrate that it can be used not only to develop knowledge and skills but also to focus on attitudes, ways of behaving, and their development. This suggests that high-fidelity simulation should be referred to as any modality that students use to acquire new clinical skills.

Lioce et al. (2020) confirmed that high-fidelity simulation can be defined as the degree to which the simulated environment (including equipment, tools, moulage, sensory props, manikin, and room) replicates reality and the look of the real environment and its materials. This means that learners can take part in a safe environment and make mistakes without hurting real patients. Many researchers consider high-fidelity simulation to be educationally effective in medical education (Barry et al. 2005; Torre et al. 2011; both cited in Mckimm and Forrest, 2013, p. 28), with the aim of providing HFS experience to those who join the simulation experience to improve themselves professionally and educationally. However, Hamstra et al. (2014) critiqued the use of the term manikin fidelity by pointing out that the term creates confusion around the distinction between high, medium, and low fidelity and high, medium, and low manikin fidelity. Indeed, a medium-fidelity manikin simulation in a low-fidelity scenario cannot be considered a medium-fidelity simulation scenario because the manikin is medium. Therefore, teachers should carefully consider which high-fidelity simulations they will implement.

2.3 Types of Fidelity Simulation

Simulations range from simple to complex. Simple simulations involve decision environments with low-level uncertainty that can be constructed with high or low levels of relevant information. Information at a high level is easily obtainable and relationships among the key decision variables are highly predictable and very stable' (Jeffries, 2005).

The three prominent models of fidelity simulation that have been recognised in the literature are low-, medium-, and high-fidelity simulations. Beaubien and Baker (2017) argued that these three different fidelity simulations attract different psychological fidelity, equipment fidelity, and environment fidelity, which are considered components of the scenario as a whole (Fiq.1). However, Forrest and McKimm (2019, p. 7) posited that the three types of fidelity simulation depend on the degree to which the manikin mimics a real patient.

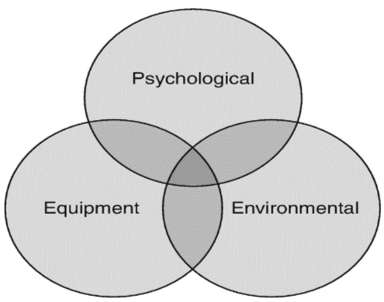
Fidelity simulation should be aligned with the sophistication of the equipment and the learning objectives; following this, the fidelity simulation concept should be applied with good coordination among the professional group to ensure that the simulation is realistic (Riley 2015, p. 130). In fact, Forrest and McKimm (2013, p. 53) noted that the different elements within the simulation scenario may have different degrees of fidelity, and optimising the fidelity of the simulation based on educational value does not mean maximising.

The terms ‘high fidelity’ and ‘low fidelity’ are not binary but multi-dimensional constructs (Maxworthy et al. 2022). Nanji et al. (2013) and Rudolph et al. (2007) clarified that the following Dieckmann terminology leads to a new categorisation of fidelity into three models. In fidelity simulation models, ‘physical *fidelity*’ stands for ‘the degree to which the simulation approximates the auditory, olfactory, tactile, and visual nature of the situation’, while ‘conceptual *fidelity*’ stands for ‘the degree to which the simulation progresses plausibly given the causal factors involved’, whereas the ‘emotional/experiential *fidelity*’ stands for ‘the degree to which the simulation creates feelings in learners that they would expect in a comparable real-world situation. Thus, the three kinds of fidelity combine to influence how realism is perceived by learners in a simulation, and the perceptions of the learners regarding realism can be different, even if all the experiences of simulation fidelity are the same (Dieckman et al. 2007). Moreover, it is not clear what level of fidelity is required to achieve authenticity (Bland et al. 2011).

Hellaby (2013) noted that learners usually know that they are attending a simulation, so they can distinguish it from reality. However, Alinier (2011) stated that if the scenario is too realistic, learners might feel anxious and be more concerned about preventing harm than about learning. Thus, Maxworthy et al. (2022) pointed out that there is no evidence showing that high-fidelity simulation is better than low-fidelity simulation with regard to learning outcomes and learners' engagement. Forrest and McKimm (2019) argued that there is a real disadvantage to increasing the realism of the simulation related to cost increases.

Forrest and McKimm (2019, p. 7) confirmed that there is an issue with the term fidelity, with confusion surrounding the distinction between high, medium, and low fidelity and high-, medium-, and low-fidelity manikin simulations. Hamstra et al. (2014) supported this perspective by pointing out that the manikin's fidelity is dynamic, depending on the manikin used and the learning outcomes. Hamstra et al. (2014) added that the term '*manikin fidelity*' should be replaced with the terms '*functional task alignment*' and '*physical resemblance*'. However, simulation educators need to be aware that this issue still exists and that confusion about the term fidelity will remain for some time (Forrest and McKimm 2019). From this discussion, there is a clear difference between low-, medium-, and high-fidelity manikin simulation and low-, medium-, and high-fidelity simulation, so more differences between the three types of manikin fidelity simulation are highlighted in the next section.

Figure 1: Venn diagram describing the relationship of various components of a simulation experience that can be described by the term 'fidelity' (Rehmann et al. 1995, p. 16).



2.3.1 Differences between low-, medium-, and high-fidelity manikin simulations

Forrest and McKimm (2019, p. 19) listed some differences between the three manikins of fidelity simulation, including that low-fidelity manikin simulation is used in cardiopulmonary resuscitation training, medium-fidelity manikin simulation enables the learner to have a greater degree of interaction with the manikin, and high-fidelity manikin simulation is used in corporate complexes and computer systems for generating sophisticated physiological responses, such as breathing, blinking, pulse and heart rate, and heart and lung sounds, which affords interaction with the learners. Moreover, the responses of the manikin can be controlled by the operator in a simulator to model pharmacological interventions and pathological states (Weller et al. 2012). Based on these factors, the following paragraphs discuss the differences between the three models of fidelity manikin simulation according to the literature.

Regarding the definition of fidelity, Maxworthy et al. (2022) argued that there is no specific definition of these terms, and fidelity can be seen as experiential learning, which refers to the realism of the scenario from the point of view of learners, whereas technology refers to simulators or other technologies and is opposed to fidelity. Hellaby (2013, p. 8) asserted that high-fidelity manikin simulation has disadvantages, such as the need for more maintenance, the need for continued repair, the fact that malfunctioning manikins may limit the number of educators who are using them, the need for more time to prepare for the simulation activity, and the fact that educational institutions should employ simulation technicians to maintain and operate the manikins. Hellaby (2011) mentioned that there are areas where it cannot mimic or replicate a high-fidelity manikin simulation, such as anaphylaxis shock, where the manikin dose has not caused a rash or drawn on the skin. However, Massoth et al. (2019) explained that high-fidelity manikin simulation can be referred to as equal or worse performance and growth in knowledge compared to low-fidelity manikin simulation, whereas there is no distinct advantage of high-fidelity manikin simulation compared to low-fidelity manikin simulation in terms of improving skills (Nimbalkar et al. 2015; Cheng et al.

2015). Therefore, these two fidelity manikin simulations are not the same in the literature (for example, Finan et al., 2012; Thompson, 2021). Thus, it can be deduced that although low-fidelity manikin simulation and high-fidelity manikin simulation are similar, there are differences between them. In evaluating how learners feel at a particular time and how they feel in a specific situation, there is no significant difference in state anxiety between the high-fidelity manikin simulation and the low-fidelity manikin simulation. Butler et al. (2009) stated that students are satisfied with the implementation of active learning strategies with both high-fidelity manikin simulation and low-fidelity manikin simulation.

Simulated scenarios provide students with the chance to engage in healthcare practice inside an appropriate educational environment, allowing them to apply their knowledge, skills, and attitudes regardless of the fidelity of the simulation methods used, whether low or high. (Tosterud et al. 2013). To clarify this point, learners in low-fidelity simulation should only use the specific learning of psychomotor skills by intravenous cannulation of plastic arms or a static manikin, whereas in high-fidelity simulation, the utilisation of advanced technologies and carefully designed environments facilitates the replication of problems and the creation of realistic patient scenarios that closely resemble those encountered in clinical practice.

When fidelity manikin simulations were introduced in 1960, they were designed based on the idea of constructivism, where learning occurs in a highly experiential way by connecting learners together to perform mental and physical activities and affording reflection in order to distribute learning in a safe environment. However, fidelity manikin simulations are evolving, and this has led healthcare schools to invest in the idea of fidelity manikin simulations that focus on improving learner training and performance. Although all types of fidelity manikin simulations share the same idea, they are considered an educational technique that enables learners to be interactive and immersed in activity by recreating all or part of a clinical practice without harming real patients. There are also differences among them in terms of the predetermined learning outcomes, technology principles, and realism of the scenario, resulting in three types of simulations: low-fidelity manikin simulation, medium-fidelity manikin simulation, and high-fidelity manikin simulation. However, Munshi et al. (2015) indicated that using a high-fidelity manikin simulation is expensive. Thus, low-fidelity simulation could be used for several reasons, such as a lack of simulation technician support and time restrictions. Thus, this thesis draws on participants' perceptions of using high-fidelity simulations specifically for high-fidelity manikin simulations.

2.4 Understanding Simulation Learning Theories

Scholars have stressed the significance of comprehending learning theory. First, Douglas et al. (1980, p. 18) argued that the utilisation of theoretical frameworks enables us to gain an in-depth understanding of the entirety of our educational practice and research. This implies that educators can gain an understanding of the process of learning within certain educational settings by comprehending learning theory. According to Beard and Wilson (2006, p. 132), to enhance the efficacy of learning, it is imperative to incorporate the theoretical foundations that underlie the specific learning approach. This inclusion serves to augment the clarity, focus, and direction of the learning design process while also facilitating the development and presentation of well-defined and efficient organisational components that address appropriate instruction concerns. Beard and Wilson (2006, p. 8) claimed that the use of learning theory enables individuals to establish connections between their own work and that of others, fostering the development of cohesive frameworks and facilitating a profound comprehension of their actions. Moreover, it has the potential to facilitate the transfer of acquired experiences to novel contexts and situations, which is of utmost significance.

According to Kurt Lewin, a good theory is highly practical in design (Schein 1996 p. 28). Wilson (1997, p. 23) described the functions of good learning theory: first, it helps educators envision how learning can be used most effectively to enhance communication and information retrieval; second, it helps educators maximise the efficiency of their educational efforts by investing time and limited resources most effectively; and third, it enables educators to interpret and plan from the known to the unknown. For these reasons, Hammond et al. (2001, p. 15) argued that scholars have attempted to comprehend learning for over 2,000 years by debating learning theories that address fundamental concerns: How does learning occur? What causes motivation? What influences the growth and development of learners? Wilson and Peterson (2006, p. 6) are prominent scholars who have conducted extensive studies on learning theories. They investigated theories that encompass concepts related to learning as an active process in which learners actively construct their own knowledge. They also explored the notion of learning as both an individual and a social phenomenon, as well as the potential of learner and group differences to serve as valuable resources rather than hindrances to be surmounted. According to Wilson and Peterson (2006, p. 14), these theories hold promise in assisting educators in comprehending the underlying factors influencing their instructional approaches. Furthermore, these theories have the ability to disrupt established teaching patterns and encourage educators to critically evaluate and reconsider their pedagogical practices. Rutherford-Hemming (2012) pointed out that the basis of simulation is grounded in the principles of adult learning theory. Paramedic students, being adult individuals, have well-defined expectations regarding the responsibilities of their lecturers in terms of knowledge dissemination. Adults, including paramedic students, commonly acquire knowledge through engagement with peers and active involvement, which serves to strengthen the learning process (Foley 2004, p. 331).

Due to the importance of learning theory for each learning design, it is important to highlight and debate the theories that were applied in the context of this study, simulation. In this regard, in *The Comprehensive Textbook of Healthcare Simulation,* Levine et al. (2013, p. 53) made the following important statements:

> To better understand the learner and the process of learning, it is essential to possess at least a foundational understanding of learning theory. Applying learning theory and knowledge of teaching is key to the success of the educational goals of medical simulation and to patient care'.

Indeed, because the specific learning context of a simulation varies across its learners, who are placed in many different contexts and locations, it is challenging for simulation designers to create a design that suits such a heterogeneous set of learning needs and learning outcomes. The literature has discussed the learning theories that could be applied for simulation, which include experiential learning theory, behaviourism and deliberate practice, cognitivism, social learning theory, constructivism, and situated learning theory. The following sections provide more details about these learning theories within the context of simulation.

2.4.1 Experiential learning theory

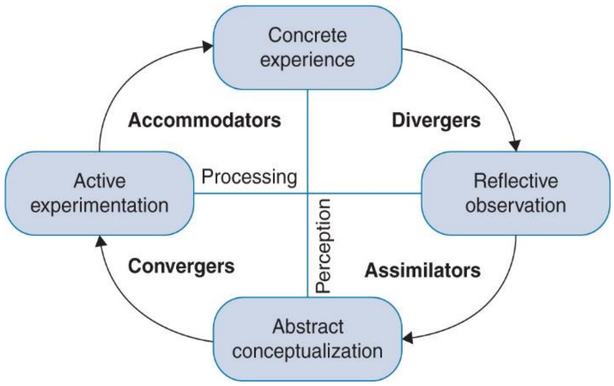
The experiential learning framework is rooted in Kurt Lewin’s (1951) theoretical foundations and intellectual achievements. Through his work with groups, he discovered the ‘T-group’ (training group) as a fortunate event when the training session’s staff grudgingly included the trainees in their evening review and analysis of the day’s events (Maxworthy et al. 2022). A viewpoint unequivocally emphasises the significance of experience that is followed by debriefing to improve experiential learning (Kolb 1984, p. 9). The seminal contributions of Dewey, Lewin, and Piaget exerted a profound impact on the subsequent evolution of conceptions pertaining to learning, knowledge, and education across subsequent decades. The impact of their work is particularly apparent in the realm of adult learning, as seen by the theories of andragogy formulated by Malcolm Knowles and the concept of experiential learning developed by Kolb (Maxworthy 2022). In his initial scholarly contributions, Knowles succinctly outlined four fundamental presumptions pertaining to adult learners, subsequently augmenting this framework with the inclusion of two more assumptions throughout subsequent decades. These assumptions have been widely accepted within the field of simulation and pertain to several aspects of adult learners, including their (1) desire for knowledge, (2) perception of themselves, (3) prior experiences, (4) preparedness for learning, (5) approach to learning, and (6) level of motivation (Knowles, 1990).

As previously mentioned (in Section 2.1), CPR was led by Dr. Bjorn and Dr. Peter through the Norwegian manufacturer of play toys in 1960 (Cooper and Taqueti 2008, p. 12). The manikin provided a unique opportunity to understand how learners train for mouth-to-mouth ventilation. It involved the new learning theory for the simulation proposed by Kolb: the theory of experiential learning (Maxworthy et al. 2022). Experiential learning has garnered significant recognition and acceptance within the educational community (Kolb 1975). Hellaby (2013, p. 5) described Kolb's experiential learning cycle as optimal knowledge acquisition occurring when individuals actively participate in real-life situations within a certain field of study and then engage in reflection to extract meaningful insights that can be used and tested in different contexts. According to Forrest and McKimm (2019, p. 15), Kolb's experiential learning theory expands on the constructivist basis founded by Dewey, who theorised that learning occurs through the dynamic interaction and collaboration of learners and subject matter experts, leading to better understanding and retention over time.

The fundamental principle of constructivism states that the acquisition of knowledge is an engaged task wherein the instructor assumes the role of a guide or facilitator (Tam 2000). Maxworthy et al. (2022) emphasised that Kolb's experiential learning theory is characterised by a cyclical nature and encompasses four distinct stages. The four stages of the experiential learning cycle are as follows: (1) concrete experience, (2) reflective observation, (3) abstract conceptualisation, and (4) active experimentation (Figure 2). Kolb (1984) acknowledged the existence of unique differences in learning preferences and strengths within each step of the learning process, which led him to construct a typology of learning styles. The four learning styles proposed by Kolb are diverging, assimilating, converging, and accommodating (Wilson and Wittman-Price 2018, p. 35). The 'diverging' style is characterised by a predominant emphasis on real experience and thoughtful observation. Individuals with divergent cognitive styles possess a notable ability to examine and analyse tangible circumstances from multiple perspectives. It is probable that individuals would exhibit a preference for collaborative work settings and personalised feedback. The 'assimilating' style is characterised by a predominance of abstract conceptualisation and contemplative observation. Assimilators possess notable proficiency in comprehensively seeing a diverse array of information and subsequently synthesising it into a succinct and coherent structure. Such individuals are inclined to prefer engaging in activities such as reading and attending lectures, delving into analytical models, and allocating time for contemplation. The major learning-type abilities for the ‘converging’ approach are abstract conceptualisation and active experimentation. Individuals with convergent thinking styles excel in the identification and application of practical applications for ideas and theories. It is probable that such individuals would have a preference for engaging in experiments, simulations, laboratory work, and practical applications. The ‘accommodating’ approach is characterised by a predominant focus on actual experience and active exploration. They possess a strong aptitude for acquiring knowledge through practical and experiential learning. It is probable that these individuals possess a propensity to collaborate with others, establish objectives, engage in practical activities, and experiment with diverse methodologies to accomplish a certain project.

It is crucial to acknowledge that there are variations in individuals’ learning processes, necessitating educators to include these learning styles while developing and implementing educational curricula (Kolb and Kolb 2005). Kolb’s experiential learning theory has major implications for simulation educators. Primarily, it provides justification and legitimacy for the use of simulation in educational programmes. In a broader context, this emphasises the significance of incorporating a wide array of methodologies within an educational curriculum (Maxworthy et al. 2022). The necessity for reflection is clearly emphasised, a practice that simulation instructors commonly facilitate by employing effective debriefing techniques. However, according to the idea, it is necessary to delve further and guarantee that all four stages are adequately addressed (Clark et al. 2010).

Figure 2: Kolb’s experiential learning model (Rehmann et al. 1995, p. 16).



Moreover, Forrest and McKimm (2019, p. 15) argued that throughout history, the healthcare sector has relied on an apprenticeship model as a means of education whereby learners actively participate in providing direct care to patients. However, this approach is not considered optimal for experiential learning due to its limited opportunities for reflection and experimentation. Moreover, the primary focus on patient safety further restricts the effectiveness of this model. Simulation-based education (SBE) is a method that addresses these concerns and creates a practical learning environment where learners and clinicians can develop, enhance, and sustain their skills in settings that are relevant to their practice. This approach ensures that patient and clinician safety is not compromised. Forrest and McKimm (2019, p. 15) assumed that the optimal approaches in simulation-based education advocate a purposeful procedure of reflection that enhances the integration of theory and practice, the application of acquired knowledge to different professional contexts, and the growth of people and teams. Reflective practice serves as a valuable tool for recognising one's strengths and areas in need of growth while also fostering an awareness of the underlying ideas, attitudes, and values that influence one's performance. It has been identified that paramedic students may have distinct learning needs in high-fidelity manikin simulation activities; thus, EMS educators should be more conscious when applying Kolb's experiential learning cycles by identifying the unique learning style from the students' perspectives, because Kolb's learning cycles can be interpreted from various perspectives, including cognitivism, phenomenology, and adult learning.

The experiential learning theory proposed by Kolb emphasises the presence of multiple perspectives and adaptability, which shed light on the existence of diverse learning styles and stages throughout the learning process. This theory does not seek to assign certain learning styles to individual students but rather recognises the variability and complexity inherent in the learning experience. (Williams et al. 2013). When paramedic students have the ability to organise simulation activities, this might optimise their educational practices. The experiential learning cycles might provide a road map for EMS educators to use as they attempt to increase the activeness of high-fidelity manikin simulation activities. According to Alrazeeni et al. (2021), experiential learning is a useful and effective way to develop psychomotor skills and competencies in EMS students. Moreover, paramedic students have the opportunity to perform, reflect on, discuss, and provide feedback. Therefore, it is essential to provide quality-based education and give them the required knowledge, skills, and competencies to be able to provide safe, efficient, and ethical care to a wide variety of patient groups. The experiential learning theory umbrella could provide direction to EMS educators in structuring teaching and learning strategies. Instructional strategies frequently categorised as experiential learning include lifelong learning, self-directed problem solving, and reflective practice. Moreover, EMS educators who embrace instructional approach teaching should not only prepare paramedic students with the substantive knowledge necessary for competent practice but also create an environment in which paramedic students learn to think critically, practice reflectively, work effectively in groups, and access and use new information to support their practice. EMS educators should also help paramedic students experience each phase of Kolb's cycle in the high-fidelity manikin simulation to achieve optimal learning. Nevertheless, paramedic students do not always use all phases equally, usually showing a preference for one or two phases based on their individual learning styles (Poore et al. 2014).

2.4.2 Behaviourism and deliberate practice theory

Behaviourism has been extensively applied in education for hundreds of years. (Wilson and Wittman-Price 2018, p. 57). Simulation-based education is supported by behaviourism and cognitive theories (Hellaby 2013, p. 6). Behaviourist (performance) and cognitive (problem solving) approaches reveal essential philosophical assumptions that align with simulation-based education (Forrest and McKimm 2013, p. 45). In brief, the process of learning within the framework of behaviourism theory involves the acquisition of knowledge and skills through the receiving of instructions that elicit modifications in student behaviour. Behaviourism is a psychological approach that places emphasis on the study of observable actions and the approaches by which they can be influenced, as opposed to the examination of unobservable mental events (Skinner 1963, p. 375). Duvivier et al. (2011) argued that behaviourism theory has implications for designing simulation environments that value the instructional design of curricula. An example of a simulation activity that uses instructional design is when the learner repeats a cognitive or psychomotor task that is designed to transfer instructions, specific feedback, or rigorous assessment in a timely manner. This is a process known as deliberate practice in the design of simulation-based education attempting to serve trial-and-error processes by transferring direct feedback from expert educators to learners (Ericsson et al. 1993). Effective feedback includes providing precise details regarding how the performance aligns with predetermined standards and offering guidance on how the learner can enhance or refine their performance (Castanelli, 2009). The behaviourist approach is increasingly less prominent within high-fidelity manikin simulations in EMS education. Interpretive learner-central education based on constructivism, cognitivism, and humanist philosophies is perceived as an alternative to meeting the learning needs of modern paramedic students in simulation (Donelon 2014). Regardless of this philosophical shift, many EMS scholars contend that the Tyler model of behaviourism still has a role in psychomotor clinical skill acquisition (Jensen 2020). However, the passive learner role of behaviourist pedagogy restricts the capacity to actively involve paramedic students in the cultivation of problem-solving skills and the comprehension of broader contextual concepts (Wilson and Wittman-Price 2018). Nevertheless, it is plausible that this constrained conscious effort or rote learning enables paramedic students to effortlessly retrieve crucial technical skills and clinical concepts. One clear example of the behaviourism theory in the high-fidelity Manikin simulation is the assessment of clinical practice in EMS education. The direct observation of the paramedic students' performance during the high-fidelity simulation activity by EMS educators then the educator makes the decision to fail or pass grades based on the students' performance.

By contrast, Wilson and Wittmann-Price (2018, p. 57) argued that the behaviourist theoretical framework places emphasis on teacher-centred instruction, whereas cognitive and constructivist approaches prioritise student-centred instruction. According to the idea of cognitivism, the process of learning involves active engagement on the part of learners, who must actively arrange new knowledge within the framework of their existing knowledge to derive meaning from it. Therefore, the acquisition of information and learning varies among students due to their reliance on individual prior knowledge, as well as their capacity and dedication to the process of assimilating and integrating new knowledge with existing knowledge. Due to this rationale, under the framework of cognitivism theory, 'well-indexed and stored schema lead to reduced decision-making time and improved quality in contextually stressed situations, creating adaptive, resilient, and risk-taking practitioners' (Cannon-Bowers 1998, p. 21). This shows the importance of providing specific techniques such as task analysis, crew resource management principles, and guided reflection techniques for students in accordance with their previous knowledge for effective learning.

2.4.3 Social constructivism

Rice and Wilson (1999, p. 29) supported Vygotsky (1987), arguing that social constructivism theory (Vygotsky's theory) matches the characteristics of the simulation environment. Rice and Wilson (1999, p. 28) argued that the constructivist model is deeply influenced by social learning paradigms and is closely linked to the field of cognitive science. Vygotsky places significant value on the essential function of interaction with others in the cognitive development process and the construction of meaning (Wilson and Wittmann-Price 2018, p. 59). Vygotsky's theory of social constructivism posits that higher mental functions include a process of transitioning from the societal level, known as interpsychological, to the individual level, referred to as intrapsychological (Kozulin 2003, p. 157). Kozulin (2003, p. 95) outlined the three fundamental assumptions of social constructivism that hold significance in comprehending and implementing learning models from the perspective of social constructivism: reality, knowledge, and learning.

According to social constructivists, the perception of reality and the acquisition of knowledge are shaped by social and cultural factors, which are influenced by human behaviours, such as interpersonal relationships and engagement with the surrounding environment. These processes are essential for the establishment of meaning. According to this theoretical framework, the process of learning is inherently social in nature, as it involves active participation in social activities to foster the development of meaningful knowledge and understanding. (Forrest and McKimm 2019, p. 17). In this sense, understanding something deeply in social constructivism theory requires learners to actively construct their knowledge by themselves by engaging and interacting with their peers and with the contents of various activities, such as working with teams on simulation lab activities, engaging in useful discussions, working on a case scenario for problem solving, and providing debriefing (reflection) for the learners by the facilitator, which is known as a mature social medium. While the teacher may not possess knowledge of the precise constructs that each learner will create, they might still have a grasp of the general scope of knowledge that learners can acquire within a particular subject (Kozulin 2003, p. 183). This is because ‘constructivist environments facilitate the generation of diverse perspectives across many circumstances. The existence of a singular, universally correct interpretation or solution to an issue is not supported. Students are strongly encouraged to employ a variety of problem-solving strategies and to provide justifications for their solutions (Kozulin 2003, p. 326).

The best-known formulation in Vygotsky’s literature review is the zone of proximal development (ZPD) (Rice and Wilson 1999, p. 28). In brief, Vygotsky’s conceptualisation of the ZPD entails the disparity between an individual’s current state of development and the level of accomplishment that can be reached through collaborative interactions with peers (Rice and Wilson 1999, p. 29). Learning takes place within the ZPD, necessitating the collaborative efforts of learners and the guidance provided by facilitators. The collaborative engagement of learners with individuals who have already attained a more advanced level of development can facilitate their progression towards a higher degree of development. (Shabani et al. 2010, pp. 240-241). Indeed, individuals engaged in high-fidelity manikin simulation have the potential to attain a heightened level of proficiency or enhance their existing level within their ZPD through collaboration with individuals at a more advanced stage of development. This can be achieved by actively participating in simulation activities, receiving pre-briefing on the intended learning outcomes, exchanging creative concepts during the briefing stage, illustrating real-life scenarios as examples, posing inquiries, and providing justifications for their viewpoints.

The use of high-fidelity manikin simulations by learners to engage in social interactions facilitates the process of sense-making and enhances their comprehension, aligning with the principles of social constructivism theory. According to the constructivist perspective, the function of the EMS educator is that of a facilitator, whereas the responsibility of the paramedic student is to construct reality through interactions inside the high-fidelity manikin simulation environment. Constructivism advocates for the active participation of paramedic students in high-fidelity manikin simulations, the cultivation of social and interpersonal skills, the promotion of a positive attitude towards learning, the acquisition of a comprehensive grasp of the given information, and the development of efficient thinking abilities. The acquisition of critical thinking skills contributes to the improvement of paramedic students' decision-making abilities in relation to pre-hospital scenarios while also fostering the growth of social and interpersonal competencies. In addition, it is imperative for EMS instructors to actively promote and foster a learning environment that encourages engagement and social interaction among paramedic students. Active learning is widely recognised as a fundamental factor in achieving successful learning outcomes, with its impact being of paramount importance.

Additionally, the social context in which learning takes place has the potential to significantly augment the effectiveness of the learning process. One additional aspect that impacts learning outcomes is the insufficient availability of high-quality simulation resources. However, Liu and Matthews (2005, p. 398) claimed that it is contended that numerous aspects of Vygotsky's learning theory remain substantiated and validated. Liu and Matthews (2005, p. 388) referred to one of the criticisms directed at social constructivist learning theories: the inability to adequately address the transfer of learning in cross-community contexts. Further, Erlam et al. (2017, p. 3) presented some limitations of the simulation to support social constructivism by discussing some arguments that the simulation lacks clear instructions for facilitators to actively engage in the simulation processes, which is difficult, especially when the simulation is designed with the intention of social constructivism. Another issue associated with the constructivist approach is the potential for learners to unintentionally develop knowledge that is either erroneous or not optimally suited to the problem at hand (Kala et al. 2010). This suggests that high-fidelity manikin simulation is not necessarily compatible with constructivist theory because not all learners in high-fidelity manikin simulation construct new knowledge, as there are learners in simulation activities who prefer to acquire information from the information provided by teachers and have no intention of interacting with their peers in the environment; alternatively, not all learners in simulation are from different learner levels. Erlam et al. (2017) suggested another theory that could also match the characteristics of the simulation environment: cognitivism.

2.4.4 Cognitivism

Forrest and McKimm (2019, p. 15) stressed that cognitivism pertains to the concealed mental processes involved in activities, such as perceiving, retrieving memories, and solving problems. This means that the cognitivist approach to learning entails a shift away from stimulus–response learning models towards an emphasis on students' cognitive processes, including their beliefs, thought processes, perceptions, and insights. Erlam (2015) argued that Bandura's research revealed that individuals have the capacity to acquire novel behaviours through the process of observational learning, wherein they can acquire these behaviours by simply observing others engage in them. Significantly, the individuals in the study were not required to execute the activities during the learning phase.

The concept of cognitivism has a significant influence on the design of simulations, particularly in the development of pre-briefing materials and model simulation clips that aim to demonstrate the proficient care provided by experts in managing clients throughout deteriorating clinical scenarios. Students have the ability to acquire knowledge through the process of seeing model clips, such as YouTube videos. Therefore, learners have the capacity to incorporate this learning into their cognitive schema prior to participating in the simulation session.

To explain the relationship between simulation and Piaget's work, which inspired thoughts on how to maximise the development of such cognitive schema, Schunk (2012) posited equilibration, which refers to the inherent inclination to attain an optimal state of equilibrium or adaptation between cognitive structures and the environment, serving as the principal impetus driving cognitive development. To address cognitive dissonance, individuals have the option of employing either assimilation or accommodation, which are two fundamental processes of equilibration. Assimilation is a cognitive process that involves incorporating external information or experiences into pre-existing mental frameworks or structures. The concept of accommodation pertains to the process of modifying internal structures in order to align them with external reality. Both of these processes facilitate the acquisition of knowledge through simulation as students endeavour to attain a state of balance.

In simulation, the acquisition of proficiency in recognising and recalling major patterns can require a substantial investment of time, with experts often dedicating thousands of hours to developing this skill. A proficient individual possesses extensive knowledge of several domain-specific patterns and norms. They also possess the ability to discern when it is confirmed to deviate from these rules, a skill that is nearly as crucial as mastery of the rules (Pretz et al. 2003). As a result, professionals possess the ability to identify infrequent occurrences within a specific field, as well as situations that may initially appear to be one thing but are perhaps something else. Similarly, those with expertise possess the ability to effectively discern and choose the most optimal course of action among a range of viable possibilities. The continual development and retention of expertise is a perpetual undertaking for healthcare professionals, encompassing the accumulation of contextually relevant knowledge pertaining to the healthcare setting itself (Forrest and McKimm 2019, p. 15).

Erlam and Clair (2016) observed instances of accommodation when students were presented with a simulated video depicting educators providing care for a distressed infant with a croup. The video demonstration depicted the delivery of nebulised medicine preceding the intramuscular injection. The simulation was conducted by students who administered the injection prior to administering the nebuliser. After observing the reversed sequence in the model video, the participants made adjustments to their own performance to maintain coherence with this external reality. The individuals were capable of providing a justification for the appropriateness of this modification, stating that ‘the administration of nebulised medication allows for faster absorption compared to injection; thus, it should be administered prior to the injection’. The provision of this accommodation and explanation instilled in the students an increased sense of assurance in their ability to effectively and securely provide care for a patient of this nature.

In EMS education, cognitivism becomes evident as paramedic students acquire knowledge of pathophysiology through theoretical lectures. The utilisation of high-fidelity manikin simulation is particularly suitable for cognitive learning, as it facilitates the development of critical thinking and clinical reasoning skills among paramedic students. The integration of pathophysiology and pharmacology ideas into high-fidelity manikin simulation exercises can enhance students’ clinical skills. However, the concept of cognitivism has also received criticism. For example, Erlam et al. (2015) emphasised that in the context of learning, the presence of schemata can enhance the meaningfulness of the learning experience. However, it is important to note that a learner may encounter significant challenges when faced with a lack of appropriate schemata or pre-existing knowledge that is necessary for understanding and assimilating new information. Burke and Mancuso (2012) also supported this perspective, as they posited that simulation in the realm of developing clinical thinking and problem solving is grounded in cognitive theory. The absence of cognitive architectural characteristics in instructional design may result in inferior outcomes inside the simulation lab. The theory of constructivism steers the construction of simulations along a distinct trajectory.

2.4.5 Social learning theory

Banduras' explanation proposes that by means of careful observation and soliciting feedback, the learner gathers information from the surrounding environment regarding the anticipated standards of performance (Bandura and Walters 1977, pp. 145-150). Social learning theory proposes a mutually influential association between an individual's behaviour and their social and physical surroundings, wherein both factors exert an impact on one another. Thus, simulation-based environments that accurately replicate the real healthcare environment have the potential to enhance learners' acquisition of transferrable expertise to a greater extent compared to environments with lower contextual fidelity (Forest and McKimm p.19).

In the context of simulation scenarios, students are frequently given two distinct categories of roles: process-based roles and response-based roles (Jeffries 2008). Students who are involved in process-based roles, such as EMS educators or paramedic student team leaders, possess the capacity to make decisions during the scenario and are actively involved in interacting with the high-fidelity manikin simulation. Students who assume response-based roles, such as spectators, do not actively engage with the high-fidelity manikin simulation. Typically, process-based roles are initially assigned, followed by the allocation of response-based roles to the remaining learners. There may be various challenges that arise when students engage in the role of observer in a response-based context. It is possible for students to assume a passive role as witnesses and display a lack of attentiveness towards the events unfolding in a given circumstance (Bethards 2014). However, Kaplan et al. (2012) findings demonstrated that there is no difference in the learning experience in simulation activities between the students participating in the observational role and in the process-based role. In addition to these roles, Brauer and Tittle (2012) noted that whereas social learning theory discards traditional belief, in actuality, new theory has experienced renewed criticism in the last twenty years. These authors also argued that social learning theory lacks sufficient empirical support (Proctor and Niemeyer 2020).

The debates surrounding social learning theory reflect the need to examine its validity in different learning settings. Moving the debate forward, Brauer and Tittle (2012) called for longitudinal research capable of observing operant conditioning mechanisms. The EMS educator usually assigns one of the paramedic students to be a team leader during the high-fidelity manikin simulation, and the rest of the students become observers. Therefore, paramedic students should have their attention directed towards the running scenario to learn from it and cannot learn much by just observing the simulation scenario. The EMS educator should give the paramedic students the opportunity to discuss what they observe so that they can compare their judgement with those of other students.

Once the paramedic students have organised the elements of the simulation scenario, the EMS educator refines the desired learning outcomes by giving subsequent feedback to the students. The EMS educator should be conscious of applying the four phases of enactment to model behaviour. The EMS educator should consider the extrinsic factors that motivate paramedic students inside the simulation labs, such as the promise of a reward. As a sequence, designing opportunities for attention, retention, motor reproduction, and motivation processes helps ensure that all paramedic students participating in the high-fidelity manikin simulation experience, regardless of their role, have the same opportunities to achieve the scenario learning objectives. Moreover, Bethards (2014) suggested a list of the four components of Bandura’s observational role in the high-fidelity manikin simulation: providing worksheets or guidelines for observers to ‘attend to’ modelling behaviours, assigning different concepts to each observer, and verbally debriefing immediately after the scenario. Facilitating observer involvement in the discussion through learner-led debriefing can ensure that scenarios have the same basic behavioural skills and provide a clear description of expectations and responsibilities.

2.4.6 Situated learning theory

Brown et al. (1989, p. 3) argued that the theory of situated learning places emphasis on the significance of the circumstance or context in which knowledge is acquired. The proposition is that knowledge is inherently contextual, as it is not only influenced by the specific temporal and spatial circumstances in which it is acquired but is also actively shaped by the process of learning itself. The situated learning theory encourages educators and learners to emphasise and effectively handle the discrepancies between the actual practice environment and the simulated learning environment (Forrest and McKimm 2019, p. 17). Yardley et al. (2013) claimed this as being mindful of the gap. Situated learning proposes that it is important to consider the representation of the practice environment in an SBE. There appears to be a demand for increased authenticity’ in the given situation, wherein the simulation scenario aligns with the real-world practice setting in a suitable manner. It could also indicate that in certain cases, SBE may not be the appropriate setting for acquiring practical knowledge or that in-context simulation might be more advantageous (Paige and Daley 2009).

In summary, high-fidelity manikin simulation activity is an educational modality that has garnered significant attention from scholars and practitioners alike. Its conceptual underpinnings and practical applications have been the subject of extensive discourse among educators and academics, aiming to elucidate its fundamental nature and its alignment with established theories of experiential learning. Moreover, the literature suggests that the utilisation of high-fidelity manikin simulation is characterised by a prevalent eclectic approach to learning. Behaviourist principles play a crucial role in the acquisition of new skills within the psychomotor domain. Cognitive principles, by contrast, facilitate the conceptualisation of knowledge, as exemplified by the EMS process within the cognitive domain. Lastly, constructivist principles elucidate the personal significance attached to the knowledge acquired within the affective domain. The aforementioned frameworks all provide a rationale for the importance of learning at various stages. However, it is imperative to acknowledge that a comprehensive understanding of learning in simulation cannot be achieved through the lens of any single paradigm. The implementation of high-fidelity simulation necessitates the inclusion of learning opportunities that afford the learner, specifically the student, immersive experiences in a practical setting, commonly referred to as practical. The utilisation of this high-fidelity manikin simulation environment aligns with educational frameworks grounded in an experience-based approach to learning. Furthermore, scholarly articles discussing the utilisation of high-fidelity manikin simulation have referred to experiential learning as the dominant pedagogical framework (Parker and Myrick 2010). However, it is imperative to conduct further study to elucidate the significance and impact of simulation, as well as the learning theories that underpin them, in order to optimise their advantages and facilitate optimal learning outcomes in simulated environments. The integration of several learning theories into the development of simulations has potential. The primary objective of this PhD dissertation is to investigate faculty's and students' perceptions of high-fidelity manikin simulation within the context of these learning theories. The investigation of participants' perspectives regarding their preparedness, obstacles, and challenges in constructing the simulation scenario has provided valuable insights into the potential use of the different learning theories within a research setting.

2.5 Evaluation of High-Fidelity Simulation in Healthcare Education

The purpose of evaluation procedures is to systematically gather, categories, and analyse data pertaining to the progress, execution, and results of programmes (Fry and Hemmer 2012, p. 289). Evaluations may encompass a variety of objectives, such as assessing the viability of a programme before its execution, ascertaining the fidelity of programme implementation, evaluating the impacts of a programme (which can be examined at various levels, ranging from individual outcomes to broader population-level effects), and comprehending the underlying mechanisms that drive programme outcomes (Brenas and Shaban-Nejad 2020). The importance of evaluation in the field of HFS in healthcare education cannot be overstated (Carey and Rossler 2020). The utilisation of this approach enables the enhancement of both the substance and execution of interventions, the evaluation of various immediate and enduring effects of HFS, and the facilitation of informed determinations regarding the distribution of financial resources. Ideally, evaluation encompasses the measurement of both programme outcomes and impacts (referred to as outcome evaluation), as well as the comprehension of the underlying processes that contribute to these outcomes (known as programme evaluation).

Increasingly in HFS research, there has been a trend towards more robust approaches that are rigorous and utilise theory (Jeffries 2021). In the context of evaluation, the utilisation of frameworks or models has been employed to provide guidance for the evaluation process. Various evaluation models are employed in the HFS. One example of a result evaluation model that has received significant attention in the academic literature is the Kirkpatrick model, which has been widely referenced in simulation research (Jeffries 2020; Noh et al. 2020; Piot et al. 2020). In the Kirkpatrick model, the four levels of evaluation consist of reaction, learning, behaviour, and results. Due to the flexibility of the Kirkpatrick model, it can be adopted to evaluate learning situations, such as HFSs, and to determine which levels are appropriate for evaluating and selecting the tools that work in a given situation (Kirkpatrick and Kirkpatrick, 2016). Learner's satisfaction and self-confidence (Level 1), both reactions to simulation, are the measures that have been the most heavily reached (Wilson and Wittmann-Price, 2014, p. 315). Learner's reactions to simulation have been overwhelmingly positive (Jeffries, 2022 p. 23). In the Kirkpatrick model, learning (Level 2) is measured as a cognitive construct (Dos et al. 2016; Al Khasawneh et al. 2021; Kiernan, 2018). Simulation can be utilised by simulation educators as a means of critically examining the utilisation of knowledge assessments only for a specific practice profession (Alconero-Camarero et al. 2021).

The last two levels of behaviour and results in the Kirkpatrick model have not been studied as extensively as satisfaction and learning. Behaviour measures the change in job performance resulting from the learning process, while results measure the tangible outcomes of the learning process in relation to cost, quality, and efficiency (Kirkpatrick and Kirkpatrick 2016). The challenge associated with seeking and sustaining behavioural modifications in the workplace as a result of simulation is attributed to the prevailing organisational culture (Jeffries et al. 2015). However, the model has had numerous criticisms, originating from both internal and external sources within the subject of HFS, as well as within and beyond the field of simulation (Yardley and Dornan 2012). The model primarily emphasises results, neglecting to account for the influence of person and contextual factors on training outcomes (Frye and Hemmer 2012). It does not allow for the underlying mechanisms that influence the outcomes to be explored. Moreover, the focal results pertain to immediate, measurable outcomes. Evaluating longer-term, intricate outcomes, such as those anticipated in Levels 3 and 4, poses significant challenges, as indicated by the comparatively higher frequency of measurements for Levels 1 and 2 in comparison to Levels 3 and 4 (Steinert 2018). Further, the model posits the existence of positive causal links between the levels. It may be inferred that positive reactions play a significant role in enhancing the process of learning, hence resulting in behavioural modifications and beneficial outcomes in programme implementation.

The Kirkpatrick model primarily emphasises the intended objectives of educational interventions while potentially overlooking consequences that fall beyond the model's categorisation as well as unintentional impacts. Therefore, there are a number of other evaluation models that can be used in healthcare education, which, although used less frequently than the Kirkpatrick model, are better placed to evaluate the complex processes that occur in HFS, such as CIPP, realist evaluation, theory-driven evaluation, contribution analysis, layered analysis, and the RE-AIM framework (Allen et al. 2022).

2.6 Models of Evaluation in Healthcare Education

Outcome evaluation is a type of assessment that concentrates on assessing the outcomes or impacts of a specific intervention, with the aim of addressing the question, ‘Did the intervention achieve its intended results?’. Outcome evaluations are commonly driven by a taxonomy, such as the Kirkpatrick model, which offers a straightforward approach for classifying outcomes and is known for its ease of use (Haji et al. 2013). Although outcome evaluations are valuable for determining the effectiveness of a particular intervention, they often overlook the intricate structure of educational interventions and the underlying processes that contribute to outcomes, including long-term and unintended consequences. The probable explanation for the lack of substantial effects observed in the majority of educational intervention research is likely to be attributed to this factor (Cianciolo et al. 2019).

Programme evaluation, by contrast, aims to surpass the mere determination of whether a programme is effective by delving into the mechanisms and reasons behind its success. Programme evaluation encompasses the systematic examination and assessment of a programme, encompassing both its design and implementation, as well as its resulting consequences (Frye and Hemmer 2012). The objective of programme evaluation is to ascertain the factors that contribute to the variability in programme results, both internal and external, and to assess whether these factors, as well as the outcomes themselves, are favourable or unfavourable (Frye and Hemmer 2012, p. 289). It is therefore a more appropriate approach to use in evaluating the complex interventions and systems that are usually the focus of simulation research. The use of outcome evaluation is prevalent in simulations.

The example of the Kirkpatrick model illustrates that outcome assessment models should not be considered the definitive standard for programme evaluation for a multitude of reasons. It is imperative to provide researchers and evaluators with the necessary tools and knowledge to transition from outcome assessment methods that solely concentrate on preset results without delving into the underlying mechanisms and causes of these outcomes (Allen et al. 2022). Instead, there is a need to adopt programme evaluation models that possess the capacity to comprehensively capture the intricate nature of health promotion and education (HPE) interventions (Allen et al. 2022).

2.7 Key aspects of Embedding Simulation in a Programme

McGaghie et al. (2010) clarified that there is a substantial body of literature that provides ample evidence supporting the incorporation of simulation into clinical education programmes. However, there is a certain reluctance to fully embrace and implement this pedagogical approach. Forrest and McKimm (2019, p. 21) confirmed that the emphasis lies on the utilisation of the equipment rather than on contemplating the most suitable application of simulation within the programme and the expected learning outcomes. The misperception that simulated learning is primarily a technological tool rather than a pedagogical approach can ultimately result in a failure to fully capitalise on available learning opportunities. Dedicating sufficient time to contemplate the utilisation of simulation in a programme and employing careful planning might yield beneficial outcomes for both learners and faculty members.

A comprehensive six-stage methodology, namely identify, learn, quality, assessment, feedback for learners, and feedback for faculty (ILQAFF), has been designed to facilitate the strategic planning and effective implementation of simulated learning. This concept has the potential for application in several settings (Forrest and McKimm 2019, p. 21). The ILQAFF stages included the most common characteristics of implementing simulations from the literature review. The following sections provide the main general characteristics that implementing simulation has, along with a discussion of their meanings.

Some researchers believe that the main idea of implementing simulation is to identify the main target audience, the need for training, and the learner needs, and that the educator is required to collaborate closely with the operating teams to ascertain the equipment requirements, room design, and staff support needs. The accessibility of necessary equipment, resources, and manikin simulators is required for the planned event (Riley, 2015, p. 33; Forrest and McKimm, 2019, p. 21). Wilson and Wittman-Price (2018, p. 18) defined the planning stage in simulation as identifying the simulation team, identifying whether the simulation will or will not be videotaped, and identifying the materials needed. Brewer (2011) found that the planning process can be systematically divided for each scenario to prevent it from becoming excessively burdensome. However, it is important to note that even preparation for a single simulation can be time-consuming. Despite the use of robust planning, the scenario frequently undergoes development and evolution over time, necessitating more modifications (Riley 2015). McKimm and Forrest (2013, p. 169) argued that in order for a centre or course to achieve success, it is imperative to incorporate additional activities during the planning phase. This study encompasses various aspects, such as quality assurance, governance, ethics, storage, maintenance, and the imperative to recognise the shifts in contemporary healthcare delivery. Hence, the implication is that for the successful implementation of simulation practices, stakeholders should engage in the early stages before the scheduled simulation. This perception can be attributed to a limited comprehension of the potential benefits offered by simulation practices. It is important to recognise that simulation is not merely an additional work to be included in instructional methods but rather a valuable tool that can enhance teaching delivery. There is concern that EMS programmes in Saudi Arabia begin to use the high-fidelity manikin simulation without the appropriate environment, administrative support, or faculty preparedness. Thus, this thesis assesses the preparedness of the faculty to lead and implement high-fidelity manikin simulation and to direct EMS programmes on the appropriate method for establishing and using simulation in the undergraduate curriculum (Alexander et al. 2015).

It is important to consider that the foundation of every educational intervention should be rooted in the learners' needs rather than the educators' subjective perceptions of what should be taught (Forrest and McKimm, 2019, p. 21). Riley (2008, p. 69) clarified the meaning of the learner's needs by highlighting the learning objectives that need to be identified. The recognition of prior learning and experiences among the learner group is crucial, and engaging in discussions with experts within the professional or clinical setting can enhance comprehension and facilitate the growth of the learning event. Rather than asking, What am I going to teach?, instructors should consider the question, What does the learner want or need to learn? Alinier (2011) stated that the number of learning objectives often ranges from one to four, depending on the length of the simulation scenario and the proficiency levels of the participants. Forrest and McKimm (2019, p. 21) explained that objectives should be formulated in a manner that adheres to the SMART criteria, which stand for specified, measurable, achievable, realistic, and time-bound. This approach enables the assessment of whether objectives have been satisfactorily accomplished. Therefore, before implementing a high-fidelity manikin simulation, the EMS educator should have a written description of the objectives based on the learner's needs.

Local simulation and clinical education centres, as well as universities and simulation organisations, such as the Association for Simulated Healthcare in Practice and the International Nursing Association for Clinical Simulation and Learning, can assist in the identification of suitable courses and accreditation options (Purva and Nicklin 2018; Durham 2013). According to the standards, simulation activities should be in alignment with the curricula or training needs so that the patient perspective is at the centre of education planning. The institution's faculty member who is experienced in simulation-based education oversees the programme design and ensures that it is kept to date and relevant. If there is any assessment as part of the simulation, this assessment is quality assurance, and programmes and faculty undergo regular evaluations (Purva and Nicklin 2018). Furthermore, both the Association for Simulated Practice in Healthcare and the International Nursing Association for Clinical Simulation and Learning offer guidelines for the optimal implementation of SBE. The formulation of objectives should adhere to SMART criteria, ensuring that they are specified, measurable, achievable, realistic, and time-bound. This approach enables a comprehensive evaluation of whether the objectives have been successfully accomplished (Forrest and McKimm 2019, p. 21). However, Sunderland (2017) believed that faculty members engaged in the development and implementation of simulated learning scenarios should have received training and undertaken evaluation in this particular pedagogical approach. Thus, professional standards for educators are currently being widely embraced in conjunction with the growing implementation of regulations and quality assurance measures. EMS educators, consequently, must possess an awareness of these transformations and be equipped to adopt a lifelong learning stance towards their personal growth and advancement (Forrest and McKimm 2013, p. 4). Formal training for EMS educators is required by standards of best practice, simulation guidelines, and regulations. The literature identifies a relationship between the effective training of simulation educators and the higher achievement of expected learner outcomes (Beroz 2017). Unintended or negative consequences for paramedic students can occur if EMS educators are not adequately trained in the use of high-fidelity manikin simulations (Kolbe and Rudolph 2018). Paige et al. (2020) identified the areas where educators need training to implement effective simulation, such as debriefing, coaching, scenario design, evaluation of learning, feedback, and simulation standards.

The selected assessment methods should accurately align with the intended learning objectives. It is crucial to take into account the purpose of assessment, specifically whether it is formative, which involves identifying the strengths and weaknesses of learners and providing feedback on how they can enhance their performance, or summative, which involves evaluating learning based on rigorous marking criteria, often resulting in a pass or fail outcome, also referred to as high-stakes assessment. If there is uncertainty over the necessity of summative assessment, it is advisable to consider its implications for patient safety. Could there be a heightened risk to patients if a satisfactory level of practice is not achieved? If the response is affirmative, it is necessary to implement summative assessment (Forrest and McKimm 2019, p. 21). A good episode of skill teaching should incorporate components of positive critique and provide opportunities for both initial and summative assessments, as well as formative assessments (Riely 2008, p. 78).

In addition to offering feedback on the selected assessment methods, such as video debriefing, it is important to contemplate the potential benefits of alternative mechanisms that might be advantageous for students. For instance, learners can be granted access to their recordings for personal reflection subsequent to the event. The utilisation of feed forward, which focuses on enhancing future performance, and impassive approaches, which involve comparing progress to previous performance irrespective of overall achievement, can be especially advantageous in educational programmes that span a period of weeks or months (JISC 2015). Feedback with high-fidelity manikin simulation is crucial in EMS education for three reasons: feedback has the potential to enhance motivation among paramedic students through the identification of disparities between their current performance and the desired level of performance. Additionally, feedback serves to alleviate uncertainty regarding paramedic students' performance and facilitates the acquisition of error correction skills. Specifically, corrective feedback serves the purpose of drawing attention to faults, substituting the faulty action with the appropriate reaction, and strengthening the response in order to enhance the likelihood of paramedic students engaging in appropriate behaviour in subsequent instances.

2.8 Key Aspects of High-Fidelity Manikin Simulation Phases

In their book on simulation, Hertel and Millis (2002, p. 38) indicated that the purpose of including scenarios, often referred to as cases, in healthcare simulations is to establish a contextual framework that facilitates the acquisition of clinical practice knowledge. They offer a distinctive framework for incorporating substantial principles. Hellaby (2013) pointed out that every simulated learning event incorporates components that actively include various learning theories, whether through the use of scenarios, debriefing sessions, or following scenarios that allow for the application of acquired knowledge and skills. Forrest and McKimm (2019, p. 23) clarified that scenarios play a crucial role in simulation-based education (SBE) and need careful design to guarantee that the simulation effectively targets predetermined learning objectives. Developing scenarios can present challenges and may require several iterations to effectively facilitate learning. This suggests that it might be important to specify a particular number of steps that illustrate the simulation phases. However, Forrest and McKimm (2019, p. 22) identified simulation phases that can be used to guide simulation scenarios, such as preparation, briefing, simulation activity, debriefing (feedback), reflection, and evaluation. The background provides context for the event, allowing learners to situate themselves inside the constructed world (Hellaby 2013). Riley (2008, pp. 33-35) claimed that a lesson plan serves as a strategic guide for trainers to efficiently present a lesson, enabling learners to successfully attain the intended learning outcomes. The plan has several components, such as objectives, educational goals, instructional strategies, assessment techniques, evaluation procedures, and required resources. A well-designed instructional session allows both instructors and learners to clearly visualise their objectives, the path they will traverse, and the challenges they will experience along the way. Simulation is a pedagogical approach that endeavours to establish a secure setting for practical training by employing proficient planning and facilitation abilities, as well as a blend of clinical and classroom-oriented instructional techniques. It is crucial to allocate an adequate amount of time for the processes of briefing, scenario participation, and debriefing.

Some researchers have attempted to assess students' preparedness before the simulation activity. For example, Biggs (2014) posited that the curriculum effectively incorporates and harmonises learning outcomes, teaching, and learning experiences, and assessment and evaluation methods. Forrest and McKimm (2019, p. 25) claimed that simulation activities should be developed to supplement other learning experiences, namely the acquisition of clinical and practical skills and competencies. These experiences occur in many settings, including the classroom, clinical rotations, and skills laboratories. In addition, Kneebone (2009) explained simulation as a highly valuable tool for the integration and reinforcement of clinical and communication skills education, as it allows for the recreation of the authentic setting of patient care in a controlled environment. This suggests that with respect to a simulation, preparation, which should be planned in advance, whether technically or in terms of supplies, can be implemented effectively for learners. However, Forrest and McKimm (2019, p. 25) claimed that the scenario should be structured based on predetermined learning outcomes, which can be articulated as either performance objectives or competences. According to established guidelines, it is recommended to limit the number of elements within each area of knowledge, skills, and behaviour to a maximum of three. Forrest and McKimm (2019, p. 25) further underscored that a meticulously designed simulation guides the overall trajectory of the learning experience for both learners and facilitators. The academic analysis encompasses the evaluation of various factors, such as the prescribed curriculum, the learners' experiences, and the range of resources at hand, including time constraints. It also involves assessing the delivery methods, the availability and expertise of faculty members, the teaching and learning environment, the necessary equipment, the course schedule, and the profiles of the learners, whether they are from a single profession or multiple professions. The lesson plan has three essential components: the concise outline, the simulated event (scenario), and the debriefing.

The feature of briefing in simulation activities is derived from the concept of introducing the scenario, which prepares both learners and instructors to participate in the active learning experience of the simulation. According to Riley (2008, p. 73), it is important for learners to have a clear comprehension of the anticipated requirements at the initiation of the simulated activity. This includes discerning elements that can be effectively simulated and that cannot be feasibly replicated. This can be effectively achieved by providing a concise orientation and briefing session before engaging in the activity. It is important to note that if the teacher does not demonstrate a belief in the efficacy of simulation as a learning tool, the learners are likely to adopt a similar perspective.

Many researchers have illustrated briefing needs in simulation activities; for example, Hellaby (2013, p. 28) argued that the purpose of a briefing is to cultivate a secure learning environment, define the anticipated objectives of the session, provide guidelines for appropriate conduct, and acquaint the learners with the simulation location and equipment. Further, Husebø et al. (2012) argued that the briefing step, despite its significance, is sometimes overlooked, but it is a crucial opportunity to evaluate whether the learners possess a comprehension of the instructions and to provide clarification if required. Additionally, it emphasises the need to clarify the exact elements that will be addressed to mitigate any potential ambiguity or confusion (Husebø et al. 2012). Moreover, Crawford et al. (2019, p. 119) recommended utilising a written or recorded briefing strategy for every scenario, particularly for those that include high-stakes evaluation. This will aid a student in developing a sense of confidence in meeting the expectations and requirements of a specific setting.

Akselbo and Aune (2023, p. 5) confirmed that pre-briefing activities serve the purpose of creating a psychologically secure learning environment through two strategies: (1) facilitating the establishment of a shared cognitive framework among learners and equipping them with the necessary knowledge and understanding to engage with the educational material presented in the simulation-based experience (preparation); and (2) communicating essential guidelines for the simulation-based encounter (preparation session). Existing research suggests that an effective structure for the briefing process is crucial to effectively achieve the desired learning results. Meakim et al. (2013, p. S7) suggested steps for conducting a briefing encompass an introduction to the equipment, environment, responsibilities, time allocation, objectives, and patient circumstances. The pre-briefing session in the high-fidelity manikin simulation is designed to establish the atmosphere and expectations for the forthcoming educational encounter. The pre-simulation briefing encompasses various essential elements. The activities encompassed in this process are the evaluation of the session's goals and objectives, the establishment of a fiction contract agreement with paramedic students, the provision of logistical information pertaining to the session, and the commitment to treat the students with due respect. The aforementioned components aim to establish a psychologically secure environment for paramedic trainees, fostering a sense of ease and facilitating the process of making and learning from mistakes. According to Hughes and Hughes (2019), the absence of psychological safety inside the simulation lab setting can hinder students' ability to fully maximise their learning experience.

The clinical scenario should be framed within the context of the learners' clinical experiences. It is important to recognise that the concept of learning opportunities is closely associated with a willingness to engage in the present moment within a training context (Forrest and McKimm 2013, p. 49). Dieckmann et al. (2010) clarified that in a given scenario, participants have the option to adhere to the intended course of action, therefore experiencing the learning opportunities that have been strategically designed by the simulation team. However, it is also plausible for players to deviate from the anticipated path and respond in unforeseen ways, both by the simulation team and themselves. In some situations, the presence of lifesavers may become necessary to adapt to unforeseen circumstances or to halt and then resume the scenario. Vygotsky and Cole (1978) stated that for situations that prove too challenging, it is plausible that participants may necessitate additional time or a more lucid exposition of the issue in order to independently arrive at a solution. If the scenario is deemed too simplistic, it may be necessary for participants to confront supplementary obstacles to expand the zone of proximal growth. In addition, Forrest and McKimm (2013) explained that the simulation team should possess the capacity to identify the educational opportunities that arise from unforeseen circumstances. The objective is to determine the appropriate degree of optimal difficulty for the learner rather than only focusing on the amount of difficulty in the scenario that exceeds the participants' coping abilities.

The existing body of literature pertaining to this topic is in consensus that a debriefing session that follows a systematic approach fosters reflective learning. This outcome is more likely to be achieved when the debriefing session is carefully and thoughtfully designed (Gururaja et al. 2008; Fanning and Gaba, 2007). Feedback plays a crucial role in the process of learning and is widely seen as the most significant factor in facilitating effective learning within the context of simulation-based medical education (McGaghie et al. 2010). According to Forrest and McKimm (2019, p. 25), when constructing or organising a scenario, there may be a temptation to assign equal or greater amounts of time to the actual delivery of the scenario. However, it is more beneficial to adhere to a ratio of 1:2, meaning that a 20-minute scenario should be followed by a 40-minute debriefing session. To facilitate reflection and learning during this phase, debriefing models recommended prioritising the predetermined objectives of the simulation and employing a systematic methodology instead of relying on unstructured dialogues (Dreifuerst 2009). Many researchers have illustrated that there are several debriefing techniques available that are based on evidence and theories derived from educational research. The selection of a certain approach is determined by the faculty. The refocusing of learners on learning outcomes and the assessment of their achievements are of significant importance. This process may be improved by the use of video capture, labelling, and subsequent review. It is essential to receive feedback from both experienced faculty members and peers who are sufficiently knowledgeable and prepared to deliver helpful comments (Forrest and McKimm 2019, p. 25). For example, in Akselbo and Aune's (2023, p. 49) debriefing framework derived from Steinwachs' debriefing model, all instructors who participate should be acquainted with the subject matter throughout their training as facilitators. The students are led by the facilitator in a structured manner through the three distinct phases of debriefing: description, analysis, and application (Akselbo and Aune 2023, p. 50). Further, Hellaby (2013, p. 40) argued that if the debriefing process is executed inadequately, it possesses the capacity to generate confusion among learners, diminish their confidence, and negatively impact the overall reputation of the simulation.

Facilitating reflection regarding personal capabilities and establishing connections between these proficiencies and the clinical environment are crucial endeavours (Forrest and McKimm 2013, p. 29). According to Atkins and Schutz (2013), the significance of meticulous observation of the process in various scenarios, as well as subsequent reflection during debriefing sessions, cannot be overstated. These practices allow participants to delve into the potential learning outcomes that may be derived from simulations and applied to their real-life professional endeavours. The facilitators' capacity to foster reflection necessitates the possession of certain skills, including accurate observation and the ability to provide non-judgmental descriptions of actions. The manner in which facilitators interact with learners during HFS can vary, particularly when working with a group of learners who are engaged in a simulation scenario. This includes actively listening to learners' verbal communication regarding their skills and employing effective open-ended questions (Forrest and McKimm 2013, p. 93). Simulation exemplifies Kolb's experiential learning cycle, wherein learners engage in or observe an experience and subsequently engage in a debriefing session. During this debriefing, learners engage in a process of reflection and learning that can subsequently be implemented within the clinical context (Crawford et al. 2019, p. 195). Hellby (2008, p. 72) confirmed that it would be beneficial to inform students that although perfection is not anticipated, the aim is to utilise interaction with the simulation environment as a means for subsequent reflection. The use of video can significantly enhance the process of reflecting on one's actions. In fact, educators who employ experience-based simulations find that they are able to build and improve their skills at an accelerated rate. This technique may be used for both self-reflection and supported reflection following an event (Hellby 2008, p. 76). Abegglen et al. (2020) suggested using readily available models to evaluate debriefing, particularly the Objective Structured Assessment for Debriefing from Imperial College of London and the Debriefing Assessment for Simulation in Healthcare from Harvard.

In a general sense, the objectives of assessment encompass guiding learning, known as formative assessment or assessment for learning, as well as evaluating learning, referred to as summative assessment or assessment of learning (Forrest and McKimm 2019, p. 71). An effective skills-teaching simulation activity should incorporate the practice of providing constructive feedback, offering opportunities for initial, formative, and summative assessment, and undergoing evaluative inspection to ascertain its achievement of intended outcomes (Hellaby 2008, p. 78). If the objective of the assessment is to facilitate learning, learners will be motivated to demonstrate and enhance their areas of weakness. When the objective is to assess one's learning, individuals may have a tendency to conceal their areas of weakness and instead emphasise their strengths. Individuals will likely desire to refrain from situations that may expose their shortcomings (Forrest and McKimm 2019, p. 71). According to Forrest and McKimm (2013, pp. 65-67), simulation allows individuals involved in assessment to consistently and reliably evaluate clinical performance through the utilisation of advanced technology, such as high-fidelity manikins. However, numerous checklists and global rating scales have been extensively developed, tested, and validated in diverse contexts. These instruments, including the Objective Structured Clinical Examination, the Objective Structured Assessment of Technical Skills, and the Rescuing a Patient in Deteriorating Situations, present both opportunities and challenges for educators.

Further, Forrest and McKimm (2019, p. 72) argued that the validity of relying on learners' verbal or written appraisals of their intended actions is comparatively lower than that of actual observation. The optimal scenario would involve closely observing paramedic students in diverse clinical practice settings where they encounter varied degrees of external demands and internal tensions. Simulating diverse environments is a valuable alternative to real-life events, as it allows for the replication of infrequently observed or difficult-to-observe occurrences.

In summary, the term high-fidelity manikin simulation can be seen in health education as an experiential learning activity, assessment, briefing, scenario, and debriefing. Akselbo and Aune (2023, pp. 41-43) considered simulation activities to be successful when they have at least two of the following characteristics: (1) the inclusion of students' viewpoints is crucial in the assessment of simulation exercises as an effective pedagogical approach for attaining learning objectives and in substantiating the substantial allocation of resources necessary for conducting such simulations, and (2) a comprehensive understanding of the professional domain is needed to offer students sufficient assistance during all phases of the simulation activities. To guarantee this, the individuals participating in the simulations consisted exclusively of paramedics or healthcare experts. Additionally, they possess extensive teaching experience, are qualified facilitators, and serve as simulation facilitators. Due to the inherent unpredictability of simulations, the expertise of the participating teachers plays a crucial role in effectively managing unforeseen circumstances. Moreover, the simulation laboratory is meticulously prepared with the necessary equipment to facilitate the activity, and (3) the simulation group sizes should be between 4 and 6 students who are actively engaging.

Regardless of whether students actively engage in the simulation or passively observe it, their learning outcomes should remain unaffected, as long as they all participate in the pre-simulation briefings and post-simulation debriefings. However, there are ongoing discussions regarding the interpretation of these attributes. This may be attributed to the inherent challenge of defining fidelity in manikin simulation, which varies depending on the simulation modality and the level of fidelity it offers. Therefore, it is crucial to discuss the fidelity of the manikin simulation in order to establish a comprehensive understanding of its definition. This is particularly important for universities and healthcare institutions that rely on simulation and seek to enhance their credibility by incorporating low-, medium-, and high-fidelity simulations. It is evident from the characteristics of simulation that these different levels of fidelity not only facilitate educational benefits for participants but also equip them with skills and knowledge that can contribute to their overall disciplinary, professional, and personal development.

2.9 Participants In High-Fidelity Manikin Simulation Activity

Crawford et al. (2019, p. 149) posited that simulation operations encompass a comprehensive set of roles and duties that delineate the administration, management, coordination, and technological facilitation of simulation activities necessary to effectively support the educational delivery of simulation. It is possible for one individual to undertake all three of these jobs. The development of a simulation operation framework tailored to the specific needs and requirements of your institution is crucial for ensuring the consistent delivery of high-quality simulation experiences. The framework should aim to facilitate transparency and foster collaboration among all stakeholders involved in the simulation, ensuring that each participant in the delivery of the simulated experience comprehends the extent of the help being offered. During certain intervals of a simulation encounter, the personnel may not be visibly present, although they are diligently operating in the background to prepare the facilitator and participants for fruitful experiences. The simulation operation framework effectively enables and empowers all individuals engaged in its operations, fostering the development of trust among different positions within the organisation. This is particularly achieved when a clear vision is established and constantly adhered to. The process of staff support in this simulation operation framework consists of six parts, namely faculty/staff pre-brief, learner pre-brief, scenario implementation, learner debriefing, faculty/staff debriefing, and evaluation (Dadaleares and Crawford 2019, p. 96). However, it is important to know which participants are joining the high-fidelity manikin simulation and how they usually behave when they join these simulation activities. Awareness of low-, medium-, and high-fidelity manikin participants is crucial because it helps with understanding their needs, and this could have a significant effect on the future evolution of healthcare simulation (Dadaleares and Crawford 2019, p. 159). Further, investigation of participants' perceptions, identification of their challenges, and preparedness for simulation are essential to improving high-fidelity manikin simulation in the future and maximising their potential.

Many researchers classify the participants in simulations in terms of their roles or duties. For example, Dadaleares and Crawford (2019, p. 159) classify primary programme stakeholders and compile a thorough needs assessment. The faculty, simulation technicians, specialists, learners, and directors should all document exactly what they need to see and hear from their perspective. Forrest and McKimm (2019, p. 41) stressed that the enhancement of healthcare cannot be achieved just by healthcare practitioners. The aforementioned difficulties are collective in nature, necessitating a collaborative approach to identifying and implementing resolutions. However, the perspectives of caretakers, clinicians, managers, and policymakers vary significantly, and the lack of involvement of all stakeholders often leads to HFS failure. Interaction serves as the fundamental basis of healthcare education. This is similar to Forrest and McKimm's (2013, p. 6) argument, as several factors require careful consideration in the context of a high-fidelity manikin simulation. These factors encompass the identification of learners' training needs and their respective numbers, the recruitment, training, and retention of faculty members, the selection of appropriate equipment and its effective maintenance, the provision of high-quality training that aligns with pedagogical principles and caters to learners' needs, and the implementation of quality assurance measures for all activities.

Furthermore, the establishment of collaborative partnerships with key stakeholders is of the utmost significance, particularly in guaranteeing the long-term viability and endurance of the project (Forrest and McKimm 2013, p. 6). In addition, Wilson and Wittmann-Price (2018, p. 91) added that the simulation should include the participation of all relevant educational stakeholders and should obtain essential administrative support, encompassing financial resources and necessary materials. One of the essential responsibilities entails the provision of instruction to stakeholders, including learners, educators, and simulation technicians, regarding the utilisation of low-, medium-, and high-fidelity manikin simulations as an educational approach (Wilson and Wittmann-Price 2018, p. 161). These explanations support the conclusion that participants in HFS activities are either educational or administrative. Educational participants are usually those who are running the simulation, which makes them lead the scenario and pre-brief their learners by meeting their learning outcomes and tasks to complete summative or formative assignments, as well as interact and collaborate with their learners in debriefing and reflection on their clinical performance, whereas administrative participants may join the simulation to wholly or partially maintain the equipment and maintain it or provide funds and provide all the necessary materials for the simulation experience.

Coordinators, also known as managers, effectively handle day-to-day operations. Coordinators are individuals with extensive managerial experience, exceptional time management abilities, technical proficiency, and the capacity to collaborate across several fields with ingenuity, composure, and perceptiveness, often in demanding circumstances (Crawford et al. 2019, p. 53). In general, their responsibilities encompass the coordination of many aspects, such as regulating entry to premises, overseeing the usage of equipment and supplies, and, in certain cases, managing the logistical aspects related to transportation to on-site clinical areas. Coordinators collaborate with operations directors to ensure the accuracy and integrity of utilisation data, financial ledgers, procurement transactions, inventory and accounting records, and equipment maintenance contracts. In the context of centre management, coordinators are responsible for the maintenance of schedules pertaining to the utilisation of the facility. In certain centres, coordinators may also have the responsibility of overseeing the staffing of specific programme areas (Dadaleares and Crawford 2019 p. 53).

The successful execution of activities and events within an HFS necessitates continuous coordination, preparation, execution, dismantling, and upkeep of facilities, equipment, and resources (Bailey et al. 2015). Simulation technicians play a crucial role in organising and overseeing various activities and events (Bailey et al. 2015). They are responsible for effectively managing the inventory and accessibility of essential resources, such as beds, gurneys, chairs, tables, lighting, scrub sinks, curtains/dividers, linens, and gowns, as well as clinical equipment, such as 12-lead ECG machines and laryngoscopes (Dadaleares and Crawford 2019, p. 55). Additionally, they handle the maintenance and availability of clinical and surgical instruments, such as scalpels and forceps, medical supplies, including catheter kits, gloves, and gauze, and simulated treatments, such as medications, fluids, and oxygen (Crawford et al. 2019, p. 150). These individuals will be responsible for establishing and validating the arrangement and functioning of equipment and resources intended for use in scheduled activities (Wilson and Wittmann-Price 2018, p. 160). They are also likely to engage in collaboration with educators and other personnel to assess the practicality of protocols or scripts throughout the development of events.

Simulation technicians frequently assist in familiarising new users with simulation spaces by providing information on the capabilities and functionalities of the simulators, as well as outlining the limitations and possibilities associated with their use (Wilson and Wittmann-Price 2018, p. 160). They guide users in locating the necessary resources essential for their tasks. During simulated events, simulation technicians may offer various resources, such as central line kits, run additional equipment such as fluoroscopy machines or fulfil the role of ancillary clinical support workers, such as providing lab services (Forrest and McKimm 2013, p. 187). These individuals will collaborate with control room technicians to ensure the smooth execution of scheduled activities and events or to address and resolve any issues that may arise. Simulation technicians are also responsible for many tasks related to the deconstruction and cleanup of events. These tasks include the safe management of sharps and biohazards, proper waste disposal, laundry services, resetting facilities, cleaning and refilling reusable resources, and assessing the inventory that needs to be procured for future events. Technicians engage in regular cleaning and maintenance procedures for simulators and equipment subsequent to their utilisation (Forrest and McKimm 2013, p. 187). They promptly notify operations management of any issues that necessitate expertise in professional maintenance or repair services (Forrest and McKimm 2013, p. 187).

Hallmark et al. (2021) emphasised that it is imperative for educators to engage in professional development initiatives with the aim of enhancing their capacity to assess the distinct requirements of their learners and formulate efficacious pedagogical approaches. Simulation learning plays a pivotal role in defining the core responsibilities of educators from this particular standpoint. This concept was also discussed by Hellaby (2013, p. 110), who suggested that faculty development does not occur in isolation but rather needs to be integrated within the training process. The enhancement of simulation abilities among the faculty necessitates the provision of training and mentoring. The continuity of this process is crucial, and it is imperative that management supports and encourages faculty development through regular performance reviews and the identification of learning requirements.

However, according to Solli et al. (2022), the role of the facilitator has been largely ignored in the literature regarding low-, medium-, and high-fidelity simulation to date, alternating between active and passive facilitation with three basic subcategories: (i) practical support—the facilitator plays an important role in ensuring the flow of the simulated scenarios; (ii) guiding communication—the facilitator is important to students in paving their way to achieving the learning outcomes; and (iii) emotional influence—the facilitator's presence in the simulation room during the simulated scenarios influenced students' emotions. Other researchers have commented on the multitude of roles that facilitators play in simulation activities. For example, it facilitators carefully synchronise their prompts with the aim of affording students the opportunity to engage independently in problem-solving activities prior to providing guidance that aligns with their ZPD (Clapper 2015).

Further, many researchers have explored the replication of reality to provide a safe learning opportunity for participants in simulation activities, so there are two key terms that educators and students should familiarise themselves with: fiction contract and suspension of disbelief (Muckler 2017). There are also studies on the facilitator's role in safety and debriefing. For example, Rudolph et al. (2014) investigated the use of a safe container for learning in simulation, where the facilitator should include a safe context, clarify objectives, roles, confidentiality, a fiction contract, understand learner expectations, respect the learners, and ensure psychological safety. According to Kolbe et al. (2020), for debriefing to be effective, it is crucial to establish a strong sense of psychological safety. This entails creating an environment where individuals feel secure in taking interpersonal risks without fear of experiencing embarrassment, rejection, or any kind of punishment for expressing their thoughts, admitting their lack of knowledge, or seeking clarification by asking questions. Boese et al. (2013) indicated that existing explanations of the facilitator's role in simulation activities fail to comprehensively acknowledge the intricacies of teaching and the teaching environment. Thus, further investigation is necessary to explore facilitators' personal experiences and to gain a comprehensive understanding of how simulation can be optimally utilised.

Simulation activities require learners to actively engage in the learning process and to avoid relying solely on teachers or facilitators. Learners are expected to possess the ability to assess their own performance, recognise areas where skills or knowledge are lacking, and assume accountability for their learning advancement

(Akselbo and Aune 2023, p. 66). Spanager et al. (2015) argued that simulation activities have the capacity to fulfil the emphasised aspects of contemporary higher education, including active learning, interprofessional learning, collaborative learning, and learner-centred learning. Obviously, low-, medium-, and high-fidelity simulations are face-to-face activities; thus, they are all designed to facilitate learning, especially since learners participate and have the opportunity to practice and improve their clinical skills, and the educators could support the learners in getting the most out of learning. Simulation places the responsibility for the learning process in the hands of the educators themselves. Educators should pay attention to the process of group dynamics and psychological safety (Forrest and McKimm 2013, p. 7), especially because simulation is often perceived as challenging (Berragan et al. 2011).

CHAPTER 3: Literature Review

This chapter presents an examination of the extant literature regarding HFS in the healthcare discipline. A gap in EMS education regarding examining faculty members' and students' perceptions of HFS is identified. This chapter further discusses the theoretical framework that guided this thesis.

3.1 Introduction

High-fidelity Manikin simulation is a concept in education that has recently gained popularity in higher education, namely nursing education (Solnick and Weiss 2007). The literature reveals that HFS not only boosts students' self-confidence but also enhances their capacity to manage unfamiliar situations (Labrague et al. 2019). Research indicates a positive correlation between academic achievement and HFS readiness (Hanshaw and Dickerson 2020). Many studies on HFS have focused on students' readiness for HFS, while few have evaluated HFS interventions. Researchers have used several validated quantitative instruments to evaluate simulation activities (Adamson 2015). The most commonly used instruments are the Simulation Design Scale (SDS), Educational Practices Questionnaire (EPQ), and Student Satisfaction and Self-Confidence in Learning (SSSL), developed by Jeffries and Rizzolo (2006) (Adamson 2015). Publications on HFS interventions, whether quantitative or qualitative, enrich the literature. These studies have taken into account the perceptions of both teachers and students, or both. Furthermore, researchers have studied HFS in the local context of Saudi Arabia, including one study at a simulation center in King Fahad Medical City in Riyadh.

3.2 THE THEORETICAL BASIS OF HFS LEARNING

HFS is underpinned by the adult learning theory that was developed on the basis of andragogy by Malcom Knowles (Shea 2015). Andragogy refers to the science of helping adults learn. The foundational ideas of andragogy for adult learning prioritise the learner. Adult learners are considered a primary source of data for making wise selections about the learning process, going beyond simple respect for the learner (Shea 2015). According to Knowles' theory, andragogy is based on six presumptions: 1) the adult's self-concept is well developed, as they typically prefer to choose what they want to learn; 2) adult learners have a wealth of experience; 3) adults' capacity to learn is influenced by their needs; 4) adults tend to be problem oriented; 5) adults are typically internally motivated; and 6) adults should understand why they must learn something (Fenwick and Tennant 2020). Because both paramedic students and EMS simulation educators are considered adults, adult learning theory has often been applied in EMS education. However, ALFORDAlford (2013) argued that adult learning is complex and cannot be explained by a single theory.

HFS and Knowles' adult learning theory are closely related (MAK 2019). According to Knowles (1975), gaining the independent skills to take advantage of every educational opportunity — in both formal educational settings and day-to-day life — is the primary goal of education. Seven components of HFS are mentioned in Knowles' definition: 1) the teacher as a facilitator, 2) identification of learning needs, 3) establishing learning goals, 4) selection of relevant resources, 5) process implementation, 6) adherence to a learning contract, and 7) evaluation of the educational process.

Knowles et al. (2005) suggested three advantages of HFS. Learners who take the lead learn more and learn more effectively than those who are taught passively. In addition, those learners become more motivated and purposeful when they approach learning. Also, they tend to remember and apply what they learn more effectively. Many educators agree with Knowles's definition of HFS and its advantages (Kaufman 2003). According to Wang (2011), adults rarely learn, recall, or apply solutions to questions they did not come up with themselves. In addition, Wang (2011) asserted that HFS is crucial for enabling paramedic students to acquire independent learning abilities and a sense of responsibility and assertiveness — essential characteristics throughout a healthcare professional career — in a setting that is continuously changing. Others agreed that HFS results in more effective learning outcomes (Hurley 2014; Warren et al. 2016).

Students with high readiness demonstrate a desire to take advantage of innovative opportunities, like HFS, to learn new knowledge and skills (Hanshaw and Dickerson (2020). Research suggests that simulation readiness is a critical factor in determining the efficacy of HFS. In addition to encouraging students' participation in HFS, readiness expands their knowledge and consequently enhances their performance (Wanger et al. 2009). Furthermore, Wanger et al. (2009) asserted that students's readiness has considerably increased the potential for HFS. In addition to giving students the option to keep a record of their learning activities, Readines enables self-evaluation, topic understanding before the simulation activity, and peers for interaction, which are thought to be some of the processes by which simulation readiness enhances HFS.

However, there is evidence of increasing resistance to the general use of HFS concepts, and the limitations of HFS and its unsuitability for all situations are being realised, especially in health care education (Shin et al. 2015). Yockey and Henry (2019) concluded that nursing students prefer a teacher-centred approach and express anxiety regarding HFS, especially at early stages. Furthermore, Yockey and Henry (2019) asserted that this anxiety regarding HFS is not limited to the students and can also involve the teachers.

Kaakinen and Awood (2009) highlighted the importance of ensuring that teachers and students understand the concept and gain the skills required for HFS for it to be a successful learning approach. Knowles (1975) listed competencies required for teachers: 1) the capability of establishing a learning environment that is supportive and collaborative rather than competitive; 2) the capability of promoting group decision-making; 3) the capability of identifying learners' needs and, more essentially, assist learners in identifying their own needs; 4) the capability to convert learning needs into precise, attainable, and practical learning objectives to aid learners in setting their own goals; 5) the capability to encourage group learning in a way that enables members to create lesson plans and work towards shared objectives; and 6) the capacity to assess learning outcomes in a way that encourages peer evaluation and reflection on learning.

The successful implementation of HFS depends not only on teacher training, but also on student readiness. As Jeffries (2020) explained, before HFS is incorporated into the curriculum, courses and seminars about HFS should be provided. Motivation is a critical personal factor and one of the key assumptions of andragogy. Knowles believed that adults are motivated internally through higher self-esteem and self-actualisation. Furthermore, he believed that adults are most driven to achieve their learning objectives when they are acknowledged and recognised for their contributions (Wanger et al. 2009). Practically, to enhance motivation, Keller’s Attention, Relevance, Confidence and Satisfaction model was developed to include four factors for motivation (DuPont 2012).

3.3 PERCEPTIONS OF HFS IN HEALTH PROFESSIONAL EDUCATION

There are many publications on HFS in medical and nursing education. Most studies focus on challenges and readiness as a learning need. However, no studies evaluate HFS interventions or examined the implementation of HFS activities in EMS education.

Most recent studies on HFS evaluation have focused on simulation design features, educational practice, student satisfaction, and self-confidence in learning. One of these studies was a literature review that involved the analysis of 20 articles in different health professional disciplines. Hanshaw and Dickerson (2020) conducted the study to evaluate HFS outcomes. The articles' selection criteria included studies that focused on undergraduate prelicensure baccalaureate nursing students evaluated for high-fidelity simulation outcomes (omitting dissertations and qualitative studies). Jeffries and Rizzolo SDS were the most used instruments.

Jeffries and Rizzolo designed the SDS, a 20-item self-report questionnaire, to assess five key design dimensions in simulation-based learning. The scale’s two parts, the presence of SDS and the importance of SDS, each consist of five specific dimensions: objectives and information (five items), support (four items), problem solving (five items), feedback/guided reflection (four items), and fidelity/realism (two items). The questionnaire rates its items on a Likert scale ranging from 1 to 5. Hanshaw and Dickerson (2020) reported that the positive correlations between perceptions of the simulation design features, self-confidence, and critical thinking skill scores were statistically significant. Moreover, most studies suggested that students with a more positive perception of the design features of the simulations had better learning outcomes. Based on this result, simulations need to be designed and implemented with more differentiation in order to be perceived more appropriately by students.

Another systematic review using Kirkpatrick's framework to examine five randomised controlled trials, one quasi-experimental comparative crossover design, and six pre-test-post-test studies to determine the relationship between simulation and learning outcomes (Johnston et al. 2018). This study included articles published in English between 2000 and 2016 that focused on a debriefing intervention after high-fidelity patient simulation in health care education. The exclusion criteria were discussion or review papers, descriptive studies, and case reports. The authors categorized studies that delved into participants' experiences and debriefing satisfaction at level 1, the lowest evaluation level. It could be perceived that there is no relevance between reaction criteria and other-level evaluations of learning, behavior, and results. The reviewers found that although studies evaluating learner reactions specific to debriefing may not provide evidence to suggest learning occurred following debriefing, this research is not redundant. Valuable feedback on perceptions and satisfaction will influence the design and implementation of future simulation learning experiences, affecting the learning that does occur as a result of debriefing. Furthermore, debriefing discussions routinely incorporate strategies for behavior improvement, whether self-reported or not, to support a change in skills and knowledge. Researchers advised that this is an area where future research is needed to assist with the development and improvement of simulation education.

Another descriptive study examined student perceptions of best educational practices in simulation and evaluated their satisfaction and self-confidence in simulation (Zapko and Ferranto 2018).The authors used the EPQ and SSSL instruments to evaluate a specific simulation activity. The authors reported that the use of serial simulation as a learning tool received support. Students were satisfied with the experience, felt confident in their performance, and believed the simulations were based on sound educational practices and important for learning. Furthermore, serial simulations and having students experience exercises more than once in consecutive years is a valuable method of clinical instruction. When conducted well, simulations can lead to increased student satisfaction and self-confidence.

An evaluative study of simulation was conducted in in the University of Medical Sciences. This study was conducted at Sabzevar University of Medical Sciences in Sabzerar, Iran (Yazdimoghaddam et al. 2020). The study objective was to designing a comprehensive clinical competency test of operating room technology student. The study was framed by Stufflebeam's CIPP model. This was a mixed methods study. Purposive sampling method was employed in the qualitative stage, and a census was conducted in the quantitative part. A comprehensive clinical competency test was designed in this research using the Delphi technique and was conducted with 18 students. Then, clinical skills evaluation was performed by descriptive-analytical statistical tests and evaluator's observation using the CIPP model.

The study results in the implementation stage showed that the operating room technology students had a range of excellent to weak performances in exhibiting basic skills at different levels. The study recommended that the comprehensive test, designed based on the delphi technique of experts, and using the CIPP model can be a good criterion for the evaluation of the operating room technology students before entering the clerkship (Yazdimoghaddam et al. 2020). The study highlighted the results obtained from the evaluation have been useful for curriculum planners and professors in improving teaching methods and have led to better decisions.

More recently, a study was published that evaluated the effectiveness of a simulation activity in a baccalaureate nursing programme (Zhang 2017). The study included 10 nursing students. The study used semi-structured interviews to explore students' perception about simulation-assisted learning. Three main themes which were found from the study included 1. Students' positive views of the new educational experience of simulation; 2. Factors currently making simulation less attractive to students; and 3. The teacher's role in insuring a positive learning experience. The researchers concluded that the implementation of simulation-assisted teaching has been a positive experience for majority nursing students. Further efforts are needed in developing quality simulation-based course curriculum as well as planning and structuring its teaching process. The pedagogy approach requires close collaboration between faculty and students.

Another study evaluated HFS intervention using focus group interviews were conducted with three cohorts of students enrolled in a baccalaureate nursing program who experienced simulation four to twelve times per academic year in United of States (Najjar et al. 2015). Five prominent themes emerged during analysis Emotional Processing; Anxiety; Making Connections; Fidelity; and Learning. The Simulation Learning Model – Student Experience (SLM-SE) was developed to illustrate the student’s multi-dimensional experience of learning through high-fidelity simulation. The results indicated students are better equipped to learn through increasing confidence and experience, continued reflection-on action and enhanced peer-to-peer interaction. This study suggests that for future research include developing strategies to optimize students’ experiences for learning in simulation. The effectiveness of simulation for facilitating student development of self-efficacy, knowledge, clinical judgment, and proficiency in technical skills was highlighted in the study, and this finding is consistent with other studies (Crea 2011; Meyer et al. 2011).

An assessment of HFS abilities and perspectives using both quantitative and qualitative methods was conducted with undergraduate nursing students in South Korea, where the situation is similar to Saudi Arabia, as EMS education has recently undergone a paradigm shift from teacher-centred to student-centred education (Lee et al. 2015). The students’ scores on a validated quantitative questionnaire demonstrated that more than 70% of students scored high on increased ability to identify changes in the patient's condition, critical thinking, decision-making, effectiveness of peer observation, and debriefing in effectiveness of simulation. According to the responses on reflective journals, the students believed that high-fidelity simulation was a very interesting method of learning, and they felt safe with the simulated patient. They felt that having richer nursing experience without jeopardizing a patient's condition. In addition, they believed that there is an improvement in motivation toward learning, confidence in clinical nursing, a sense of accomplishment, and a feeling of empathy for the patient. However, The students also claimed that there was a negative experiences related to simulation training, decreased sense of realism in simulation, lack of communication skills, lack of basic nursing skills and time constraints. The authors argued that the South Korea nursing education system adopted HFS as a teaching approach in the early 2000s; however, it is important to consider the applicability of simulation to nursing curriculum, and to set the task difficulty level. Students reported both positive and negative experiences of simulation. They claimed that appropriate preparation of the students and instructors is one of the requirements for implementing HFS as a learning approach. To improve students' abilities, future simulation programs can be designed by reinforcing the positive experiences and modifying the negative results in agreement with existing research (Boerjan et al. 2008).

Student and faculty perceptions of HFS have been studied at Robert Morris University, with nursing students as participants (Howard et al. 2011). Qualitative data were collected through focus groups using content analysis from 6 faculty and 151 students completed the simulation evaluation survey. All levels of faculty and students were overwhelmingly positive. Faculty members agreed that the use of simulation was beneficial to the achievement of learning objectives, but many challenges related to the use of the technology were experienced. Nursing students were aware of the usefulness of HFS in achieving the modern career requirements of becoming critical thinkers, problem solvers, and self-directed learners. The students claimed that simulations cannot substitute for actual clinical experiences. The authors made three conclusions. First, the study support the integration of HFHS experiences throughout the curriculum, as evidenced by positive responses from students through the simulation evaluation survey. Although students felt positively that simulation should be included in the curriculum, they did not feel it should totally substitute for all clinical experiences, and students appeared to become more comfortable with simulation as they experienced more scenarios in the curriculum, which is consistent with previous publications (Siddiqui et al. 2008). Second, faculty viewed the HFHS experiences as positive but offered suggestions for improvement. The following should be included when schools implement simulation across the curriculum: a dedicated simulation coordinator or champion, technological support, adequate facilities, standardized programming forms, funds for supplies that enhance realism, and workload release time for faculty to gain understanding related to the use of this innovative yet highly technical teaching technique. This finding supported Jones and Hegge (2008), who argued that HFS could be challenging for faculty in early years. Third, More research is needed to document actual learning outcomes, best practices related to implementation of simulation, and differences in student perceptions related to their age and type of curriculum. With appropriate faculty support, both financial and developmental, and a standardized framework, HFHS can be implemented successfully within nursing education programs in agreement with other studies (Hanberg et al. 2007; Akhtar-Danesh et al. 2009; Schlairet 2011).

In line with previous research that found the simulation educators role to be crucial for HFS (Kolp et al. 2014), a systemised rapid review and synthesis of the literature study was conducted in Qatar to investigate the competencies needed for simulation educators (Topping et al. 2015). Data were collected from Web of Science, PubMed, CINAHL Plus, PsycInfo, ERIC, the Cochrane Library and Science Direct. The search was limited to articles published in English, 2002–2012. The papers that provided descriptions of educator preparation identified simulation-based workshops, or experiential training, as the most common approaches for enhancing skills. SBL was not associated with any one theoretical perspective. Delivery of SBL appeared to demand competencies associated with planning and designing simulations, facilitating learning in “safe” environments, expert nursing knowledge based on credible clinical realism, reference to evidence-based knowledge and demonstration of professional values and identity.

It is impossible to ignore the effects of the coronavirus disease 2019 (COVID-19) pandemic, especially on the educational field. HFS emerged as a crucial teaching and learning strategy during the COVID-19 pandemic (Lim et al. 2020). A study was published reflected the use of simulation related to the simulation design features and educational practices’ features to examine students satisfaction and self-confidence in learning during the COVID-19 pandemic in Jordan (Mohammed and Mohammed 2020). The study involved 118 nursing students who were enrolled in different academic years. Researchers implemented the SDS, EPQ, and SSCL scale. The study findings revealed that around half of the nursing students had a low level of satisfaction with the simulation activity, and the highest percent of them had a high level of self-confidence in managing the simulated situations.

A cross-sectional observational study conducted at the College of Medicine at King Fahad Medical City, King Saud Bin Abdulaziz University for health sciences Riyadh/KSA was recently published (Ahmed et al. 2016). The study's aim was to evaluate the perception of medical teachers toward the integration of simulation-based medical education (SBME) in undergraduate curriculum and also identify contextual barriers faced by medical teachers. The study was not explicitly framed by any specific evaluation model. The sample included 78 medical teachers from three universities. The authors highlighted that the positive perception and attitude of medical teachers toward the integration of SBME in undergraduate curriculum. Several teachers stated that they needed formal training with simulation. Most of the participants stated that top perceived barriers for effective SBME include teachers’ supported with time and resources and the early integration into the curriculum. Most participants stated that the critical challenges need to be addressed by medical schools in order to enhance the integration

SBME in undergraduate curricula. This conclusion is consistent with the belief that faculty facilitation plays an essential role in its success (Nehring et al. 2013; Peterson et al. 2017).

3.4 Summary

In this literature review, I found that HFS is an active research area in medical and nursing education. The concept of HFS is underpinned by the adult learning theory and has been shown to have several educational benefits. It improves academic achievement and preparedness for lifelong career development in a rapidly modernising field, and it is an effective method of learning in the era of health care simulation. However, some limitations of HFS should be considered in some conditions, as HFS is significantly dependant on several factors related to the students, teachers, simulation coordinators, simulation specialists and learning environment. Therefore, the success of such a learning activity relies on improving teachers’ and students’ readiness for HFS.

Students' and faculty's perceptions of HFS have been studied worldwide. Most studies focus on simulation design features, the educational practices and students satisfactions, and there is a paucity of studies in the literature that evaluate HFS interventions. Furthermore, most evaluative studies in this review were not based on evaluation models. Most published studies were from USA, UK, and Canada. In addition, one article was published in Saudi Arabia. Most of the articles were in the nursing field and investigated students' perceptions through quantitative validated instruments. Previous research suggests that certain factors have an impact on implementing HFS. These factors include the preparation, formal training, and resources. Studies indicate that HFS is one of the most common methods used for delivering simulation, and simulation-based curricula enhance student’s readiness after graduation. Faculty and student training for HFS is frequently proposed in the literature. However, the literature lacks studies investigating HFS from a faculty and students perspective in EMS education in Saudi Arabia, although previous research has claimed that faculty facilitation has an essential role in the HFS process. Therefore, faculty and students are primary stakeholders, and their opinions are needed for further development and improvement. Evaluation of HFS interventions that were recently implemented in the EMS colleges in Saudi Arabia is essential, especially considering the issues and concerns reported by faculty about its usefulness. Therefore, there is need to investigate the unique experience of the EMS colleges from the faculty and students perspective considering the context and multiple factors affecting HFS.

3.5 Theoretical Frameworks and Examining Perceptions to Evaluate Educational Interventions and Learning Needs

This section uses the findings of the literature review from the previous sections to provide a framework for examining faculty and students' perceptions regarding HFS in EMS education in Saudi Arabia. Several evaluation models exist to assist evaluators in choosing the appropriate methods for their specific evaluative questions (Goldie 2006). Each model has evaluation assumptions and prioritises certain evaluation components (Goldie 2006). This chapter identified an appropriate theoretical framework to map out the thesis's future studies. The theoretical framework resulted from two models that evaluated programme outcomes and programme input and process of the HFS in EMS education in Saudi Arabia. The Kirkpatrick model captures how the simulation is implemented by teachers and students, simulation design characteristics, educational best practices, and teacher and learner satisfaction to evaluate the programme outcomes during the HFS. The CIPP model provides an insightful explanation of the impact of the preparation and the challenges in the HFS by programme input and process evaluation. By combining these models, this thesis successfully evaluated the effectiveness of high-fidelity manikin simulation by examining faculty and student's satisfaction, preparation, and challenges in implementing HFS sessions. The theoretical framework underpinned the exploration of the aim of the thesis with a series of three studies that evaluated the simulation and identified the challenges. The focus of the three studies is to interrogate the main populations of this thesis—EMS educators and paramedic students (Chapters 5–7).

CHAPTER 4: Methodology

4.1 Thesis Design

This thesis was conducted at an EMS colleges in Saudi Arabia and used a mixed method research (MMR) design on studies one and two and a quantitative design on study 3, focussing on EMS simulation educators and paramedic students. The approach in studies one and two encapsulated mixed-method activities (Cresswell, 2003; Thomas, 2023), unveiling context-specific information and socio-historic events. On the other hand, the approach in study 3 encapsulated quantitative to examine the reliability and validity of simulation design scale (SDS), the educational practices (EPQ) and student's satisfaction and self-confidence in learning (SSCL) instruments (Duckett 2021). The interpretive approach aligns with various pedagogical theories, including brain-based learning, cognitive constructivism, behaviourism, and social learning.

Thomas emphasises diverse evidence sources for data validation and knowledge enhancement, consistent with the suggestion to minimise biases and enhance data validity by incorporating information from various sources (2023, p. 146). The combination of both qualitative and quantitative data tends to generate a saturated and generalised view as suggested by Saldana (2011, pp. 8-9). This approach implies a broader context and understanding of the research topic, informing the development of research questions, and identifying gaps in existing knowledge specific to faculty and students in the HFS sessions based on their experiences.

4.2 Thesis instruments

Two measurement instruments were used in study one and two, including the Simulation Design Scale (SDS) (see Appendices 1) and the Educational Practices Questionnaire (EPQ) (see Appendices 2), to examine faculty's and students' perceptions of HFS and to evaluate its outcomes (National League of Nursing 2020). These research instruments were developed and validated by the National League for Nursing (2020) and were designed to tap into the learning and teaching experiences by having participants rate their agreement as to whether their experiences adhere to simulated design principles and educational practices. A teacher version and a student version were developed in which the same questions were asked with slight rewording to reflect the sample characteristics. Moreover, three translated measurement instruments were used in study three including the Simulation Design Scale (SDS) (see Appendices 3), The Students satisfaction and Self-Confidence in learning (SSCL) (see Appendices 4) and the Educational Practices Questionnaire (EPQ) (see Appendices 5), to examine the psychometric properties of an Arabic version of the survey, with the aim of making it available for further research and evaluation studies in Arabic-speaking settings.

The SDS questionnaire is a 20-item instrument developed to measure constructs from the Jeffries and Rizzolo (2006) simulation model. The self-reported questionnaire was designed to evaluate five central design dimensions in SBL (National League of Nursing, 2020a). The scale consists of five specific dimensions: objectives and information (five items), support (four items), problem solving (five items), feedback/guided reflection (four items), and fidelity/realism (two items) (Jeffries and Rizzolo 2006). The EPQ questionnaire is a 17-item, self-reported questionnaire designed to evaluate educational practices in simulation (National League of Nursing, 2020a). The EPQ scale consists of four dimensions: active learning (eleven items), collaboration (two items), diverse ways of learning (two items), and high expectations (two items) (Jeffries and Rizzolo 2006). The SSCL questionnaire is a 13-item, self-reported questionnaire designed to evaluate student satisfaction and self-confidence in simulation (National League of Nursing, 2020a). The SSCL questionnaire consists of two dimensions: students' satisfaction with the simulation activity (five items) and self-confidence with simulation (eight items). The SDS, EPQ, and SCLS instruments were designed to assess the learning experience by having participants rate their agreement with the items. The responses were graded from 1 (strongly disagree) to 5 (strongly agree) on a five-point Likert scale. The survey was not considered time-consuming; most participants completed it in approximately 5–10 minutes. The American iterations of the SDS, EPQ, and SSCL questionnaires have been permitted for utilisation in research, as stated by the NLN (2020b). The data were screened for missing values before analysis of the data. The participants were required to answer every survey question. Therefore, No missing values were identified.

4.3 Quantitative Data Analysis

I used SPSS software for descriptive analysis, including mean and standard deviation, to analyze the quantitative data collected from the faculty and students (Kemp et al. 2018). The surveys primarily consisted of Likert scale questions to measure the extent to which respondents agree or disagree with a statement. I included a brief open-ended questions at the end of the survey to allow participants to provide additional comments or insights. This technique provided a structured approach to examine the data and gain a comprehensive understanding of the participants' lived experiences, as suggested by Thomas (2023).

4.4 Qualitative Data Analysis

According to Braun and Clarke (2006), thematic analysis is a core method for qualitative analysis as qualitative methodologies are so numerous, intricate, and subtle. Thematic analysis is the first qualitative technique of analysis that researchers should understand as it offers fundamental skills that are helpful for conducting other types of qualitative analysis (Braun and Clarke 2006). Therefore, thematic analysis was a reasonable option for me. In addition to being a relatively easy method to learn and practice, Braun and Clarke (2013) mentioned other advantages. One of the main advantages is flexibility; it is suitable for different types of theoretical frameworks (i.e. either inductive or deductive approach), research questions, data collection methods (interviews, focus grout. etc), and sample sizes. However, it has limited interpretative ability if not based on a theoretical framework as it could be perceived as simply description of participants' views. The inductive data collected underwent an open-coding process, leading to the identification of themes and sub-themes. However, it has some key challenges for example subjectivity in theme identification which means different researchers may identify different themes within the same dataset (Terry et al. 2017).

4.5 Ethics

Approval to conduct the three studies was obtained from the administration and management of the Colleges of Emergency Medical Services (Appendix 6). Consent to participate in the three studies was obtained from each participant (Appendix 7-9). Ethical approval was granted for the three studies by the School of Medicine Research Ethics Committee (SREC) (see Appendix 10-12).

Confidentiality was assured before the start of the three studies. In terms of the questionnaires, all responses were anonymised, including any answers that could potentially reveal the identity of the participants. The participants' replies were gathered as numerical values ranging from 1 to 5, and they were assessed using Likert scales. They were informed that they could withdraw from the three studies at any point (Punch 2005). They also had full authority to refuse to answer any questions that made them uncomfortable. For the open-ended questions, the participants needed to be made aware that no question had any completely right or wrong answers. The use of pseudonyms is recommended in interviews (Eisenhauer and Wynaden 2001), and each student and faculty member was provided with a unique identifying number (e.g. F1, S1). These numbers were later recorded in a separate file. However, confidentiality is a multifaceted procedure that goes beyond simply concealing the identities of research participants or locations. Anonymising data alone does not necessarily cover all aspects of confidentiality in a comprehensive manner (Lancaster 2017). I also informed the respondents that the raw data from their interviews and surveys would be kept at Cardiff University for no longer than five years and that their answers would be confidential.

Reflexivity is key in addressing potential bias in qualitative research, and to this end, having been an EMS educator myself at one of the colleges and having close colleagues on the different EMS schools in Saudi Arabia may have influenced the credibility and validity of the findings. To mitigate potential bias, certain approaches and measures were applied during the process of data collection and analysis. Taking a study leave from college for more than 3 years prior to extending an invitation to all students and faculty members at the EMS colleges might have partially addressed the issue of establishing a potential relationship with the participants. Qualitative research, particularly interviews, relies heavily on establishing trust and rapport between the researcher and the participants to produce comprehensive data (Guillemin and Heggen 2009). At this juncture, establishing rapport with the participants could facilitate the attainment of this objective.

CHAPTER 5: Evaluation of High-Fidelity Manikin Simulation at King Saud University: A Mixed Methods Study of Faculty and Student Perceptions

This chapter is the first in a series of three studies in this thesis, the focus of which is the evaluation of high-fidelity manikin simulation in emergency medical service (EMS) education in Saudi Arabia.

5.1 Abstract

Background: High-fidelity simulation has long been perceived as playing an important role in a range of healthcare educational settings. However, faculty and students continue to experience significant challenges in its implementation. This study was set to evaluate students' and faculty's experiences of high-fidelity manikin simulation activities at an EMS college in Saudi Arabia.

Methods: This study utilised a cross-sectional mixed methods approach. A questionnaire was designed to examine the participants' ratings of their experiences using the outcome evaluation model (Kirkpatrick and Kirkpatrick 2016). Two instruments were used: the Simulation Design Scale and the Educational Practices Questionnaire. Semi-structured interviews were conducted to enable participants to reflect on their experiences and to obtain rich and meaningful contextual data on their preparedness, barriers, and challenges by using the programme evaluation model, specifically CIPP evaluation (Stufflebeam and Zhang 2017). Students and faculty at the College of Emergency Medical Services at King Saud University, Riyadh, were invited to participate in the study. In total, 32 faculty members and 57 students completed the questionnaire, and 9 faculty members and 16 students volunteered to take part in the semi-structured interview.

Results: The findings suggest that both faculty and students were satisfied with the simulation design features and educational practices for implementing high-fidelity

manikin simulation. The findings from the semi-structured interviews highlighted the challenges and barriers that faculty and students face in the preparation and implementation of high-fidelity manikin simulation in their teaching, including institutional issues, support needs, and feedback and assessment.

Conclusion: The results indicated that while participants generally perceived their experiences of high-fidelity manikin simulation positively, when asked to reflect on these experiences, some challenges emerged. The main challenges to effective high-fidelity manikin simulation were the lack of teachers' formal orientation, insufficient time, and equipment malfunction, and the delayed integration of simulation objectives into the curriculum. To improve the incorporation of high-fidelity manikin simulation activities into undergraduate curricula and maximise their implementation, the institution should address the hurdles identified.

5.2 Introduction

High-fidelity simulation (HFS) has long been perceived as playing an important role in a range of healthcare educational settings. It is defined as a means of creating the most authentic and realistic clinical environments that offer novices opportunities to employ a broad spectrum of cognitive and physical skills that may not otherwise be possible or practiced (Hill et al. 2023). The goal of HFS is to provide experiential learning opportunities that allow students 'to shift from knowledge to higher cognitive levels, such as application and analyses' (Zigmont et al. 2011).

The inclusion of clinical experience is an essential element within the undergraduate emergency medical service (EMS) curriculum (Hoyle et al. 2017). However, in comparison to other healthcare settings, the use of HFS in EMS education is fairly recent (Wheeler and Dippenaar 2020). Similar to other healthcare settings, HFS plays an important role in preparing paramedic students for the reality of their clinical work and has been shown to have many positive outcomes for students and patient safety (Morris and Faulk 2012). It is perceived as a way of addressing the educational needs of paramedic students and preparing them for the reality of the clinical setting. Many paramedic students report feelings of ineptitude and lack of confidence as they anticipate their first experiences in a new clinical area (Dyess and Sherman 2009). Limitations on the availability of clinical hours allotted to emergency medical services education programmes (Parsh, 2010; Richardson and Claman 2014; Werth et al. 2014) and the growing complexity of the patient population (Alanazi et al. 2017) increase the importance of effective HFS experiences for students.

Due to the range of benefits of HFS, EMS colleges have invested a great deal of resources in terms of space, equipment, funds, and technical facilities in HFS (Bredmose et al. 2020), but they have come across a variety of challenges, including the time it takes to build a quality simulation experience for their students (Reid-Searl et al. 2012). In the absence of the services and support needed for implementing HFS, expensive simulators are often underused or remain in their packages for long periods (Nehring and Lashley 2010). Indeed, simulation laboratories are very expensive (Gates et al. 2012) and are commonly used as a hospital environment, complete with beds, manikins, intravenous pumps, critical signals, heart monitoring, and emergency devices to promote realism. Beyond administrating budgeting, deans and directors are responsible for training faculty to ensure that student learning outcomes are achieved. Guimond et al. (2011) recommended that institutions should evaluate the resources available to them to support simulation and address any obstacles to its success.

While the potential value and benefits of HFS are well established (Jeffries 2021), the extent to which those who use HFS fully benefit from its educational potential is less clear. Despite its strengths, many problems can arise in its implementation. For instance, unprepared educators in simulation pedagogy can lead to ineffective facilitation and cueing during the scenario, which can result in poor course outcomes (Hallmark 2015). Furthermore, if debriefing is not provided or is superficial, opportunities to close the knowledge gaps of paramedic students or address misconceptions will be missed (Hallmark 2015). Research suggests that when students are not provided with an appropriate briefing, they are more likely to feel anxious (Meyer et al. 2014). Indeed, evidence suggests that teaching staff members at Saudi Arabian healthcare colleges in general and EMS colleges in particular begin their jobs without any foundational training or HFS courses (Ahmed et al. 2016). The principles of implementing HFS are often learned through experience; new faculties do not undergo training in HFS. Rather, it is expected that EMS teachers already possess teaching skills. The training of educators on the use of HFS varies between schools of health specialties, and educators report the need for training in simulation pedagogy as a primary concern (Levet-Jones et al. 2014).

To maximise the benefits of HFS, it is important to understand the experiences of those who implement and have experience with this teaching approach (Rogers et al. 2015). Understanding their experiences and challenges will help ascertain whether learning needs exist and whether they can be addressed. HFS is a resource-intensive method due to the initial setup and maintenance of a simulation laboratory, as well as the professionals required to oversee the scenario's implementation, such as those responsible for the preparations and technology used, as well as those who assist the students (Campbell and Daley 2017).

As highlighted in the litrature review for this thesis, the majority of studies on educators' and students' perceptions and feelings of preparedness to use HFS in their teaching have mainly been conducted with healthcare professionals and the medical profession. Very little is known about the perceptions of those who teach in emergency medical services settings (paramedics). In addition, educators can prepare for and implement HFS with the best educational practices in mind, but ultimately, the learners determine if their learning needs are being met. Again, a review of the literature on students' and trainees' perceptions of their experiences and factors that impact their learning in HFS settings mainly comes from other healthcare and medical professions. The most effective educational intervention programmes are those that address and report on the needs of individuals within their contexts (Barrett and Davis 1995; Skeff et al. 1999). For this reason, it is important to consider the views of faculty and students and to evaluate the implementation of HFS in the EMS programme. The purpose of this study is therefore to evaluate the effectiveness of high-fidelity manikin simulation activities in an EMS college in Saudi Arabia.

5.3 Study aims

The study aimed to evaluate the effectiveness of high-fidelity manikin simulation teaching delivered to paramedic students at the College of Emergency Medical Services, King Saud University, Riyadh, Saudi Arabia. This was achieved using Kirkpatrick's evaluation model, with a specific focus on learners' and teachers' satisfaction with HFS (Level 1), so focus on providing HFS outcomes achievement as well as the CIPP evaluation model, with a specific focus on input and process evaluation so providing useful information during all phases of HFS implementation. The study aimed to examine teachers' and students' perceptions as follows:

1. To what extent are faculty and students satisfied with the efficacy of high-fidelity manikin simulation experiences?
2. What similarities and differences exist in faculty's and students' perceptions and experiences of high-fidelity manikin simulation efficacy?
3. What are faculty's and students' perceptions of potential challenges that may impact the implementation and effectiveness of high-fidelity manikin simulation experiences to identify their learning needs?
4. How can challenges and barriers be addressed to improve the educational value of high-fidelity manikin simulation activities?

5.4 Methodology

5.4.1 Research design

This study used a cross-sectional mixed methods design combining quantitative and qualitative methods, such as a questionnaire and semi-structured interviews, to evaluate high-fidelity manikin simulation activities from the perspective of the two evaluation models, including the Kirkpatrick outcome evaluation model (Holtschneider and Park 2019) and the CIPP programme evaluation (Graham and McAleer 2018). McKim (2017) indicated that mixed methods are frequently used to address criticisms of both quantitative and qualitative methods. They asserted that qualitative methods are frequently criticised for their lack of objectivity and generalisability, whereas quantitative methods are frequently criticised for their lack of participant voice and meaningful interpretation (McKim 2017). In this case, mixed methods allowed me to include the faculty's and students' voices alongside the questionnaire results. The aim of the quantitative data gained via the questionnaire was to broadly establish whether high-fidelity manikin simulation education met its intended outcomes in the EMS college, whereas the qualitative results provided through semi-structured interviews were designed to gain additional insight and explanations regarding why and how high-fidelity manikin simulation may or may not achieve its intended outcomes.

Mixed methods facilitate data triangulation, wherein researchers use multiple data sources to verify and validate findings (Creswell and Clark 2011). Questionnaire data were collected to address the first and second research questions, with a focus on the outcome evaluation model. The qualitative data collected via semi-structured interviews focused on the third and fourth research questions using the CIPP evaluation model. This was done to gain a better understanding of the participants' encounters regarding preparation and the challenges they faced during their HFS experience to identify their learning needs.

5.4.2 Setting and sample

The sample consisted of faculty members and students at the College of Emergency Medical Services at King Saud University in Riyadh, as they were the main stakeholders in the EMS HFS laboratories. This study provided an opportunity to gather valuable data for the institution regarding students' and faculty's experiences with high-fidelity manikin simulation to identify potential improvement and development. The college had six laboratories that performed HFS. The management of all aspects of simulation, from the creation of scenarios to the running of the simulator, was the responsibility of all EMS instructors because there was no technical assistance.

All 40 faculty members and over 200 students at the Faculty of Emergency Medical Services at King Saud University were invited to participate in the study after attending a high-fidelity manikin simulation activity. The inclusion criteria were teachers in the EMS college who had been involved in the teaching of high-fidelity manikin sessions for at least one academic year and students who had been involved in HFS for at least 10 simulation sessions. The participants did not have English as their first language; however, they demonstrated a high level of proficiency in English, as it is the main language of teaching in EMS education in Saudi Arabia. Consequently, the interviews and surveys were carried out in English.

The sampling method employed in this study was non-probability convenience sampling, which involved recruiting individuals based on their ease of access and availability (Sedgwick 2013). This is in line with the majority of research conducted in the field of medical education, which relies on non-probability sampling methods (Mujere 2016). In addition, the utilisation of this sample method was deemed appropriate for the research due to anticipated challenges in participant accessibility, given their substantial teaching and clinical responsibilities throughout the COVID-19 pandemic. Nonetheless, it is important to acknowledge that non-probability sampling methods may introduce a potential source of bias, as they do not fully capture the characteristics of the entire population being studied (Tavakol and Sandars 2014).

An invitation to participate with a link to an online questionnaire was sent via the participants' university email addresses. An invitation to participate in a semi-structured interview was included at the end of the questionnaire, and the participants were asked to contact me via my Cardiff University email if they wished to participate in the interview or if they desired more details. Due to the educational setting at the time (no female EMS department), all research participants were male. In total, 32 faculty members and 57 students completed the questionnaire, out of which 9 faculty members and 16 students volunteered to take part in the semi-structured interview. This was smaller than anticipated and may be due to the COVID-19 restrictions at the time, which made data collection very challenging in all healthcare educational settings.

5.4.3 Pilot questionnaires

The questionnaire was piloted with a cohort of simulation educators and intern students. As they possess similar qualities to the participants in the main (Etchegaray and Fisher, 2011). The pilot allowed for necessary modifications to be made to the questionnaire's design and structure before its implementation in the primary research study. The main objective of the pilot questionnaire was to assess the clarity of the questions, given that the original questionnaire was in English, but the participants primarily spoke Arabic. Furthermore, the pilot survey was undertaken to assess the internet link's quality and evaluate the accuracy of the recorded results on the Bristol online survey website. It was imperative to assess whether the participants encountered any symptoms of questionnaire fatigue and to ensure that the questionnaire did not impose excessive time demands on them. During the administration of the pilot questionnaire, efforts were made to address any ambiguities included in the statements and questions, with the aim of minimising the potential influence of bias.

The pilot highlighted that the questionnaire items were deemed suitable for the students' and faculty's vocabulary levels. Several clarifications and modifications were made to the questionnaire instructions. For example, some students asked for clarification of the definition of HFS. More specifically, the questionnaire included questions that had the potential to induce misunderstandings among the participants. For example, the students were concerned about which simulation activity they should consider in their answers, whether it should be the last simulation activity that they attended or the simulation activities during the entire academic year. Therefore, it was decided to provide participants with adequate prior information on the domains included in the research questionnaire to provide clearer instructions and ask participants to consider the last high-fidelity manikin simulation they attended in their rating of their experiences.

The use of the online pilot questionnaire afforded me the opportunity to gain practical experience with the various strategies employed in disseminating questionnaires to both students and faculty members. Additionally, it provided me with insights into effectively communicating the process of administering the online questionnaire. To this end, the use of the online platform chosen for the study for administering the pilot questionnaire and collecting data (Bristol Online Survey) was found to be appropriate and fully functional. I also received specific feedback pertaining to the length and timing of the questionnaires, along with inquiries about the feasibility of reducing their length. However, such a modification was not feasible, as the questionnaires were part of a widely recognised diagnostic inventory developed by a panel of experts (Jeffries and Rizzlo 2006). Consequently, this prompted me to include explicit information regarding the expected time required to complete the questionnaire on the participants' information sheet. The purpose of this was to ensure that participants were adequately informed and not caught off guard by the questionnaire's length.

5.4.4 Questionnaire Distribution

The Bristol Online Survey (BOS) (now known as the JISC online survey) was used to administer the questionnaires. The website for the BOS questionnaire proved to be a user-friendly research instrument that facilitated the organisation, development, and analysis of the questionnaire through online means. Furthermore, it did not necessitate any intricate technological knowledge or setup expertise. There are several benefits associated with the use of BOS. First, it offers researchers an extensive pool of potential respondents, hence enabling a greater scope for data collection. Additionally, BOS facilitates the seamless sharing of surveys among participants and their professional networks. Lastly, BOS enables the execution of several statistical and comparative analyses, owing to its capacity to handle huge datasets.

The majority of the students and faculty who participated in the study communicated via email; however, some of the students did not access their emails during the COVID-19 pandemic and received a questionnaire link from their colleagues. An introductory email letter was sent to them describing the study in general and providing them with information about the study and the expected time needed to complete the questionnaire, along with the questionnaire link that contained the written consent form. They were asked to check the box in front of each consent statement to be able to access the questionnaire. A significant portion of the criticism of online surveys suggests that respondents often miss or do not read emails. This prompted me to seek a resolution to enhance the rate of online response; thus, I sent reminder notifications via telegram and WhatsApp to the participants via established networks.

5.4.5 Interview schedule

According to Kallio et al. (2016), semi-structured interviews exhibit a high degree of flexibility, as they effectively facilitate reciprocal communication between the interviewer and interviewee. This format allows for the inclusion of follow-up questions that are tailored to the responses provided by the participants, thus enhancing the depth and richness of the data collected. Additionally, semi-structured interviews provide a conducive environment for participants to freely express their perspectives and opinions. Further, the questions in this type of interview are grounded in prior knowledge, which is facilitated by the development and utilisation of an interview guide. The interview guide streamlines the process, prevents the interview from resembling a casual conversation, and minimises the collection of data that are unrelated to the research questions (Kallio et al. 2016).

Semi-structured interviews were conducted in English because the participants were qualified and taught in English throughout their studies. I used “a set of prepared, mostly open-ended questions, which guide the interview and the interviewer” (Flick 2021, p. 197). The open-ended questions allowed the participants to share their experiences regarding the implementation of high-fidelity manikin simulation activities and their perceptions of preparation and challenges.

After receiving the necessary permission for all interviews, the participants were contacted to set up the interview arrangements.

All interview questions revolved around themes such as readiness, preparedness, potential challenges, and factors that impacted the implementation of HFS from a faculty and student perspective. I used an interview guide, including a personal data sheet asking about academic degrees, years of academic experience, and experience of high-fidelity manikin simulation (Appendices 13 and 14). The interview guide was aligned with the input and process components of the CIPP model of evaluation, as proposed by Stufflebeam (1971). The first section was designed to explore the faculty's and students' understanding and their readiness and preparation for HFS sessions, reflecting the input evaluation. The second section included questions related to HFS implementation, challenges, and reflecting process evaluation.

Special attention was paid to highlighting faculty's and students' experiences by asking questions such as "*What do you do in order to prepare for the implementation of simulation in your teaching?*" and "*Reflecting back on your experience of teaching in simulated settings, can you think of times where you have come across situations that were particularly challenging?*" Such broad questions were designed to tap into their past experiences (Grant 2002).

The interviews initially were conducted in person, and each interview lasted 30–45 minutes, but due to disruption caused by the COVID-19 pandemic, some had to be conducted over the phone. The interviews were recorded and transcribed to clear any ambiguity at the time of recording and analysing the data (DiCicco-Bloom and Crabtree 2006).

5.4.6 Pilot interview

The pilot testing conducted in this study involved field testing, which is a prevalent method employed in semi-structured interviews that aims to replicate the actual interview situation and yield valuable insights regarding the interview's execution (Kallio et al. 2016). The purpose of the pilot interview was to check whether any questions needed amendments, the quality of the audio recorder, the language of the questions, and whether the participants would comprehend what I wanted to ask. The interview was conducted with a paramedic intern and one EMS simulation educator, whose role was to help me understand whether the interview schedule had any practical issues. I informed my colleagues about the need for this pilot interview and explained how their feedback would assist me in making qualitative changes to the structure and design to make it more effective (Kvale and Brinkmann 2009). I received valuable insights into the practical aspects of my questions and the topic itself.

The pilot interview provided a valuable interview experience (Kvale and Brinkmann 2009). I had to be particularly careful about how I worded my questions, taking care not to include any leading questions that would prompt the participants to answer in a particular manner. This was observed in my pilot interview and was therefore corrected in the actual interviews. As the participants in my interviews were my students and college colleagues, social awkwardness was also involved. This could also have prompted them to answer in a certain way regarding what they thought was the right answer, according to my opinions on the topic. Therefore, I made every effort to enhance the participants' mindfulness during the interview schedule (Creswell 2011; Whittemore et al. 2001).

5.4.7 Interview process

All interviews were completed via phone or face to face on the EMS college campus and participants were given the liberty to choose the date and time of their interviews. I tried to ensure that all respondents were physically and mentally at ease during the interview (Gadd 2004). A casual conversation was engaged in before the actual interview to establish rapport. The interviews were initially intended to be held face-to-face so that the authenticity of the information could be cross-checked, as Creswell (2014) opined that the interview should have as few disruptions as possible. However, it is worth noting that conducting in-person interviews entails both time and financial costs, although these can be mitigated by ensuring convenient accessibility for interviewees and securing an appropriate venue for the interviews (Opdenakker 2006).

The utilisation and adoption of phone interviews have gained increasing popularity (Mahfoud et al. 2015). In instances where scheduling issues or logistical challenges hindered the organisation of face-to-face interviews, participants were provided with the option of phone interviews to maximise participant enrolment. The phone interviews were conducted on the Google Duo app. Mahfoud et al. (2015) highlighted the merits and limitations of the phone interview. Besides lower costs and increased time efficiency, phone interviews have coverage biases (low telephone ownership among those with low education and low income) and a higher level of nonresponse rates. In the phone interview, the interviewer is unaware of the interviewee's surroundings. Consequently, the interviewer's ability to create a favourable interview atmosphere can be diminished.

To gain the trust of my respondents, I reminded them that this research was being conducted for my PhD study at Cardiff University and that I was also a member of the college's Medical Education department. Bullock's (2016) recommendations on how to conduct interviews in qualitative research were followed. To begin with, I reiterated the goal of the study to the participants and confirmed their readiness to proceed. I ensured that the questions were not overly complicated, listened attentively, verified, and elucidated information, and refrained from abruptly shifting between subjects or rigidly adhering to the sequential order of the questions. Alternatively, I ensured a more organic progression by acknowledging subsequent inquiries if the respondent had started discussing them in relation to a previous query. To verify my comprehension of their reply, I either restated my understanding of their message in different words or requested further clarification without passing any judgments. Each interview lasted approximately 45 minutes. At the end of the interview, I invited participants to freely talk about and share any comments or questions they might have that would add any further details. I thanked each participant for their assistance and ended by assuring them that what they had said would remain confidential. As soon as an interview was completed, I completed my notes by recording my immediate impressions and then transcribing them.

5.4.8 Data analysis

Survey data were retrieved and transferred from the BOS website in SPSS 26 form. Each of the participants' responses had one data row in an SPSS programme sheet, and each question typically had one data column, occupying one variable. Data were analysed with descriptive statistics, including mean and standard deviations (Altman and Bland, 1999), to examine participants' ratings of their experiences with high-fidelity manikin simulation. However, if the mean was 5, this indicated that the majority of participants answered "strongly agree", a mean of 4 indicated that most participants answered "agree", a mean of 3 would be neutral and would indicate that most of participants chose "neutral", a mean of 2 indicated that the majority of participants chose "disagree", and a mean of 1 indicated that the majority of participants answered "strongly disagree". Tests of normality (the Shapiro–Wilk test) revealed that the data were not normally distributed (Laerd Statistics, 2013). The Mann–Whitney U test for paired comparisons between the faculty and students to answer question two was therefore utilised, and the research findings were expressed as mean and standard deviation, and accepted as $p < 0.05$ level of significance.

Thematic analysis (TA) was used to address the third and fourth questions, which were set to examine perceptions of preparation and the challenges and experiences of teaching and learning in HFS. To identify, analyse, and report patterns (themes) within the data (Braun and Clarke 2006). TA was chosen as the best method for analysis for several reasons. First, it does not require expert theoretical and technical knowledge and is identified as a foundational method of qualitative analysis, which makes it appropriate for early-career researchers (Braun and Clarke 2006). Second, TA is not tied to a specific theoretical framework, making it flexible for use in a variety of paradigms and frameworks (Braun and Clarke 2006). The analysis progressed through a six-step process, as recommended by Braun and Clarke (2006).

During phase one, I familiarised myself with the data. The initial phase involved transcribing the verbal data obtained from the interviews. I executed the transcription procedure. Despite being a time-consuming task, it allowed me to become acquainted with the data. Consequently, transcription involves an engaged process of interpretation rather than a mere process of typing. This step involved thorough engagement with the data, reading it multiple times, and making detailed notes to attain comprehensive knowledge and explore potential patterns.

The second phase entailed generating preliminary codes. Codes are the basic units of relevant information inside raw data that are significant to the analyst in understanding a phenomenon (Braun and Clarke 2006, p. 88). In this phase, the process entailed extracting each data segment that was deemed significant and subsequently associating it with a corresponding code. Subsequently, all the codes were compiled. Codes serve as the foundation for recurring patterns; thus, codes can be classified into more general categories known as themes, which leads to the generation of themes (Phase 3).

The fourth phase consisted of reviewing the themes, which was accomplished through two stages of analysis. During the first stage, the data extracts pertaining to each specific theme were examined to verify the coherence of the data. Several themes were modified when necessary, involving the development of new themes and the merging of existing ones. At level two, I thoroughly examined the themes in connection to the entire dataset to ensure their appropriate representation. This served as a measure of research validity. Moreover, the transcripts coded were also checked by my PhD supervisor (MT) to ensure reflexivity.

In the fifth stage, the process entailed establishing and assigning themes to various topics. During this phase, I determined the fundamental nature of each theme and the specific theme of the data it represented. I accomplished this by providing an explanation of each individual theme and describing the content of the data and its connection to the research questions. The goal was to ensure that there was minimum overlap or duplication between the themes. Ultimately, the sixth stage entailed generating the report, which will be discussed in the following sections (Table 3).

5.5 Results

The study aimed to explore the effectiveness of high-fidelity manikin simulation sessions at the College of Emergency Medical Services at King Saud University, Riyadh, from a faculty and student perspective, using the Kirkpatrick evaluation model and CIPP evaluation model. The quantitative data presented in the following sections are the survey findings and the data retrieved by the Bristol Online Survey website through which the questionnaire was distributed. The data were screened for missing data. In addition, Cronbach's alpha coefficient was used to assess the internal consistency and reliability of the surveys. Exploratory factor analysis (EFA) was conducted to determine the validity of the factor structure because this was the first time the questionnaires were tested in the same study in this context, and hence, no a priori factor structure hypothesis had been presumed, particularly given that it was the first time to be used in EMS (Fabrigar and Wegener 2011). Moreover, the descriptive data to examine faculty's and students' perceptions regarding the simulation design features and the best educational practices to answer research question one and the Mann–Whitney U test for paired comparisons between the faculty and students to answer research question 2 were therefore utilised.

After conducting qualitative data analysis using the thematic analysis method by Braun and Clarke (2006), the findings are displayed as themes and subthemes in Table 3. Themes are recurring patterns of significance seen in data that encapsulate the core findings of a study, particularly in relation to research questions three and four (Braun and Clarke 2006; Joffe 2011). After thoroughly analysing the interview transcripts and creating various codes, I discovered six subthemes. These were then grouped into three overarching themes: institutional difficulties, support needs, and feedback and assessment (Table 3). Participants' quotations were anonymised using pseudonyms to ensure confidentiality, and any identifying information was omitted from the quotes.

5.5.1 Examination of students' and faculty's perceptions of the simulation design features and best educational practices of high-fidelity manikin simulation

Thirty-two EMS faculty members volunteered to complete the questionnaire for this study. The mean years of experience with simulation were 5.13 years. Eight teachers had a bachelor's degree, twenty-one teachers had a master's degree, two teachers had a PhD, and one teacher had an MPhil degree. Thirty-two teachers reported using high-fidelity manikin simulation in different modules, such as EMT basic, patient assessment, cardiology, airway management, critical care, clinical consideration, and trauma and medical courses (for a full breakdown of demographic data, please see Appendix 15).

Fifty-seven students completed the questionnaire, including 14 participants in their first year of the EMS programme (24.6%), 22 participants in the second year (38.6%), 12 participants in the third year (21.1%), and 9 participants in the fourth year (intern) (15.8%). The simulated manikin experiences rated by participants related to patient scenarios in EMT basic, patient assessment, cardiology, airway management, critical care, clinical consideration, and trauma, medical courses, emergency pharmacology, obstetrics, critical thinking, and intubation (for a full breakdown of demographic data, please see Appendix 16).

5.5.2 Data screening and missing data

The data were screened for missing values before analysis of the data. No missing values were identified (Appendix 17). Tests of normality (Kolmogrov–Smirnov) were conducted to show that the data collected were not normally distributed (Laerd Statistics, 2013) (Appendix 18). Therefore, I utilised the Mann–Whitney U test for paired comparisons between the faculty and students.

5.5.3 Validity and reliability of questionnaires

The validity and reliability of the questionnaires were examined before analysing the data. The SDS and the EPQ responses were analysed statistically, and one of the most important types of analysis carried out in this research was measuring reliability. Reliability has a number of different features, one of the most important being Cronbach's alpha coefficient (Pallant 2020; Warner 2012), which is important in measuring the scale's internal consistency to determine if any of the items are correlated with each other (Pallant 2020). The optimal alpha coefficient value should be above .70 (DeVellis and Thorpe 2021). However, as shown in Table 1, the Cronbach's alpha coefficient for the SDS-PO (presence) was .76 and .86 for the SDS-IO (importance) (student surveys). The Cronbach's alpha coefficient for the SDS-PO (presence) was .75 and .87 for the SDS-IO (importance) (faculty surveys). Moreover, as shown in Table 2, the Cronbach's alpha coefficient was .70 for the EPQ-PO (presence) and .88 for the EPQ-IO (importance) (student surveys). By contrast, the Cronbach's alpha coefficient was .80 for the EPQ-PO (presence) and .85 for the EPQ-IO (importance) (faculty surveys). The findings suggest an acceptable level of reliability (see Appendix 19).

EFA was conducted to determine the validity of the factor structure because this was the first time the questionnaires were tested in the same study in this context, and, hence, no a priori factor structure hypothesis had been presumed, considering also that it was the first time to be used in EMS (Fabrigar and Wegener 2011). All factors in the SDS scale are rated above 0.40 and do not have the same factor structure as the English version (Jeffries and Rizzlo 2006) (see Appendix 20). All factors in the EPQ scale rated above 0.40 and had the same factor structure as the English version (Jeffries and Rizzlo 2006) (see Appendix 21). According to Thompson (2004), the sample size significantly affects the accuracy of all statistical estimations, including those made in EFA. Devellis and Thorpe (2021) added that, more precisely, in exploratory factor analysis (EFA), the capacity to reproduce a factor structure is influenced to some extent by the size of the sample used in the initial analysis. Finally, the findings suggested that the SDS and EPQ scales were reliable and valid. The exploratory factor analysis results were also checked by my PhD supervisor (MT).

Teachers' and students' evaluation of simulated design features

Table 1 presents the mean, SD, and test of differences between faculty's and students' satisfaction and perceptions of the importance of the design features of

HFS (Appendix 22). The teachers' overall rating on the SDS-PO (presence) scale (M = 3.74, SD = 0.57) was similar to the students' overall rating (M = 3.58, SD ± 0.59), suggesting that both on average were satisfied with their experiences. With the lowest possible score on all scales being 1 and the highest being 5, the results suggest that faculty and students were fairly satisfied with all aspects of the simulated experience they reflected upon and agreed that the design features were important for learning. This includes ratings of the objectives of the experience (M = 3.96, SD = 0.80; M = 3.68, SD = 0.79, respectively), the support given (M = 4.08, SD ± 0.81; M = 4.71, SD = 0.98, respectively), facilitation of problem solving (M = 3.91, SD = 0.84; M = 3.63, SD = 0.94, respectively), realism of the simulation scenario (M = 3.46, SD = 0.63; M = 3.21, SD = 1.47, respectively), and provision of feedback (M = 2.80, SD ± 1.13; M = 3.46, SD = 1.07, respectively). Only in this aspect of the questionnaire were significant differences found, with faculty rating their experiences of feedback as lower than students ($p = 0.003$).

Table 1 further shows that the ratings on the SDS-IO (importance) scale were similar between faculty and students. On average, both faculty and students rated the design features of the simulated experience as important (M = 4.17, SD = 0.47; M = 4.20, SD ± 0.51, respectively). Significant differences were found on the rating of realism, with students rating this aspect of the simulated experience as more important (M = 4.62, SD = 0.79; M = 4.28, SD = 0.65, $p = .005$). Nevertheless, with an average higher than 4, both still rated realism as an important aspect of the simulated experiences.

Table 1: Descriptive statistics, and Mann–Whitney U test results comparing ratings of faculty and students on the SDS.

	Variable	**N items**	**Faculty n = 32**			**Students n = 57**			**Mann–Whitney U test**
			Mean	SD	α	Mean	SD	α	P-value
	Objectives	5	3.96	.80	.71	3.68	0.79	.70	.072

SDS (PO)	Support	4	4.08	0.81	.73	3.71	0.98	.70	.082
	Problem solving	5	3.91	.84	.73	3.63	0.94	.71	.196
	Fidelity	2	3.46	.63	.72	3.21	1.47	.70	.904
	Feedback	4	2.80	1.13	.71	3.46	1.09	.73	***.003***
	Total	20	3.74	0.57	.75	3.58	0.59	.76	.246
SDS (IO)	Objectives	5	4.00	0.78	.79	4.20	0.51	.72	.221
	Support	4	4.25	0.63	.71	4.46	0.55	.75	.141
	Problem solving	5	4.21	0.49	.73	3.91	0.84	.70	0.304
	Fidelity	2	4.28	0.79	.71	4.62	0.65	.70	***.005***
	Feedback	4	4.17	0.57	.70	4.11	0.70	.74	.736
	Total	20	4.17	0.47	.87	4.20	0.51	.86	.302

Teachers and students evaluation of educational practises

Table 2 presents the mean, SD, and test of differences between faculty's and students' satisfaction and perceptions of the importance of the educational practices of HFS (Appendix 23). The teachers' overall rating on the EPQ-PO (presence) scale (M = 3.97, SD = 0.63) was similar to the students' overall rating (M = 3.76, SD ± 0.54), suggesting that both were fairly satisfied with their experiences. With the lowest possible score on all scales being 1 and the highest being 5, the results suggest that faculty and students were fairly satisfied with all aspects of the simulated experience they reflected upon and agreed that educational practices were important for learning. This includes ratings of the active learning of the experience (M = 3.83, SD = 0.72; M = 3.70, SD = 0.63, respectively), the collaboration given (M = 4.10, SD ± 1.12; M = 3.31, SD = 1.42, respectively), diverse ways of learning given (M = 3.73, SD = 1.00; M = 4.28, SD = 1.01, respectively), and high expectations of the simulation scenario (M = 4.12, SD = 0.36; M = 3.96, SD = 1.10, respectively). As can be seen, it was only two on this aspect of the questionnaire that significant differences were found, with students rating their experiences of collaboration lower than faculty (p = 0.003) and faculty rating their experiences of diverse ways of learning lower than students (p = 0.003).

As illustrated in Table 2, the ratings on the EPQ-IO (importance) scale were similar between faculty and students. On average, both faculty and students rated the educational practices of the simulated experience as important (M = 4.20, SD = 0.40; M = 4.00, SD ± 0.48, respectively). Significant differences were found in the rating of collaboration, with students rating this aspect of the simulated experience as more important (M = 4.03, SD = 0.68; M = 4.58, SD = 0.71, p = .001). Nevertheless, with an average higher than 4, both still rated collaboration as an important aspect of the simulated experiences.

Table 2: Descriptive statistics, and Mann–Whitney U test results comparing ratings of faculty and students on the EPQ.

	Variable	**N items**	**Faculty n = 32**			**Students n = 57**			**Mann–Whitney U test**
			Mean	SD	α	Mean	SD	α	P-value
EPQ (PO)	Active learning	11	3.83	0.72	.81	3.70	0.63	.70	.416
	Collaboration	2	4.10	1.12	.76	3.31	1.42	.72	**.003**
	Diverse ways of learning	2	3.73	1.00	.71	4.28	1.01	.76	**.003**
	High expectation	2	4.12	0.36	.71	3.96	1.10	.70	.319

	Total	17	3.97	0.63	.80	3.76	0.54	.70	.416
EPQ (IO)	Active learning	11	4.20	0.40	.80	4.00	0.48	.70	.059
	Collaboration	2	4.03	0.68	.76	4.58	0.71	.72	**.001**
	Diverse ways of learning	2	4.03	0.59	.71	4.53	0.63	.76	.008
	High expectation	2	4.12	0.50	.71	4.40	0.68	.70	.042
	Total	17	4.20	0.38	.85	4.18	0.48	.88	.523

5.5.4 Exploration of participants' preparation and the challenges in high-fidelity manikin simulation

Preparation and challenges were explored by asking participants to reflect and report on the extent to which they felt prepared for HFS teaching or learning activities. Participants were also asked to reflect on any challenges and barriers and to identify their learning needs. The following sections will present the qualitative results of these semi-structured interviews using the programme evaluation model, specifically the input and process aspects of the CIPP evaluation model.

Nine teachers and 16 students participated in a qualitative, semi-structured interview. The interviews took place after the collection of the questionnaire data, but the questionnaire data had not been analysed at the time of the interviews. Therefore, the interview schedule was not based on any particular findings from the questionnaires but rather focused on understanding the participants' experience in HFS to supplement the quantitative data.

Three themes were identified that captured participants' perceptions of preparedness and the challenges associated with the implementation and use of HFS. The themes were institutional issues, support needs, and assessment and feedback. Table 3 provides a summary of the themes of learning needs and challenges that emerged from faculty and students, alongside their definitions and subthemes.

Table 3: Themes and subthemes representing challenges and needs

	Theme	Description	Subthemes
1	**Institutional issues**	The teachers' and students' needs related to institutional administration and resources	Orientation Equipment malfunction
2	**Support needs**	Teachers' and students support needs to maximise their new learning	Need for senior colleagues' support Need for briefing
3	**Assessment and feedback**	The teachers' and students' needs related to assessment and debriefing	Lack of assessment guidelines Constructive feedback and debriefing

THEME 1: Institutional issues

The first theme presents the faculty's and students' perceptions regarding institutional issues, and this theme represents the sub-themes of the faculty's and students' perceptions regarding the orientation and equipment malfunction of HFS equipment based on their perceptions of preparedness and readiness that could impact their educational process (input) and attitudes towards such activities (process).

Orientation

The lack of orientation is the first subtheme of the institutional issues that also concerns the participant's preparation and readiness for the high-fidelity manikin simulation activity (input evaluation). The responses indicated that most participants viewed the preparation for HFS as a lack of orientation. For example, one teacher stated:

> *Well, to be honest, I thought I was not prepared…* (F3)

Another teacher reported:

> *There is a lack of preparation. That is it.* (F4)

The students also believed that they did not feel properly prepared for the simulation lab at the beginning of their HFS experience. For example, one student mentioned:

> *… As a student, I want to inform me what the simulation will be like.* (S7)

Another student explained:

> *We can do orientation labs to get us to know the manikins and how the equipment works.* (S5)

Equipment malfunction

The subtheme of equipment malfunction reflects the students' and faculty's perceptions regarding the interruption during the HFS sessions, which impacted scenario progression. All participants mentioned that they felt at a loss as to how to handle the situation when there was an equipment malfunction. For most participants, the reason for not checking the function of the equipment's was either workload or miscommunication with the module's main instructor. For example, one teacher reported:

> *The equipment's in the lab, sometimes we have fault equipment's, for example; not ready because of the miscommunication between the main instructor and the technician in the labs. Another issue is the workload, since we have other responsibilities.* (F4)

Another teacher confirmed:

> *If there is a malfunction in the manikin, it's a challenging situation for me.* (F3)

Some of the teachers reported that they did not know what they should do to run the HFS with equipment malfunctions. One teacher mentioned, '*The lack of knowledge, the awareness about how to use the simulation manikins, which is sometimes, which means a challenging situation where, when I have to do something that I don't know how to do it. This is the most stressful and challenging situation for me. If I want to use the manikin, but I can't do what I have to do because I don't know …*' (F8).

Similarly, the students had difficulties regarding equipment malfunction during the simulation activity. For example, one student reported:

> *The manikin maybe did not work or was broken. if the manikin didn't work. Sometimes, the equipment is not prepared.* (S1)

Another student stated:

> *I was in the middle of the case scenario, and it was about lung sound, and unfortunately, the manikin has shut down, so we cannot listen and try to differentiate between the lung*

> *sounds. I think the technical problems of the manikins' time could negatively impact you as a learner.* (S3)

THEME 2: Support needs

The theme of support needs reflects the faculty's and students' perceptions of the curriculum elements of HFS in terms of objectives, content, and assessment methods. The theme demonstrates the faculties' and students' perceptions of the objectives of high-fidelity manikin simulation activity and the role of assessment in HFS (i.e. input evaluation). In addition, the theme demonstrates how faculty selected content for their HFS sessions and whether their students' perceived learning objectives were being achieved (i.e. process evaluation). The data coded under this theme were sub-grouped into the following subthemes: need for senior colleague's support, and need for briefing.

Need for senior colleagues

This subtheme presents the faculties' and students' perceptions of the objectives of HFS sessions and whether their perceived objectives are being met. The curriculum design for EMS education does not contain objectives specific to each HFS activity; rather, it contains formal objectives for the entire module. One teacher mentioned a lack of clear objectives for HFS sessions, and he sought support from other stakeholders during the HFS activity. The other teacher was compliant with the delay in receiving the objectives of the simulation. For example, one teacher stated:

> *I will try to overcome these challenges as much as I can, either by involving the main instructor or asking my colleagues how they will overcome them because we have different lives at the same time. So I will add them all or at the same time sometimes…* (F3)

Another teacher reported:

The objectives of this lab, assignment of the subject, they should send the objectives of each lab before this, but some currently we are doing this before them also, before the lab, like 10 minutes. So, I know the message or the information that they want the students to have. They proposed to have a quality evaluation, but we did not implement this… (F9)

The lack of specific objectives led to inconsistent faculty perceptions of the objectives of HFS sessions. Most of the teachers stated that the lack of objectives of the HFS sessions affected the learners during the HFS process. For example, one teacher reported:

I think they miss learning some skills, and they get bad impressions about the simulation. (F6)

Although there is a lack of clarity about the objectives of each HFS session, all teachers showed great enthusiasm for their positions and attempted to resolve the issues by suggesting that before running every HFS session, it should be aligned with a specific procedure or a meeting. For example:

I would say a dry run; it's one of the most important elements before starting the lab. The second is checking the equipment. Third, make sure the scenarios are applicable to your equipment in your simulated session. I would say these three main things… (F3)

Another teacher suggested:

We have to release the policy procedure to identify each member or participant's rules and responsibilities. Therefore, we will be free and will be able to make the contribution and improve the simulation environment… (F4)

Some of the students reported that their simulation experiences were negatively impacted by a lack of clear objectives. One student mentioned, '*The faculty members should also prepare. Sometimes, some information may be forgotten. Or they forget to explain it'* (S4). Another student stated, *'Well, usually we do not receive any information regarding the nature of the scenario and how it would be done. As a result of this, I become more nervous inside the lab'* (S5).

Need for briefing

The need for more information, clarity, and briefing subtheme is defined by the topics and content that faculty include in HFS sessions and how content is chosen. The lack of formal learning objectives led to diversity in the faculty's methods of choosing content for their sessions. Some of the teachers' responses regarding the content of the sessions indicated that they prefer to start with communication with students, and then give them some of the contents of the HFS session, such as PowerPoint slides, as stated in brief by one teacher: '*I think first we can start with communication, early communication, sharing slides and asking previous teachers of the course and asking tutors about what are the other challenges*' (F5). Another participant added that before conducting the HFS sessions, there should be standardisation regarding the content topics that are usually taught:

> *There is we will have a debriefing session to put us on the same page to understand what we will do, all at the same time to standardise our process, then we will go to our labs, they have to assume this is a real situation…* (F3)

The students also faced challenges regarding the lack of briefing of the contents before the simulation lab. For example, one student stated:

Faculties should prepare checklists and inform us before going into simulation, and can verify the steps so we have clear information and clear orders to work on … (S15)

THEME 3: Assessment and feedback

The theme of assessment and feedback reflects the faculty's and students' perceptions of the challenges related to debriefing at the end of the HFS session (process evaluation). Motivation is a crucial element for engagement in HFS activity and is described as the student's drive to engage, learn, and achieve during the simulation activity. Even though motivation is mainly intrinsic to students, especially in HFS, educators play a vital role in their students' motivation and engagement. In this theme, I present the participants' perceptions of the feedback and assessment that affect student engagement, including the intrinsic student factors and how faculty can improve HFS sessions (process evaluation).

Lack of assessment guidelines

The lack of assessment subtheme reflects the faculty's and students' perceptions of the need for assessment in HFS. All participants mentioned a lack of assessment of learning in HFS sessions. The knowledge discussed in the HFS sessions is not included in the summative assessment of the EMS education module. The reason could be the lack of standardisation of the objectives and structure of the sessions. One teacher stated:

They proposed to have a quality evaluation, but we did not implement this in this year … (F9)

Another teacher stated:

They don't understand what we're trying to say. They don't get excited about learning some stuff. Usually, we'll be a group of six people. They just keep watching what other *students do and they don't understand how it is going to be performed when they do it themself …* (F6)

The students highlighted a particular challenge that affected their ability during the simulation activity: a lack of guidelines or clear standards for assessment, particularly inside the lab where there was limited experience. One student stated:

Some of the skills I didn't learn. So I learned maybe after a little bit of time … (S14)

Another student reported:

If I knew how to do it perfectly with the manikin, I will do it with the real patient …' (S1)

Constructive feedback and debriefing

The subtheme of constructive feedback and debriefing reflects the students' and faculty's perceptions regarding engagement at the end of HFS sessions. It is important to note that all students were unsatisfied with their teachers' engagement, which confirms the ongoing observations and reports on this issue. One teacher noted:

The instructor is not capable of understanding the skills. You feel like you are evaluating the student. The consequences of your learners that they might feel bad and they might feel incompetent to performing the skills and they might feel that they can't successfully path worse … (F5)

For students, the level of trust they were able to develop in their relationship with their teachers was a key indicator of their programme evaluation of the HFS experience. Their opinions about the teachers who were responsible for guiding their debriefing were negative. One student stated:

> *There have been some mistakes. I haven't given the correct diagnosis to the instructor. Unfortunately, I haven't received clear feedback. I haven't understood my mistakes.* (S13)

Another student reported:

> *I asked faculty members about some information, some clarify, so they don't give clear answers, or they act in a way to make you never ask again.* (S4)

The third student explained:

> *There was no time for debriefing for the students to ask and react to the faculty.* (S8)

5.6 Discussion

The aim of this study was to evaluate the effectiveness of high-fidelity manikin simulation in an EMS college in Saudi Arabia. This was done by considering both outcome and programme evaluation using questionnaires and semi-structured interviews to collect data. The quantitative results provided useful insights, showing that overall, students, and faculty are satisfied with the implementation of high-fidelity manikin simulation education. The qualitative findings provided more meaningful data on what worked and what did not and the potential challenges faculty and students face in HFS education.

Student and faculty outcome evaluations of the HFS were very satisfactory, as reported by other authors (Franklin et al. 2014; Unver et al. 2017). The simulation design characteristics and the best educational practices are considered vital when using HFS (Groom et al. 2014). On the outcome evaluation for the simulation design scale, the students reported a lower rating for the fidelity (realism) of the HFS, finding a lack of reality in the simulation activity. The fact that this subscale obtained a lower rating in the outcome evaluation is not surprising. Since the fidelity of the simulation scenario had to be addressed by other factors, such as the fact that the fidelity should be aligned with the objectives of the simulation, both the faculty's and students' qualitative findings showed difficulty receiving the objectives before the simulation. The fidelity, which is focused on the realism of the HFS, must be authentic and include as many realistic environmental factors as possible (Jeffries 2020). However, according to Groom et al. (2014), the assumption that higher levels of fidelity in learning environments lead to greater learning outcomes lacks empirical evidence.

The paramedic students reported a higher rating for the support subscale during the simulation activity. According to Groom et al. (2014), the concept of support needs is vital during the simulation activity, and teachers should provide information to help students in their assessment and problem solving within the simulation activity. Moreover, according to Jeffries (2021), support should be provided to the learners before, during, and after the simulation. This support should come from the instructor or the simulation team by checking the manikin, the contents, and the decision-making during the simulation activity. However, findings from the interviews conducted with students suggest that despite the general rating of satisfaction with support, students in fact mentioned a lack of support as a challenge in the learning experience.

According to the students, the diverse ways of learning were rated highest on the evaluation of the best educational practices in the simulation activity. This finding was similar to another study in Poland, where students rated diverse ways of learning as the highest subscale (Zalewska and Zarzycka 2022). Zapko et al. (2018) highlighted that in the context of simulation, students must exhibit self-direction and assume a significant level of responsibility for their own learning. Therefore, it is logical that paramedic students ranked diverse ways of learning on the educational practices scale as the highest. By contrast, the lowest item obtained was collaboration. It is expected that this item had a low average score in the outcome evaluation of the best educational practices during the simulation, as the students were required to address the scenarios individually and did not have the chance to collaborate with others, except during the debriefing. Moreover, previous studies have reported that collaboration is rated the lowest by students (Berndt et al. 2015; Román-Cereto et al. 2022).

Both students and teachers indicated that, in general, the simulation design features and best educational practices were achieved during the HFS. Therefore, there were no significant differences between faculty's and students' perceptions regarding the outcome evaluation of the HFS. However, there was a significant difference at the subscale level. For example, there was a discrepancy regarding the feedback subscale in the simulation design features because the faculty members were not satisfied with giving constructive feedback to their students in a timely manner. Tejos et al. (2021) emphasised that feedback plays a crucial role and presents difficulty in psychomotor training. Moreover, Sawyer et al. (2017) added that feedback and debriefing are still issues in healthcare simulation activity. It may be difficult for simulation educators to gain an overview of the various methods and techniques employed in modern healthcare simulation debriefing. Therefore, investigating ways to optimise the debriefing and feedback experience is critical to maximising learning during healthcare simulations (Fey and Jenkins 2015).

In the semi-structured interviews, both faculty and students stressed facing challenges and identified learning needs in their HFS experiences. It was a vital decision to use programme evaluation, which helped the faculty and students identify their learning needs. Heitz et al. (2011) identified institutional support, including financial resources and faculty time, as well as the number of students and challenges in integrating simulation into the preclinical curriculum, as the primary obstacles to the use of simulation in medical schools. In this study, the majority of faculty and students had a negative perception of institutional support.

The faculty and students were concerned about the orientation and equipment malfunctions. Therefore, both faculty and students felt unprepared for the implementation of HFS activities. According to Dearmon et al. (2013), simulation educators should employ educational strategies for their students that promote learning, reduce anxiety and stress, and enhance self-confidence, such as orientation programmes. There should also be orientation programmes focusing on formal preparation and orientation for simulation educators to ensure competence and a smooth transition from expert simulation educator to novice simulation educator (Pezzimenti et al. 2022).

Both the faculty and students identified the equipment malfunction as a challenge during their HFS experience. According to Nielsen and Harder (2013), the majority of simulation educators are not qualified to run a manikin during a simulation activity. Moreover, Jeffries et al. (2015) added that simulation educators are often trained in the operation of manikins from vendors, not experts in simulation pedagogy. The teachers described their perceptions regarding equipment malfunctions as stressful, which might impact the students' learning. Muckler and Thomas (2019) asserted that effective functional equipment enhances the environment and suspension of disbelief, and scenario progression without interruption promotes the suspension of disbelief.

The students and teachers did not receive the simulation objectives; thus, there was a need to seek help from senior lecturers and more briefings regarding the simulation activity. However, the findings from the SDS conducted with students and faculty suggest that they were fairly satisfied with the objectives. When implementing any educational reform, it is essential to assess the results of learning and gather feedback from participants (Price et al. 2010). Subsequently, adjustments should be made in accordance with these findings. For instance, a study on the simulator experience of anaesthesiology residents in Canada found that providing residents with greater access to simulators and scenarios specific to students with clear objectives would significantly enhance the effectiveness of simulation in the curriculum (Price et al. 2010). Moreover, the simulation sessions should guarantee discussion and the achievement of learning objectives (Motola et al. 2013). Effective execution of this simulation domain is crucial for achieving desired outcomes and necessitates meticulous strategising and staff training. Nevertheless, some scholars have minimised the importance of objectives in lesson planning, asserting that classes driven by objectives result in student passivity and hinder creativity and critical thinking (Saunders 2003; Reed 2012).

The simulation educator plays a crucial role in the training of paramedic students during HFS. Students' impressions of feedback and debriefing are highly important, as their learning depends on the simulation educator's involvement. The findings from the interviews indicated that the students identified a lack of feedback and debriefing as challenges during their HFS. However, the findings from the SDS conducted with students suggest that they were fairly satisfied with the feedback. Other researchers have also documented insufficient feedback from simulation educators as a prominent issue among students, as it can result in unjust assessments of their work. For example, Cheng et al. (2017) highlighted that effective feedback has a significant impact on student motivation. In the present study, both students and teachers expressed their dissatisfaction with the inadequate feedback provided during their HFS experiences, which was also highlighted by simulation educators in a study by Nuzhat et al. (2014). This could also be the reason teachers gave low ratings to feedback acquired on the simulation design scale.

5.6.1 Theoretical implications

This study aimed to evaluate high-fidelity manikin simulation activities conducted at the College of Emergency Medical Services, King Saud University, Riyadh, where high-fidelity manikin simulation has been clearly implemented in the curriculum. Moreover, this is the first study on EMS education that considers it. Therefore, the findings of the study contribute to the body of existing literature. Most previous research on EMS education focused on the improvement of clinical skills during high-fidelity manikin simulation activities and did not evaluate the effectiveness of high-fidelity manikin simulation programmes. Furthermore, most previous research in healthcare education evaluated high-fidelity manikin simulation activities using either the outcome evaluation model or the programme evaluation model. Mixed methods were used to conduct questionnaires and semi-structured interviews to explore the faculty's and students' perceptions in depth. The study was based on Kirkpatrick's model (Level 1) and the input and process components of the CIPP model. The objectives were to determine the faculty's and students' perceptions of the simulation design features and the educational practices of high-fidelity manikin simulation sessions. Furthermore, the study is intended to examine the faculty's and students' perceptions regarding the preparation, challenges, to identify their learning needs for such sessions.

In terms of Kirkpatrick's evaluation, which concerns whether the faculty and students were satisfied with the simulation design features and the educational practices during the high-fidelity manikin simulation sessions, the findings indicate that both the faculty and students were satisfied. Moreover, there were no significant differences between the faculty and students regarding the simulation design features and the educational practices during the high-fidelity manikin simulation activities, except at the subscale level. Specifically, feedback on the presence of the SDS was in favour of the students, and faculty were not satisfied with giving clear feedback to their students in a timely manner, which aligned with the qualitative findings, in which the students found it to be an obstacle during their simulation experience. Furthermore, fidelity to the importance of the SDS is also favourable to students.

In terms of input evaluation, which concerns the preparation and readiness for implementing high-fidelity manikin simulation, in addition to the structure and curriculum of HFS sessions, the results indicate that faculty and students need an orientation to run the simulation activity and solve equipment malfunction. The faculty and students believed that they were poorly prepared for the implementation of high-fidelity manikin simulation sessions and needed guidance. Support can be delivered from the main course leader or through dry-run activities.

Moreover, the faculty and students stressed that there was a lack of briefing regarding the contents of the simulation session.

The faculty and students had similar perceptions of the objectives of the high-fidelity manikin simulation sessions. The main finding was that faculty should receive the objectives before conducting the simulation activity, and students should be able to find appropriate resources in addition to improving students' clinical training experience. The faculty suggested that the objectives of high-fidelity manikin simulation sessions should be aligned with the dry run before the run of the simulation, make sure that the scenario is applicable to the equipment's, and identify the responsibility and rule for each simulation educator. Most of the participants believed that the lack of clear objectives for the simulation session did not address the students' needs. The participants revealed that their high-fidelity manikin sessions did not include clear guidelines or a standardisation approach for each educator.

In terms of process evaluation, which concerns whether high-fidelity manikin simulation sessions were delivered as intended, and implementation issues, poor student engagement in simulation sessions was a major challenge. The students believed that the faculty did not give them clear feedback at the end of the simulation session, and some of the students stressed that there was not enough time for feedback. By contrast, the faculty believed that a lack of skills to give feedback might negatively impact students' performance. A report of these findings in terms of learning needs during the HFS experience was provided to the college.

5.6.2 Practical implications

As this research is an evaluative study aimed at informing change, the study findings can be used to make improvements at the EMS college where the study was conducted. Based on the study's qualitative findings, several approaches can be implemented to improve the educational value of high-fidelity manikin simulation sessions.

1- **Faculty and student preparation**

The faculty did not receive any formal training or support on how they should deliver sessions. Although the faculty understood the simulation concept, they were unaware of their personal roles or effective practical attitudes in conducting the sessions, as most of their recommendations for improving simulation sessions were about factors related to objectives and equipment. Moreover, students should be prepared to help them identify the simulation aspects before running the simulation. The simulation unit should liaison with the faculty development unit at the school to offer regular workshops to improve faculty and student preparedness (Acton et al. 2015; Jeffries et al. 2015; Ahmed et al. 2016; Herlihy 2022).

2- **Establishing clear learning objectives**

The objectives of the high-fidelity manikin simulation sessions were not clearly stated. In addition, poor student engagement was a significant finding in this study. The simulation unit should develop broad but focused learning objectives linked to real-life practice for high-fidelity manikin simulation sessions, which would function as a guide for the faculty in delivering the sessions, and students would be more motivated (Page-Cutrara 2014; Munangatire and Naidoo 2017; Nestel et al. 2019).

3- **Faculty debriefing training**

The students reported that they had not received clear feedback from their teachers. Therefore, teachers might need a debriefing training course to improve their teaching during high-fidelity manikin simulation sessions. Faculty can acquire debriefing training by participating in simulation educator training courses provided by different simulation programmes, attending workshops at conferences, or pursuing fellowship training or graduate degrees in simulation (Cheng et al. 2014; Ryoo and Ha 2015).

4- **Briefing before the simulation sessions**

The students believed that there was a lack of briefing. Therefore, it would be reasonable to deliver a briefing to the students before the simulation sessions (Rudolph et al. 2014; Halamek et al. 2019; Hughes and Hughes 2019).

5- **Multidisciplinary teamwork**

A multidisciplinary approach is needed to address the administrative and technical challenges that faculty and students face in a high-fidelity manikin simulation environment. The medical education unit should conduct meetings with relevant stakeholders in different departments and committees to address difficulties in running simulation activities, as administration-controlled factors play an essential role in the success of HFS (Najjuma et al. 2020; Nyein and Gregory 2020).

5.7 Study Limitations

As this was the first study to be conducted, the results must be interpreted with caution due to some limitations. The first and most significant limitation was the relatively small sample size for a questionnaire-based study: 57 students out of a possible 300 students and 32 teachers out of a potential 40. The sample size could change the significance of the study results, as more significant results are more likely to be obtained from a larger sample (Bowling 2014). In this study, the sample size was mainly affected by the COVID-19 pandemic. Therefore, this decreased the number of participants, and the possibility of reaching a large number of participants and achieving saturation was difficult. The time at which the study was undertaken was another factor affecting participant numbers, as it was also during the long summer vacation in Saudi Arabia, when most of the students had limited access to their emails.

Regarding the concept of reflexivity, I must acknowledge that I am a simulation educator in the simulation unit where the study took place. Consequently, my personal bias and potential interactions with the participants could have undermined the study's validity. Completely eliminating personal bias in planning the study, particularly in such a context, is challenging. However, I made an effort to overcome this constraint by ensuring that the research was conducted with strict adherence to rigorous standards. I employed an interview guide to improve the impartiality and validity of the study (Kallio et al. 2016). The guide was developed utilising the CIPP model, which is a well-documented framework in the literature (Frye and Hemmer 2012). Nevertheless, I was absent from the simulation unit for a duration exceeding 1 year due to study leave. Furthermore, the researcher's capacity to gather comprehensive data from interviews is contingent upon the establishment of a strong rapport and trust with the participants (Guillemin and Heggen 2009). Given this, the association with certain individuals potentially facilitated data collection, and certain measures were implemented during the interviews to mitigate personal bias. In addition, the validity of this study was enhanced through investigator triangulation (Guion et al. 2011). This is accomplished by engaging my PhD supervisor (MT) in the process of data analysis.

I found that the process of data analysis was exhausting and time-consuming, especially for a single researcher with limited time and experience. Although this process helped me immerse myself in the data to achieve a good understanding of the material, I would consider some help from a colleague, which could help save time.

Another limitation is the use of SDS and EPQ questionnaires. Although it helped me generate detailed and flexible data for this study, most of the participants reported that the questionnaire was very long and repetitive. The reason for this might have been that some questions were written in a similar way to ensure reliability. In addition, the participant asked me if we should answer the questionnaire before the lockdown or during the pandemic. Thus, it would be advantageous for future studies to consider the use of a questionnaire in a more interesting way. Future research could also examine the presence of SDS and EPQ alone. There is no need to include this importance, as it is obvious that there is a clear need and importance for using HFS in EMS education.

5.8 Suggestions for Future Research

Future research will result from the findings of the current study. First, future studies would benefit from a mixed methods approach, and the integration of a follow-up in the research design would address the frequently mentioned methodological issues and allow for inferences to be made. The HFS is evaluated using outcome evaluation, which includes the SDS and EPQ as a quantitative part, as well as programme evaluation, specifically the CIPP evaluation model.

Second, this cross-sectional mixed methods study examined a sample of faculty's and students' perceptions in one EMS college in Saudi Arabia. It is highly recommended that this study be widened to involve more faculty and students in other EMS colleges in Saudi Arabia to gain broader insights into the implementation of high-fidelity manikin simulation. Thus, more studies are needed to evaluate the programme outcomes, input, and process in this topic in order to generalise the findings at the national level.

Third, after searching the literature, there were limited studies using the SDS and EPQ scales in the Middle East. There is a lack of information regarding the reliability and validity of the SDS and EPQ scales at the national level. Little is known about its psychometric properties; therefore, additional evidence and empirical research are needed. Thus, more studies are needed to involve EMS colleges in Saudi Arabia to provide additional context-specific evidence on the psychometric properties of the SDS and EPQ.

CHAPTER 6: Evaluation of High-Fidelity Manikin Simulation in Emergency Medical Services (EMS) Education in Saudi Arabia Before and During the COVID-19 Pandemic

This chapter is the second in a series of three studies for this thesis, the aim of which is to evaluate high-fidelity manikin simulation activities in EMS education in Saudi Arabia. In contrast to the previous study, this research gathered evaluative data from various EMS institutions rather than one, and it capitalised on the opportunity to evaluate the impact of the COVID-19 pandemic on the teaching of high-fidelity manikin simulation in EMS colleges in Saudi Arabia.

6.1 Abstract

Background: High-fidelity simulation (HFS) has long been perceived as playing an important role in a range of healthcare educational settings. However, during the COVID-19 pandemic, faculty, and students experienced significant challenges in its implementation. This study was set out to evaluate high-fidelity manikin simulation activities before and during the COVID-19 pandemic in 11 EMS colleges in Saudi Arabia.

Methods: This study utilised a mixed-methods approach to evaluate the implementation of high-fidelity manikin simulation before and during the COVID-19 pandemic. Two instruments were used to collect quantitative data, including the simulation design scale (SDS) and the educational practices questionnaire (EPQ), to examine participants' ratings of their experiences with HFS activities by using Kirkpatrick's outcome evaluation model (Level 1). Interviews were designed to gather meaningful contextual data on students' and faculty's challenges and preparedness using the programme evaluation model, specifically CIPP evaluation. In total, 40 faculty members and 210 students completed the questionnaire, out of which 10 faculty members and 17 students at 11 EMS colleges in Saudi Arabia volunteered to participate in semi-structured interviews.

Results: Both faculty and students were satisfied with the simulation design features and educational practices before and during the COVID-19 pandemic for implementing a high-fidelity manikin simulation. Three themes emerged from the semi-structured interviews that described the perceptions of faculty and students: institutional issues, support needs, and teaching before and during the COVID-19 pandemic.

Conclusion: The results indicated that educators and learners were satisfied with the simulation design features and the educational practices used in the high-fidelity manikin simulation activity before and during the COVID-19 pandemic. However, the programme evaluation highlighted several challenges. The main challenges to effective high-fidelity manikin simulation before the COVID-19 pandemic were lack of teachers' formal training, lack of briefing of teachers and students before running the simulation activities, insufficient time, equipment malfunction, need for support, and the delayed integration of simulation objectives into the curriculum. Moreover, there were unprecedented challenges during the COVID-19 pandemic that negatively affected the implementation of high-fidelity manikin simulation, such as uncomfortable conditions inside the lab related to wearing the face mask all the time, the size of the lab, prohibited collaboration between the students because of the social distance guidelines, and a lack of hands-on activities, so the students did not have the opportunity to practice and improve their clinical skills. To improve the incorporation of high-fidelity manikin simulation into undergraduate curricula, EMS schools in Saudi Arabia need to address these hurdles.

6.2 Introduction

An outbreak of the novel coronavirus infection (SARS-CoV-2) has recently developed and rapidly spread worldwide, posing significant threats to global health and the economy (Sarkodie and Owusu 2021). The COVID-19 pandemic has already caused significant disruptions in universities and academic institutions. Paramedic schools are particularly experiencing distinct obstacles in their efforts to train the next cohort of paramedic professionals (Williams et al. 2021). The pandemic necessitated a suspension of paramedic students’ access to clinical training placements, which posed challenges in completing the EMS curriculum learning process. Empirical evidence shows that the pandemic has permanently altered the educational terrain (Whitfield et al. 2021).

Simulation has been extensively employed in the clinical instruction of paramedic students and practitioners. The utilisation of this approach seems to be an advantageous method for instructing, acquiring knowledge, and assessing practical abilities in the field of emergency medical services across various proficiency levels, all within a secure setting (Wheeler and Dippenaar 2020). Paramedic students benefit from an active instructional method that enhances their knowledge consolidation, fosters the development of technical and relational abilities, and establishes rules and habits for critical thinking and reflection (Williams et al. 2016). The utilisation of clinical simulation in paramedic education yields beneficial outcomes for both students and instructors, as well as for health organisations encompassing individuals, groups, and communities (Mckenna et al. 2015).

The main goals of employing simulation as a pedagogical method are to improve the quality of healthcare and ensure the safety of patients (Tavares et al. 2014). The utilisation of the high-fidelity manikin simulation aimed to replicate authentic scenarios, fostering paramedic students’ acquisition of practical experience and essential clinical paramedic competencies (Power et al. 2013). The utilisation of high-fidelity manikin simulation offers the fundamental components of a reflective practitioner’s prospective education via active engagement, collaborative teamwork, effective communication, repetitive practice, and assessment (Williams et al. 2016).

The teaching of EMS has transitioned from a training paradigm based in hospitals, which emphasises regular practice of tasks and procedures, to a simulation-based approach that teaches students to think critically and discern evidence wisely (Jee et al. 2020). Paramedic educators have the duty of training paramedic trainees to effectively confront the diverse obstacles encountered while entering the healthcare profession (Boyle et al. 2007). Paramedic students can develop competence, confidence, understanding, and satisfaction in applying their paramedic knowledge and abilities to difficult situations through clinical simulations. These simulations take place in a controlled learning setting where there is no direct connection with patients (Michau et al. 2009).

In previous epidemics, simulation was effectively employed to prepare paramedic student personnel. For example, after the SARS period, paramedic students began widely implementing simulation-based airway management and cardiac arrest training programmes (Häikiö et al. 2021). These programmes aimed to enhance the technical and interpersonal abilities of paramedic students who treat patients with highly contagious diseases (Häikiö et al. 2021). For this reason, it is important to evaluate the implementation of high-fidelity manikin simulation in EMS programmes before and during the COVID-19 pandemic to ensure that EMS institutions are better prepared for these kinds of unpredictable circumstances, thereby being able to respond and adapt more efficiently. Similar to the previous study, the evaluation framework was informed by both outcome and programme evaluation, with a focus on examining satisfaction and potential challenges before and during the pandemic.

6.3 Aims and Research Questions

The overall aim of the study was to evaluate high-fidelity manikin simulation activities delivered to paramedic students before and during the COVID-19 pandemic at EMS colleges in Saudi Arabia. This was achieved using Kirkpatrick's evaluation model, with a specific focus on Level 1 (learners' and teachers' satisfaction or reaction to the implementation of high-fidelity manikin simulation sessions before and during the COVID-19 pandemic, as well as a CIPP evaluation model with a specific focus on input and process. The study aimed to examine teachers' and students' perceptions of the following:

1. To what extent are faculty and students satisfied with their experiences of high-fidelity manikin simulation activities before and during the COVID-19 pandemic?
2. Are there similarities or differences in faculty's and students' satisfaction with high-fidelity manikin simulation activities before and during the COVID-19 pandemic?
3. Are there differences in faculty's and students' perceptions of the preparation and challenges of high-fidelity manikin simulation activities before and during the COVID-19 pandemic to identify their learning needs?
4. How can challenges and barriers be addressed to improve the educational value of high-fidelity manikin simulation activities?

6.4 Methodology

6.4.1 Research design

This study used a mixed-methods design using a questionnaire and semi-structured interviews to evaluate high-fidelity manikin simulations. Underpinned by outcome and programme evaluation models, the questionnaire focused on Kirkpatrick's Level 1 evaluation model (Holtschneider and Park 2019), and the semi-structured interview focused on the input and process components of the CIPP evaluation model (Graham and McAleer 2018). Building on findings from the previous study, it was important to use a mixed methods approach to consider faculty's and students' voices alongside the questionnaire results, which often provide limited insights into what and why educational interventions work or do not work. The aim of analysing the quantitative data gained via the questionnaire was to broadly establish whether high-fidelity manikin simulation activities met their intended outcomes after both faculty and students attended a high-fidelity manikin simulation activity and to compare the level of satisfaction before and during the COVID-19 pandemic. The qualitative semi-structured interviews were designed to gain additional insight and explanations regarding why and how HFS may or may not achieve its intended outcomes before and during the pandemic.

6.4.2 Setting and sample

The sample consisted of faculty members and students at 11 EMS colleges in Saudi Arabia, as they were the main stakeholders in the EMS HFS laboratories. Sixty-one faculty members and 558 students at these colleges were invited to participate in the study. The inclusion criteria were teachers in the EMS colleges who had been involved in the teaching of high-fidelity manikin sessions for at least one academic year before the COVID-19 pandemic and during the COVID-19 pandemic, and students who had been involved in HFS for at least 10 simulation sessions before and during the COVID-19 pandemic. The participants' first language was not English; however, they demonstrated a high level of proficiency in English, as it is the main language of teaching in EMS education in Saudi Arabia.

The sampling method was non-probability convenience sampling, which involved recruiting individuals based on their ease of access and availability. This approach was deemed appropriate for the research due to anticipated challenges in participant accessibility, given their substantial teaching and clinical responsibilities throughout the COVID-19 pandemic. Indeed, the majority of research conducted in the field of medical education relies on non-probability sampling methods. This is primarily because probability sampling techniques are more time-consuming and costly. Nonetheless, it is important to acknowledge that non-probability sampling methods may introduce a potential source of bias, as they do not fully capture the characteristics of the entire population being studied (Tavakol and Sandars 2014). In total, 40 faculty members and 210 students completed the questionnaire, out of which 10 faculty members and 17 students volunteered to participate in the semi-structured interviews.

6.4.3 Interview schedule

Semi-structured interviews were conducted using a pre-prepared interview schedule that included a set of open questions to guide the interview process (Flick

2021). Some personal data were collected and stored separately to capture information such as academic degrees, years of academic experience, and years of delivering high-fidelity manikin simulation sessions (Appendices 24 and 25). The open-ended questions allowed the participants to share individual experiences regarding the implementation of high-fidelity manikin simulation activity before and during the pandemic, which made it easier to pinpoint their preparation and challenges. All interview questions revolved around themes such as readiness, preparedness, barriers, and factors that impacted the implementation of HFS from a faculty and students' perspective. The interviews initially were conducted via phone, and each interview lasted between 30–45 minutes. Interviews were recorded and transcribed to clear any ambiguity at the time of the recording and data analyses (DiCicco-Bloom and Crabtree 2006).

The interview schedule was piloted to allow for practice before undertaking formal data collection. The purpose of the pilot interview was to check if any questions needed amendments, the quality of the audio recorder, the language of the questions, and whether the participants would comprehend what I wanted to ask. Interviews were conducted with two paramedic interns and two EMS simulation educators, whose roles were to help me understand whether the interview schedule had any practical issues (Kvale and Brinkmann 2009). I received valuable insights into the practical aspects of my questions and the topic itself, and no amendments to the questions were required.

6.4.4 Data analysis

Questionnaire data were transferred from the Bristol online survey and recorded and listed on an SPSS worksheet. Questionnaire data were analysed with descriptive statistics performed using the statistical software SPSS 26 to examine participants' satisfaction with HFS before and during the COVID-19 Pandemic to answer research question one. The data were screened, and the questionnaires were examined for reliability and validity. Tests of normality (Shapiro–Wilk test) were conducted, and the Mann–Whitney U test was used to compare faculty and student satisfaction before and during the COVID-19 pandemic to answer the second research question.

Thematic analysis (TA) was used to address the third and fourth questions that were set to examine perceptions of the challenges and experiences of teaching and learning in HFS before and during the COVID-19 pandemic. TA is a method for identifying, analysing, and reporting patterns (themes) within data and is widely used in the social sciences and in nursing research (Braun and Clarke 2006). TA was chosen as the best method for analysis for several reasons. First, it does not require expert theoretical and technical knowledge and is identified as a foundational method of qualitative analysis, which makes it appropriate for early-career researchers (Braun and Clarke 2006). Second, TA is not tied to a specific theoretical framework, making it flexible for use in a variety of paradigms and frameworks (Braun and Clarke 2006).

The analysis followed the TA method and progressed through a six-step process, as recommended by Braun and Clarke (2006). During phase one, I familiarised myself with the data. The initial phase involved transcribing the verbal data obtained from the interviews. I executed the transcription procedure. Despite being a time-consuming task, it allowed me to become acquainted with the data. Consequently, transcription involves an engaged process of interpretation rather than a mere typing process. This step involved thorough engagement with the dataset, reading it multiple times, and making detailed notes to attain comprehensive knowledge and explore potential patterns.

The second phase entailed generating preliminary codes. Codes are the basic units of relevant information inside raw data that are significant to the analyst in understanding phenomena (Braun and Clarke 2006, p. 88). In this phase, the process entailed extracting each data segment that was deemed significant and subsequently associating it with a corresponding code. Subsequently, all the codes were compiled. Codes serve as the foundation for recurring patterns; thus, they can be classified into more general categories known as themes. Moreover, I asked my PhD supervisor (MT) to help me in coding by checking the ideas and exploring the interpretations of the data. According to Byrne (2022), having multiple coders might be advantageous in a reflexive approach. Therefore, this approach was collaborative and aimed to achieve richer interpretations of meaning. Phase three of the analysis process involved generating themes.

The fourth phase was a review of themes, which was accomplished through two stages of analysis. During the first stage, the data extracts pertaining to each specific theme were examined to verify the coherence of the data. Several themes were modified when necessary, involving the development of new themes and the merging of existing ones. In stage two, I thoroughly examined the themes in connection to the entire dataset to ensure their appropriate representation. This serves as a measure of research validity.

In the fifth phase, the process entailed establishing and assigning themes to various topics. During this phase, I determined the fundamental nature of each theme and the specific theme of the data it represented. I accomplished this by providing an explanation of each individual theme and describing the content of the data and its connection to the research questions. The goal was to ensure that there was minimum overlap or duplication between the themes. Ultimately, the sixth phase entailed generating the report; this will be discussed in the qualitative results section.

6.5 Results

The study aimed to explore the effectiveness of high-fidelity manikin simulation sessions at EMS colleges in Saudi Arabia from the faculty's and students' perspectives using the Kirkpatrick evaluation model and CIPP evaluation model. The quantitative data presented in the following sections are the survey findings and the data retrieved by the Bristol Online Survey website through which the questionnaire was distributed. The data were screened for missing information. In addition, Cronbach's alpha coefficient was used to assess the internal consistency and reliability of the surveys. Confirmatory factor analysis (CFA) was conducted as an additional measure of validity (Fabrigar and Wegener 2011). Moreover, the descriptive data examined faculty and students' perceptions of satisfaction regarding the simulation design features and the best educational practices to answer the first research question. The Mann–Whitney U test for paired comparisons between faculty and students' satisfaction before and during the COVID-19 pandemic was used to answer the second research question.

After conducting qualitative data analysis using the thematic analysis method by Braun and Clarke (2006), the findings were displayed as themes and subthemes, as shown in Table 6. Themes are recurring patterns of significance seen in data that encapsulate the core findings of a study, particularly in relation to the third and fourth research questions (Braun and Clarke 2006; Joffe 2011). After thoroughly analysing the interview transcripts and creating various codes, I discovered eight subthemes. These were then grouped into three overarching themes: institutional difficulties, support needs, and teaching during the COVID-19 pandemic (Table 6). Participants' quotations were anonymised using pseudonyms to ensure confidentiality, and any identifying information was omitted from the quotes.

6.5.1 Students' and faculty's satisfaction with high-fidelity manikin simulation before and during the COVID-19 pandemic

A total of 250 students and EMS faculty completed the questionnaire. Seven teachers had a bachelor's degree, 23 teachers had a master's degree, and 10 teachers had a PhD. Teachers reported using high-fidelity manikin simulation in different modules, such as EMT basic, patient assessment, cardiology, airway management, critical care, clinical consideration, and trauma and medical courses (see Appendix 26).

The student sample included 10 participants in their first year of study (4.7%), 24 participants in the second year (11.4%), 76 participants in the third year (36.0%), and 100 participants in the fourth year (47.4%, intern). Students noted a variety of learning experiences using HFS, including patient scenarios in EMT basic, patient assessment, cardiology, airway management, critical care, clinical consideration, trauma, medical courses, emergency pharmacology, obstetrics, critical thinking, and intubation (for a full breakdown of demographic data, please see Appendix 27).

6.5.2 Data screening and missing data

The data were screened for missing values. No missing values were identified (Appendix 28). Tests of normality (Kolmogrov–Smirnov) were conducted to show that the data collected were not normally distributed (Laerd Statistics, 2013) (Appendix 29). Therefore, I utilised the Mann–Whitney U test for paired comparisons to compare student and faculty satisfaction before and during the COVID-19 pandemic.

6.5.3 Validity and reliability of questionnaires

The validity and reliability of the questionnaires were examined before analysing the data. The SDS and EPQ responses were analysed statistically, and one of the most important types of analysis carried out in this research was measuring reliability. Reliability has a number of different features, one of the most important being the Cronbach's alpha coefficient (Pallant, 2020; Warner, 2012), which is important in measuring the scale's internal consistency to determine whether any of the items are correlated with each other (Pallant, 2020). The optimal alpha coefficient value should be above .70 (DeVellis and Thorpe 2021). However, as shown in Table 4, the Cronbach's alpha coefficient for the SDS for both the student and faculty surveys before and during the COVID-19 pandemic was .97. Moreover, as shown in Table 5, the Cronbach's alpha coefficient for the EPQ (before and during the COVID-19) was .97 (student surveys). The Cronbach's alpha coefficient for the EPQ (before the COVID-19 pandemic) was .94 and .95 for the EPQ (during the COVID-19 pandemic) (faculty surveys). The findings suggest an acceptable level of reliability (see Appendix 30).

CFA was conducted to confirm the structure of the construct. The CFA findings supported a five-factor solution for the SDS and a four-factor solution for the EPQ, which is similar to the original questionnaire (see Appendix 31). Moreover, both instruments attained the desired values and indicated a perfect fit with the model

(Appendix 32). The findings suggested that the SDS and EPQ scales were reliable and valid. Confirmatory factor analysis (CFA) results were also checked by my PhD supervisor (MT).

Teachers' and students' evaluation of simulation design features before and during the COVID-19 pandemic

Table 4 presents the mean, SD, and test of differences in faculty' satisfaction and perceptions of the design features of HFS before and during the COVID-19 pandemic (Appendix 33). On average, the faculty's overall rating on the before-COVID-19 SDS (M = 4.22, SD = 0.83) was similar to their overall rating during-COVID-19 SDS (M = 4.21, SD ± 0.79), suggesting that the faculty were fairly satisfied with their experiences. With the lowest possible score on all scales being 1 and the highest being 5, the results suggest that faculty were fairly satisfied with all aspects of the simulated experience they reflected upon regarding learning before and during the COVID-19 pandemic. This includes ratings of the objectives of the experience (M = 4.19, SD = 1.07; M = 3.99, SD = 0.97, respectively), the support given (M = 4.30, SD ± 0.92; M = 4.22, SD = 0.90, respectively), facilitation of problem solving (M = 4.32, SD = 0.84; M = 4.32, SD = 1.00, respectively), realism of the simulation scenario (M = 3.96, SD = 0.94; M = 4.45, SD = 1.00, respectively), and provision of feedback (M = 4.26, SD ± 0.80; M = 4.26, SD = 1.05, respectively). Only in this aspect of the questionnaire were significant differences found, with faculty rating their experiences of fidelity before the COVID-19 pandemic as lower than their experiences during the COVID-19 pandemic (p = *0.002*).

Table 4 presents the mean, SD, and test of differences in student's satisfaction and perceptions of the design features of HFS before and during the COVID-19 pandemic (Appendix 34). The students' overall rating on the before-COVID-19 SDS (M = 3.78, SD = 0.98) was similar to their overall rating on the during-COVID-19 SDS (M = 3.68, SD ± 1.03), suggesting that the students on average were satisfied with their experiences. With the lowest possible score on all scales being 1 and the highest being 5, the results suggest that students were fairly satisfied with all aspects of the simulated experience they reflected upon for learning before and during the COVID-19 pandemic. This includes ratings of the objectives of the experience (M = 3.73, SD = 1.15; M = 3.59, SD = 1.19, respectively), the support given (M = 3.83, SD ± 1.09; M = 3.70, SD = 1.19, respectively), facilitation of problem solving (M = 3.74, SD = 1.04; M = 3.73, SD = 1.05, respectively), realism of the simulation scenario (M = 3.95, SD = 1.12; M = 3.74, SD = 1.20, respectively), and provision of feedback (M = 4.79, SD ± 1.12; M = 3.67, SD = 1.17, respectively). No significant differences were found.

Table 4: Descriptive statistics and Mann–Whitney U test results comparing ratings of faculty and students on the SDS before and during the COVID-19 pandemic.

	Variable	**N items**	**Before COVID-19**			**During COVID-19**			**Mann–Whitney U test**
			Mean	SD	α	Mean	SD	α	P-value
SDS (Faculty)	Objectives	5	4.19	1.07	.97	3.99	.97	.93	.129
	Support	4	4.30	.92	.94	4.22	.90	.90	.537
	Problem solving	5	4.32	.84	.95	4.32	1.00	.92	1.000
	Fidelity	2	3.96	.94	.89	4.45	1.00	.94	**.002**
	Feedback	4	4.26	.80	.86	4.26	1.05	.89	1.00
	Total	20	4.22	.83	.97	4.21	.79	.97	.722
SDS (students)	Objectives	5	3.73	1.15	.95	3.59	1.19	.96	1.00
	Support	4	3.83	1.09	.93	3.70	1.19	.95	.397
	Problem solving	5	3.74	1.04	.91	3.73	1.05	.91	.990
	Fidelity	2	3.95	1.12	.91	3.74	1.20	.91	.074
	Feedback	4	3.79	1.12	.94	3.67	1.17	.95	.392
	Total	20	3.78	.98	.97	3.68	1.03	.97	.768

Teachers and students evaluation of educational practices before and during the COVID-19 pandemic

Table 5 presents the mean, SD, and test of differences in faculty' satisfaction and perceptions of the educational practices of HFS before and during the COVID-19 pandemic (Appendix 35). On average, the faculty's overall rating on the before-COVID-19 EPQ (M = 4.06, SD = 0.74) was similar to their overall rating on the during-COVID-19 EPQ (M = 4.09, SD ± 0.76), suggesting that they were fairly satisfied with their experiences. With the lowest possible score on all scales being 1 and the highest being 5, the results suggest that faculty were fairly satisfied with all aspects of the simulated experience they reflected upon for learning before and during the COVID-19 pandemic. This includes ratings of the active learning of the experience (M = 4.09, SD = 0.72; M = 3.97, SD = 0.86, respectively), the collaboration given (M = 3.89, SD ± 0.88; M = 4.24, SD = 0.47, respectively), diverse ways of learning (M = 4.02, SD = 0.95; M = 4.37, SD = 0.77, respectively), and high expectations of the simulation scenario (M = 4.23, SD = 0.82; M = 4.23, SD = 0.82, respectively). No significant differences were found.

Table 5 presents the mean, SD, and test of differences in students' satisfaction with and perceptions of the educational practices of HFS before and during the COVID-19 pandemic (Appendix 36). The students' overall rating on the before-COVID-19 EPQ (M = 3.91, SD = 0.97) was similar to their overall rating on the during-COVID-19 EPQ (M = 3.78, SD ± 1.00), suggesting that the students on above average were satisfied with their experiences. With the lowest possible score on all scales being 1 and the highest being 5, the results suggest that students were fairly satisfied with all aspects of the simulated experience they reflected upon regarding their learning before and during the COVID-19 pandemic. This includes ratings of the active learning of the experience (M = 3.87, SD = 0.63; M = 3.80, SD = 0.48, respectively), the collaboration given (M = 3.31, SD ± 1.42; M = 4.07, SD = 1.10, respectively), diverse ways of learning (M = 4.28, SD = 1.01; M = 3.71, SD = 1.22, respectively), and high expectations of the simulation scenario (M = 3.91, SD = 1.14; M = 3.81, SD = 1.12, respectively). Only in two of these aspects of the questionnaire were significant differences found, with students rating their experiences of collaboration before the COVID-19 pandemic as lower than their experiences during the COVID-19 pandemic (M = 3.31, SD = 1.42; M = 4.07, SD = 1.10, *P* = .004). Moreover, students rated their experiences of diverse ways of learning before the COVID-19 pandemic as higher than their experiences during the COVID-19 pandemic (M = 4.28, SD = 1.01; M = 3.71, SD = 1.22, *P = .003*).

Table 5: Descriptive statistics, and Mann–Whitney U test results comparing ratings of faculty and students on the EPQ before and during the COVID-19 pandemic.

	Variable	**N items**	**Before COVID-19**			**During COVID-19**			**Mann–Whitney U test**
			Mean	SD	α	Mean	SD	α	P-value
EPQ (Faculty)	Active learning	11	4.09	0.72	.95	3.97	0.86	.94	.576
	Collaboration	2	3.89	.88	.42	4.27	0.47	.69	.133
	Diverse ways of learning	2	4.02	0.95	.44	4.37	0.77	.78	.021
	High expectation	2	4.23	0.82	.56	4.25	0.50	.60	.956
	Total	17	4.06	0.74	.94	4.09	0.76	.95	.740
EPQ (Student)	Active learning	11	3.87	0.63	.97	3.80	0.48	.96	.333
	Collaboration	2	3.31	1.42	.94	4.07	1.10	.93	**.004**
	Diverse ways of learning	2	4.28	1.01	.94	3.71	1.22	.93	**.003**
	High expectation	2	3.91	1.14	.88	3.81	1.12	.90	.067
	Total	17	3.91	0.97	.97	3.78	1.00	.97	.165

6.5.4 Exploration of participants' preparation and challenges in High-fidelity manikin Simulation

Ten teachers and 17 students participated in semi-structured interviews. The interviews took place after the collection of the questionnaire data, but the questionnaire data had not been analysed at the time of the interviews. Therefore, the interview schedule was not based on any particular findings from the questionnaires but rather on understanding the participants' experience in HFS. Participants were asked to reflect on and report on the extent to which they felt prepared for HFS teaching or learning activities before and during COVID-19 (input evaluation). Participants were also asked to reflect on any challenges and barriers to the implementation of HFS and suggest how they could have been addressed (process evaluation). The results focused on why and how the high-fidelity manikin simulation worked or did not work to identify the participants learning needs. According to Speed et al. (2015), it is essential that the faculty and students understand the concept and have the required skills in order for the HFS approach to be effective.

Table 6: Themes and subthemes capturing challenges and needs

Theme	Description	Subthemes
Institutional Issues	The teachers' and students' needs related to institutional administration and resources	Lack of preparation Orientation (briefing) Need for more training
Support needs	Teachers' and students support needs to maximise their learning	Colleagues' support needs Equipment malfunction
Teaching during the COVID-19 pandemic	The teachers' and students' experiences during the pandemic and lessons learned	Uncomfortable conditions Duration of sessions Suggestions

THEME 1: Institutional issues

The first theme presents the faculty's and students' perceptions of preparedness and readiness that could impact their educational process (input) and attitudes towards such activities (process) before the COVID-19 pandemic. This theme represents the subthemes of the faculty's and students' perceptions regarding preparation, orientation, and the need for more training related to HFS activities.

Lack of preparation

The lack of preparation is the first subtheme of the institutional issues and concerns the participants' preparedness and readiness for the high-fidelity manikin simulation activity (input evaluation). The responses indicated that most of the participants viewed preparation to run the high-fidelity manikin session as a lack of preparation. For example, one teacher stated:

> *In the beginning, it was a bit hard getting accustomed to these devices, because we had no prior knowledge, no experience using these devices …* (F4)

Another teacher reported:

> *I found it difficult to remember some information and revise myself using the tools and equipment.* (F6)

The students also believed that they did not feel properly prepared for the simulation lab at the beginning of their HFS experience. For example, one student mentioned:

> *You know, sometimes, especially when you're a new freshmen student. You might be afraid or perhaps nervous in front of the instructor, so mistakes happen.* (S6)

Another student explained:

> *I should have the knowledge and the different equipment before applying the practical.* (S17).

Orientation (briefing)

The lack of briefing is the second subtheme of the institutional issues that also concern the participant's preparation and readiness for the high-fidelity manikin simulation activity (input evaluation). Most participants mentioned that they had not received an orientation or briefing. For example, one teacher reported:

> *Provide the needed equipment debriefing before each lab it's necessary…* (F5)

Another teacher added:

> *They have not been trained on how to use them… if you don't know the capacities of those mannikins, you cannot use it fully to improve the simulation experience …* (F8)

The students also recommended that they need more briefing before the simulation activity. For example, one student responded:

> *I believe that should mainly focus on the objective of stimulation start with briefing of the same subject, talk about the subject before starting the simulation.* (S4)

Another student explained:

> *We have some problems when we use the simulation labs because we didn't understand the structure—what he said to us. So, we just stand still; we don't know what to do. The most important things.* (S8)

Need for more training

The need for more training subtheme reflects the faculty's and students' perceptions of the need for training to maximise the use of HFS. All participants mentioned the need for training to improve HFS sessions. The reason could be the lack of standardisation of the objectives and structure of the sessions. All participants believed that training for HFS would improve student engagement and, consequently, the educational value of the sessions. One of the teachers stated, *'The only thing they should have done is to take some time off these demonstrators and provide some sort of training programme and extensive training programme. So they can standardise the training throughout the staff'* (F6).

Another teacher stated:

> *This lab session will be reviewed all over the course without any specific goals. These are like one of the challenges when the faculty has to review the whole course, but there should be standardisation among the whole batch of learning skills, because I can change from the middle of the course. I can start from the basics, and my colleague the other staff will start differently.* (F9)

Further, the students suggested that there should be training to improve the HFS. For example, one student reported:

> *...how to do the basic simulation course. How to do the simulation for the student…* (S2)

Another student explained:

> *It should be repeated over and over without any upgrading or trying to make it better from teaching staff and holding the students. Actually, I believe our simulation is underused.*

We are using the simulation with limited awareness of how to use it. So, this is an issue. (S4)

THEME 2: Support needs

The theme of support needs reflects the faculty's and students' perceptions of the HFS curriculum elements in terms of objectives and content only. The theme demonstrates faculty and students' perceptions of the objectives of HFS and the role of content in HFS (i.e. input evaluation). It also demonstrates how faculty select content for their HFS sessions and whether their students' perceived learning objectives were achieved (i.e. process evaluation) before the COVID-19 pandemic. The data coded under this theme were sub-grouped into the following subthemes: need for senior colleague's support and equipment malfunction.

Colleagues' support needs

This subtheme presents faculty and students' perceptions of the objectives of HFS sessions and whether their perceived objectives were being met. The curriculum design for EMS education does not contain objectives specific to each HFS activity; rather, it contains formal objectives for the entire module. One teacher mentioned a lack of clear objectives for HFS sessions, and he sought support from other stakeholders during the HFS activity. Another teacher was compliant with the delay in receiving the objectives of the simulation. For example, one teacher stated:

I think more explaining for each faculty member to just highlight the expected learning outcomes and resources to gather information before enough time before the lab session. (F4)

Another teacher reported:

The main course tutor will skip the dry run, and then we will be left like without materials or anything. And sometimes course coordinators will just we'll just say this session this lab session will be reviewed for all over the course without any specific goals; these are like one of the challenges. (F6)

A third teacher stated:

Sometimes you ask for assistance from a more experienced lecture on how to work things out what sorts of features it provides, and what sorts of devices can be used, which one is more beneficial than the other. But it's more person; it's more individual effort. It wasn't coordinated efforts. And that's why it was a bit challenging, depending on the tutor. (F5)

The lack of specific objectives led to inconsistent teachers' perceptions of the objectives of the HFS sessions. Most of the students stated that the lack of objectives of the HFS sessions led to diversity in the teacher's methods of choosing content for their sessions. For example, one student reported:

We have one of the faculty members that give us, like, some just simple case and then develop to be very complicated case. And then we found what? And we found Week on some spot. (S5)

Another student reported:

To prepare me. After we entered the lab, he started to explain the scale; he started to ask whether anyone wanted to do it by himself. If he has any mistakes, he will correct them. After that. At the end of the class, we are taking a small quiz about the class today. (S4)

Equipment malfunction

The subtheme of equipment malfunction reflects the students' and faculty's perceptions regarding the interruption during the HFS sessions, which affected scenario progression. Therefore, the teachers and students could not use the high-fidelity manikin simulation without interruption during the simulation activity, thereby not achieving the learning objectives of the course. All participants mentioned that they felt at a loss as to how to handle the situation when there was an equipment malfunction. For most participants, the reason for not checking the function of the equipment was either workload or miscommunication with the module's main instructor. For example, one teacher reported:

> *Usually, one of the times, the equipment fails; this is the main issue we are facing in our college. For example, if an ECG lab session and the ECG were out of battery, then we just cancelled the class, and the students were excited about ECG but no battery.* (F6)

Another teacher confirmed:

> *I struggled with the device not working properly or not being able to, you know, turn it the right way. System failures or malfunctions, now we need some sort of manuals to fix the issue.* (F5)

Some of the teachers reported that they did not know what they should do to run the HFS with equipment malfunctions. One teacher mentioned, '*I remember one time that we were having malfunctions of one of the manikins, and I wasn't aware about how to fix it …' (F1).*

Further, the students had difficulties regarding equipment malfunction during the simulation activity. For example, one student reported:

> *If you have a unique way of checking the equipment on the device that has been used, I think it's would remove this problem that we face.* (S8)

Another student stated:

> *Students can practice at the same time in one lab. Also, the college should have a programme that checks all the lab in the college for the faculty.* (S14)

THEME 3: Teaching during the COVID-19 pandemic

The theme of teaching during the COVID-19 pandemic reflects the faculty's and students' perceptions of the challenges during the COVID-19 pandemic (process evaluation). Teaching during the COVID-19 pandemic affected the faculty's and students' engagement during the simulation activity. Motivation is a crucial element for engagement in HFS activity and is described as the student's drive to engage, learn, and achieve during the simulation activity. Even though motivation is mainly intrinsic to students, especially in HFS, educators play a vital role in their students' motivation and engagement. In this theme, I present the participants' perceptions of the factors of teaching during the COVID-19 pandemic that affect student engagement, including contextual factors and how faculty can improve HFS sessions (process evaluation).

Uncomfortable conditions

The uncomfortable conditions subtheme reflects the faculty's and students' perceptions of the conditions of the simulation labs during the COVID-19 pandemic. All participants mentioned that they encountered uncomfortable situations. Some teachers mentioned the lab space, while others felt uncomfortable because the air condition was not working during the simulation labs. One teacher stated, '*The other maybe the environment in some labs; there is no air conditioning*' (F8).

Another teacher stated:

> *Our labs … if I could just need you to imagine a small room that is around three and three meters; so that can enhance the students' experience, motivating them in a way, but still, they are not going to be in close contact with each other*. (F1)

The students highlighted particular uncomfortable conditions that affected their ability during the simulation activity to improve their clinical skills. One student stated:

> *No contact between students. It was difficult to become involved in the field of clinical practice. That's what makes our practical session in the faculty. That's make us we can say unhappy at the moment the feeling is not good.* (S17)

Another student reported:

> *You have to wear your mask all the time. And you have to do social distancing. This was a problem at the beginning.* (S6)

Duration of sessions

The subtheme of session duration reflects the students' and faculty's perceptions regarding engagement during HFS sessions. It is important to note that all teachers were unsatisfied with their students' engagement. One teacher noted:

> *Social distancing has affected our way of conducting practical sessions. The students had some skills that needed*

> *the effort of multiple students; we couldn't do these skills.* (F6)

Another teacher stated:

> *I could start with one thing that is quite involved in shortening, the time of the lab is actually extended to taking two hours, we have to cut it to an hour the psychomotor skill will be impacted greatly in each student… especially with reducing the number of students shortening the time of the lab that is impacting the whole scenario.* (F1)

For students, their opinions about teaching during the COVID-19 pandemic were negative. One student stated:

> *You can't use the labs after you finish, so you don't have that enough. If you want to use it before the Oski or exams, just practice more for yourself. You cannot do it because it needs to be sanitised.* (S1)

Another student reported:

> *There were certain challenges ... we forgot the skills ... Some manikins for the paediatrics were not good for intubation, which we used for intubation. And that was one of the challenges. During that time, we needed to verbalise our procedure and not do it hands-on.* (S2)

The third student explained:

> *One of the most challenging challenges facing a lot of students and a lot of groups was the time of the practice*

> *session, which was maybe one hour or at least two hours, so that's I think it's not enough for practicing all skills.* (S13).

Suggestions

This subtheme refers to the teachers' and students' suggestions on how they can improve the effectiveness of HFS sessions during the COVID-19 pandemic. The teachers and students suggested several educational strategies. For example, one teacher mentioned:

> *I think we need to we need to record videos using it first. Second, doing to the skill. So, the video is for the tutors, teaching them how to use the equipment and for the students how to do the scale just to standardise the teaching methods between the tutors, and maybe doing more guidelines.* (F2)

Another teacher stated:

> *We need to orient the older faculty; they work together, so they are a team. So, there should be like meetings, regular meetings between clinical lab instructors, so that they know what they are teaching, what hinders, what facilitates their teaching, and make sure their teaching is the same as the interrater reliability.* (F5)

In agreement, one student said, *'make sure that we ask all the questions and receive all the attention from the instructors and it will have a huge and positive impact and carry out to the students to get focus attention'* (S8). One student recommended self-directed learning inside the simulation labs: '*The students to learn for themselves, you know, to be self-directed learning*' (S6).

6.6 Discussion

The aim of this study was to evaluate the effectiveness of high-fidelity manikin simulation in 11 EMS colleges in Saudi Arabia. This was done by considering both outcome and programme evaluation using questionnaires and semi-structured interviews to collect data. The quantitative results provided useful insights, showing that overall, students, and faculty were satisfied with the implementation of high-fidelity manikin simulation education before and during the COVID-19 pandemic. The qualitative findings provided more meaningful data on what worked and what did not and the potential challenges faculty and students face in HFS sessions before and during the COVID-19 pandemic. Therefore, the findings are generalised to the national level (in the Saudi Arabian context) to underscore the importance of evaluating the programme outcomes, input, and process and address faculty and student learning needs of implementing HFS in EMS colleges in Saudi Arabia.

The findings suggest that student and faculty outcome evaluations of high-fidelity manikin simulation were very satisfactory before and during the COVID-19 pandemic, as has been reported by other authors (Conejo 2010; Franklin et al. 2014; Unver et al. 2017; Mohammed and Mohammed 2020; Al khasawneh et al. 2021). Moreover, the faculty's and students' responses in terms of outcome evaluation before the COVID-19 were similar to the previous study, where the faculty and students were also satisfied during their HFS. Simulation design characteristics and best educational practices are considered vital when implementing HFS (Groom et al. 2014). In the outcome evaluation for the simulation design features before the COVID-19 pandemic, the students reported the highest rating for fidelity during the HFS, finding a high level of realism in the scenario from their teachers. However, the findings contradicted those of the previous study, in which the students rated fidelity as the lowest during the HFS simulation. According to Presado et al. (2018), given the great level of realism exhibited by contemporary manikins, they can also enhance the assessment of students' competences in a more comprehensive manner. The implementation of simulated high-fidelity practice by increasing its fidelity enhances learning satisfaction and motivation. Therefore, students demonstrate a willingness to embrace new technologies and develop technical skills in a realistic clinical setting. However, teaching and training teachers, as well as preparing clinical scenarios and designing learning objectives, necessitate a substantial investment of time and energy (Peterson et al. 2017). It is crucial to acknowledge the INACSL Standards of Best Practice. Simulation design does not prescribe a specific level of fidelity; instead, the degree of realism should be chosen to facilitate the attainment of the intended educational objectives. Moreover, participants and educators have expressed a preference for higher levels of fidelity, considering them to be superior to lesser ones (Carey and Rossler 2020). However, the empirical research does not support this overall claim, as it finds that all levels of fidelity are useful when employed (Carey and Rossler 2020).

The paramedic students reported the lowest rating for the objectives subscale during the simulation activity before the COVID-19 pandemic. The fact that this subscale obtained a lower rating in the outcome evaluation is not surprising. Since the objectives of the simulation scenario had to be received before the simulation session, both the faculty's and students' qualitative findings showed a lack of briefing and orientation before the simulation activity. According to Lioce et al. (2013), the initiation of all simulation-based learning experiences entails the provision of unambiguous participant objectives (sometimes referred to as instructional, learning, or scenario objectives) that are made accessible to participants prior to the commencement of the simulated experience. Moreover, the participants' objectives shape the design of the simulation experience and are crucial in assessing whether the participants have achieved the desired outcomes for the experience (Sittner et al. 2015). However, some scholars have minimised the importance of objectives in lesson planning, asserting that classes driven by objectives result in student passivity and hinder creativity and critical thinking (Saunders 2003; Reed 2012).

During the COVID-19 epidemic, EMS students and educators were required to refrain from entering clinical settings due to the resultant restrictions on higher education. Therefore, the solution was to utilise simulation on the simulation units to facilitate both theoretical and practical classes. The students rated the objectives as a lower subscale on the SDS during the COVID-19 pandemic. According to Cowperthwait (2020), the simulated experience encompasses the interactive relationship between the facilitator and participants, which occurs through many stages, such as pre-briefing, simulation progression, cues, and debriefing. However, the constraints of simulation during the COVID-19 pandemic, including the requirement for specialised and exclusive personnel, ideal scenario objectives, technological and programming challenges, and significant expenses, must also be acknowledged (Ingrassia et al. 2020).

Further, the students rated the diverse ways of learning the highest on the evaluation of the best educational practices in the simulation activity before the COVID-19 pandemic. This finding was similar to the previous study and another study in Poland, where the students rated diverse ways of learning as the highest subscale (Zalewska and Zarzycka 2022). In their study, Zapko et al. (2018) highlighted that in the context of simulation, students must exhibit self-direction and assume a significant level of responsibility for their own learning. Therefore, it is logical that paramedic students ranked diverse ways of learning on the educational practices scale as the highest. By contrast, the lowest-rated item was collaboration. It is expected that this item had a low average score in the outcome evaluation of the best educational practices during the simulation, as the students were required to address the scenarios individually and did not have the chance to collaborate with others, except during the debriefing. Moreover, the findings were similar to those of the previous study, and previous studies have incorporated collaboration as the lowest rated by the students (Berndt et al. 2015; Román-Cereto et al. 2022).

In the outcome evaluation of the simulation design features before and during the COVID-19 pandemic, the teacher reported a lower rating for fidelity during the HFS. Hamstra et al. (2017) stated that fidelity is still a confusing term in healthcare simulation activities. It may be difficult for simulation educators to recognise that the identical simulator can be perceived as either high or low fidelity based on the specific elements that are highlighted or disregarded, that the level of fidelity needed varies depending on the specific training objective, and that categorising fidelity as simply high or low is overly simplistic. Therefore, the significance of fidelity in simulation-based training is widely accepted, and there is limited discussion or questioning of this assumption. Nevertheless, the assessment of structural fidelity cannot be ascertained without considering the instructional objectives. The faculty qualitative findings indicated that there was a lack of briefing and orientation regarding the expected learning outcomes, which could be why the faculty rated the fidelity subscale as the lowest on the simulation design scale. A simulator that is deemed to have low fidelity in one situation may be regarded as having high fidelity in another due to valid reasons (Hamstra et al. 2017). The faculty rated active learning the lowest on the outcome evaluation of the best educational practices in the simulation activity during the COVID-19 pandemic. It was not surprising that the teachers rated active learning as the lowest because of the COVID-19 pandemic restrictions. The teachers limited or prohibited their students from working with their peers during the simulation to comply with communicable disease policies and to protect students. The faculty qualitative findings supported this finding, where faculty indicated that the students could not have had the chance to improve their clinical practices and work with their peers because of social distance guidelines. Moreover, this was similar to a study that identified the lack of active learning during the COVID-19 pandemic as a barrier (Wholeben 2021). According to Wholeben (2021), there should be innovative teaching strategies modified in response to the COVID-19 pandemic guidelines so that students have the opportunity to be exposed to hands-on clinical experiences and to promote their achievement of learning outcomes during a global pandemic.

When comparing the perceptions of the faculty and students regarding the simulation design features and the best educational practices of the high-fidelity manikin simulation before and during the COVID-19 pandemic, both students and teachers indicated that, in general, the simulation design features before and during the COVID-19 pandemic and the best educational practices before and during the COVID-19 pandemic were satisfied during the HFS activities. There was a significant difference in the students' perceptions of the simulation design features (before and during the COVID-19 pandemic), with the students rating their experiences of collaboration before the COVID-19 pandemic as lower than their experiences during the COVID-19 pandemic. However, these findings contradict the findings from the interviews conducted with the students. In fact, the students mentioned uncomfortable conditions related to social distance as a challenge in the learning experience. Moreover, there was a significant difference in the student's perceptions of the educational practices (before and during the COVID-19 pandemic), as the students rated their experiences of diverse ways of learning during the COVID-19 pandemic lower than their experiences before the COVID-19 pandemic. This finding was not surprising because the social distance limited the student's ability to practice and improve their clinical skills during the HFS session during the COVID-19 pandemic. On the other hand, there was a significant difference in the faculty's perceptions of the simulation design features (before and during the COVID-19 pandemic), where the faculty rated their experiences of fidelity before the COVID-19 pandemic as lower than their experiences during the COVID-19 pandemic. This finding contradicts the findings from the interviews with faculty. In fact, faculty mentioned that the time of the simulation was shortened, which prohibited the students' hands-on experience, which affected their clinical skills; thus, fidelity could not be used because of that.

In the semi-structured interviews, both faculty and students stressed facing challenges and a lack of preparation and readiness in their HFS experiences, which was similar to the previous study, with the exception of the faculty and students, who mentioned that there was a lack of constructive feedback and debriefing. Using the programme evaluation model was vital, as it helped the faculty and students in all EMS colleges identify their learning needs. Moreover, the challenges reported in this study were similar among all EMS colleges in Saudi Arabia, so the findings identified the challenges that EMS faculty and paramedic students face during their HFS sessions on a national level. In this study, the majority of faculty and students had a more negative perception of institutional support, specifically the lack of briefing and training to implement HFS activities. The purpose of the briefing activity was to aid the participants in defining the objectives of the scenario. This usually involves conveying information about the patient's condition, assigning roles and tasks, specifying time limits, and providing an introduction to the equipment and overall setting (Page-Cutrara 2015; McDermott 2016; Chamberlain 2017). According to Meyer et al. (2014), when students are not provided with an appropriate briefing, they are more likely to feel anxious. Moreover, Akselbo and Aune (2023, p. 5) confirmed that pre-briefing activities serve the purpose of creating a psychologically secure learning environment by facilitating the establishment of a shared cognitive framework among learners and equipping them with the necessary knowledge and understanding to engage with the educational material presented in the simulation-based experience (preparation), communicating essential guidelines for the simulation-based encounter (preparation session). Furthermore, Crawford et al. (2019, p. 119) recommended utilising a written or recorded briefing video for every scenario, particularly for those that included high-stakes evaluations. Therefore, this will aid a student in developing a sense of confidence in meeting the expectations and requirements of a specific setting. However, there is little evidence to suggest that video recordings of briefings significantly enhance the learning process (Cheng et al. 2014; Levett-Jones and Lapkin 2014). The findings of this study were similar to previous studies in China and the US, where the students mentioned the lack of briefing as an obstacle during their simulation activity (Zhang 2017; Maret 2018). For paramedic students to meet training objectives, the execution of the high-fidelity manikin simulation session must be planned and purposeful.

The faculty and students were also concerned about receiving training to maximise the usefulness of the high-fidelity manikin simulation. Therefore, neither faculty nor students felt prepared for the implementation of the HFS activity. According to Paige et al. (2020), standards of best practice, simulation guidelines, and regulatory and certifying agencies mandate that educators who utilise simulation-based education (SBE) undergo formal training. Moreover, proficiency in various aspects, including designing scenarios, leading pre-briefing sessions, conducting simulations, and facilitating debriefing, is essential for successfully managing a simulation experience. Additionally, establishing and upholding a trustworthy atmosphere is of utmost importance (Zigmont et al. 2011). There is a correlation between the successful training of simulation educators and the attainment of desired learner outcomes (Rizzolo et al. 2015; Beroz 2017). Therefore, if educators are not sufficiently trained in the application of HFS, there can be unintended or adverse implications for the learner (Kolbe and Rudolph 2018). The results of this study align with previous studies that mentioned a lack of formal training as a challenge to implementing simulation (Hollema 2015; Lee et al. 2015; Ahmed et al. 2016).

Both faculty and students identified equipment malfunction as a challenge during their HFS experience. According to Nielsen and Harder (2013), the majority of simulation educators are not qualified to run a manikin during a simulation activity. Moreover, Dearmon et al. (2014) added that simulation educators are often trained in the operation of manikins from vendors, not experts in simulation pedagogy. The teachers described their perceptions regarding equipment malfunctions as stressful, which might impact the students' learning. Muckler and Thomas (2019) asserted that effective functional equipment enhances the environment and suspension of disbelief, and scenario progression without interruption promotes the suspension of disbelief. According to Leighton (2013), one of the challenges in implementing the simulation is equipment malfunction; thus, equipment, and supplies must be gathered and relocated before the simulation activity. However, it is very expensive to perform regular maintenance of the simulation equipment (Adamson 2010). These findings are similar to previous studies that mentioned equipment malfunction as a challenge (Lee et al. 2015; Ahmed et al. 2016; Ray 2017; Mulli et al. 2022).

According to the students and teachers, there were new challenges in implementing high-fidelity manikin simulation during the COVID-19 pandemic;

thus, they experienced uncomfortable conditions and a short duration of simulation activities. The students mentioned the lack of hands-on experience as a challenge during their HFS activities. According to Miller and Guest (2021), the lack of hands-on simulation during the COVID-19 pandemic meant that the students received few practical skills. Moreover, Muckler (2017) suggested that learners should engage in complete immersion in the simulation event to the point where they genuinely see the events as real. This, in turn, enriches the learning experience. The students also revealed that social distance during COVID-19 prohibited their movement and engagement with their classmates. Therefore, the students attended the HFS activity with a lack of experiential base due to the COVID-19 pandemic (Wholeben 2021). The faculty and students also identified the size of the simulation labs, the time of the session, and the number of students inside the simulation labs as challenges with negative impacts during the COVID-19 pandemic. Other researchers have similarly documented the same challenges in teaching in simulation labs during the COVID-19 pandemic (Aldridge et al. 2021; Tabbakhian 2021).

6.6.1 Theoretical implications

This study aimed to evaluate high-fidelity manikin simulation activities conducted at EMS colleges in Saudi Arabia, where high-fidelity manikin simulation has been clearly implemented in the curriculum. Therefore, the findings of the study contribute to the body of existing literature and generalise the findings at the national level. Most previous research on EMS education focused on the improvement of cognitive and clinical skills during high-fidelity manikin simulation activities and did not evaluate the effectiveness of high-fidelity manikin simulation programmes. Furthermore, most previous research in healthcare education evaluated high-fidelity manikin simulation activities using either the outcome evaluation model or the programme evaluation model. Therefore, mixed methods were used to conduct questionnaires and semi-structured interviews to explore the faculty's and students' perceptions in depth. The study was based on Kirkpatrick's model (Level 1) and the input and process components of the CIPP model. The objectives were to determine the faculty's and students' perceptions of the simulation design features and the educational practices of high-fidelity manikin simulation sessions before and during the COVID-19 pandemic. Furthermore, the study is intended to examine the faculty's and students' perceptions regarding the preparation, challenges, to identify their learning needs for such sessions before and during the COVID-19 pandemic.

In terms of Kirkpatrick's evaluation, which concerns whether the faculty and students are satisfied with the simulation design features and the educational practices during the high-fidelity manikin simulation sessions before and during the COVID-19 pandemic, the findings indicate that both faculty and students are satisfied.

In terms of input evaluation, which concerns the preparation and readiness for implementing high-fidelity manikin simulation in addition to the structure and curriculum of HFS sessions, the results indicate that faculty and students had a lack of preparation to run the simulation activity. Moreover, the faculty and students believed that they faced a lack of briefing in terms of not clarifying the objectives of the simulation, checking the needed equipment, establishing the ambiance for the forthcoming educational encounter for the implementation of high-fidelity manikin simulation sessions, and providing the needed guidance. Therefore, support can be delivered from the main course leader or through dry-run activities. Furthermore, the faculty and students stressed that there was a need for training to maximise the implementation of high-fidelity manikin simulation activities.

The faculty and students had similar perceptions of the objectives and materials needed for high-fidelity manikin simulation sessions. The main finding was that faculty and students were not prepared and did not receive a briefing before conducting the simulation activity. The faculty and students suggested that they need training on how to implement high-fidelity manikin simulation sessions. Most of the participants believed that the standardisation approach for the simulation session might address the students' needs.

In terms of process evaluation, which concerns whether high-fidelity manikin simulation sessions were delivered as intended, implementation issues, the need for senior colleagues, and malfunctions in simulation sessions were major challenges. The faculty believed that they needed senior colleagues because of the lack of specific learning outcomes for the simulation activity. On the other hand, the students stated that the lack of objectives in the HFS sessions led to diversity in the teacher's methods of choosing content for their sessions. The findings also identified new challenges during the COVID-19 pandemic. The faculty stated that external factors, such as lab size and air conditioning, affected students' motivation in the simulation labs. The students also stressed that they were unhappy because of social distance, which negatively impacted their clinical practices and collaboration with their peers inside the simulation lab. Moreover, students mentioned that wearing a face mask throughout the simulation session was an issue. The faculty mentioned that the time of the simulation session was decreased, so their students did not have enough time to learn clinical skills. The students also stated that the large group of students and the decreased time of the simulation session were because the need to sanitise the lab affected their clinical practice and did not allow them hands-on experiences during their sessions.

6.6.2 Practical implications

As this study is an evaluative study aimed at informing change, the study findings can be used to inform improvements at the EMS colleges where the study was conducted. Based on the study's qualitative findings, the following approaches can be implemented to improve the educational value of high-fidelity manikin simulation sessions:

1- **Faculty and student preparation**

The faculty and students were not prepared for how they should deliver sessions. Although the faculty understood the simulation concept, they were unaware of their personal roles or effective practical attitudes in conducting the sessions, as most of their recommendations for improving simulation sessions were about factors related to objectives and equipment. Moreover, students should be prepared to help them identify simulation aspects before running the simulation. The simulation unit should liaison with the faculty development unit at the EMS schools to address faculty and student preparedness (Acton et al. 2015; Jeffries et al. 2015; Ahmed et al. 2016; Herlihy 2022).

2- **Faculty and students briefing before the simulation activity**

The faculty and students mentioned that there was a lack of briefing before running the simulation sessions. Although the faculty seek their colleagues' help, briefing is vital for a successful simulation. The simulation unit should liaison with the medical education unit at the EMS schools to improve faculty and student briefing before the simulation session (Kolbe et al. 2015; Druliolle 2017; Halamek et al. 2019; Hughes and Hughes 2019; Tyerman et al. 2019).

3- **Faculty training**

The faculty reported that they had not had training to use high-fidelity manikin simulations. Therefore, teachers might need a training course to improve their teaching during high-fidelity manikin simulation sessions. Faculty can acquire training by participating in simulation educator training courses provided by different simulation programmes, attending workshops at conferences, or pursuing fellowship training or graduate degrees in simulation (Acton et al. 2015; Jeffries et al. 2015; Kim et al. 2017; Seethamraju et al. 2022).

4- **Establishing clear learning objectives**

The objectives of the high-fidelity manikin simulation sessions were not clearly stated. The simulation unit in EMS schools should develop broad but focused learning objectives linked to real-life practice for the high-fidelity manikin simulation sessions, which would function as a guide for the faculty in delivering the sessions, and students would be more motivated (Page-Cutrara 2014; Munangatire and Naidoo 2017; Nestel et al. 2021).

5- **Functional equipment**

The students and faculty believed that there were equipment malfunctions during their sessions. Therefore, it would be reasonable to have a basic understanding of the functioning of equipment and checking it before the simulation sessions (Davis et al. 2014; Roh et al. 2016).

6- **Multidisciplinary teamwork**

A multidisciplinary approach is needed to address the administrative and technical challenges that faculty and students face in a high-fidelity manikin simulation environment. The medical education unit in EMS schools should conduct meetings with relevant stakeholders in different departments and committees to address difficulties in running simulation activities, as administration-controlled factors play an essential role in the success of HFS (Najjuma et al. 2020; Nyein and Gregory 2020).

6.7 Limitations

The first limitation was the use of the SDS and EPQ questionnaires. Although it helped me generate detailed and flexible data for this study, most of the participants reported that the questionnaire was very long and repetitive.

The second limitation is that the interviews were carried out in English, despite not being the primary language of the participants, in order to expedite the process and circumvent any potential complications with translation, as it is obligatory for me to compose the study in English. Despite the participants' fluency in English, the language could have hindered them from completely articulating themselves during the interviews, which is a crucial requirement for the qualitative part. However, the qualitative part is considered more valid when there is a close alignment between the meanings given by the participants and the meanings derived from the data (Van Nes et al. 2010). As suggested by Van Nes et al. (2010), conducting interviews in the native tongue and working with skilled translators to obtain the most accurate translations that faithfully capture the intended connotations should be considered in the future.

6.8 Suggestions for Future Research

The findings of the current study provide ample opportunities for future research. First, obtaining comprehensive information may have been influenced more effectively by translating the SDS and EPQ and translating the faculty's and students' interview schedules because the students asked me to explain some unclear questions, and during the interview, many students asked me to further explain some questions.

Second, this cross-sectional mixed methods study examined only a sample of the perceptions of faculty and students at EMS colleges in Saudi Arabia. It is highly recommended to widen this sample to involve more stakeholders, such as deans, heads of departments, heads of simulation units, heads of medical education departments and simulation specialist) in EMS colleges in Saudi Arabia in order to evaluate the implementation of high-fidelity manikin simulation from different perspectives.

Third, after searching the literature, there were limited studies using SDS and EPQ in the Middle East. There is a lack of information regarding the reliability and validity of the SDS and EPQ at the national level. Little is known about its psychometric properties; therefore, additional evidence and empirical research are needed. Thus, more studies are needed to involve EMS colleges in Saudi Arabia to gain additional context-specific evidence on the psychometric properties of the SDS and EPQ.

CHAPTER 7: The development of a tool to evaluate High Fidelity Simulation in the Arabic Language

7.1 Abstract

Background: A large body of research exists on the evaluation of simulation in clinical education, the majority of which uses evaluation surveys. The previous two studies utilised an English version of the National League of Nursing, which consists of three scales that have been extensively used in several countries and have strong reliability and validity. While the English version of the survey was found to be reliable and valid in the studies thus far, it can be argued that if the survey were to be used more extensively in Arabic-speaking countries to evaluate simulation-based learning, it should be made available in Arabic. The objective of this study was, therefore, to examine the psychometric properties of an Arabic version of the survey, with the aim of making it available for further research and evaluation studies in Arabic-speaking settings.

Methods: A cross-sectional questionnaire study design was utilised. A questionnaire consisting of the Simulation Design Scale, the Educational Practice Questionnaire, and the Student Satisfaction and Self-Confidence in Learning questionnaire was translated and administered to students based in 11 emergency medical services (EMS) institutions in Saudi Arabia. A total of 258 undergraduate paramedic students completed the online survey. The survey was piloted with 7 EMS simulation educators and 23 paramedic students to confirm its content validity. Exploratory factor analysis (EFA) was employed to determine the factor structure, whereas confirmatory factor analysis (CFA) was utilised to establish the construct's validity. Correlation was also utilised to examine the content validity of the survey.

Results: Internal reliability was assessed using Cronbach's alpha coefficient and corrected item-total correlation. The Cronbach's alpha for the full survey was .97, and for the individual subscales, it was between .86 and .96. EFA demonstrated that the subscales were theoretically coherent (≥ 0.40) and had the same factor

structure as the original English version. CFA revealed adequate goodness-of-fit values. The correlation revealed a strong correlation among the three translated scales. Lastly, the students were satisfied with the simulation design features and educational practices, and they expressed self-confidence in learning during their high-fidelity manikin simulation activities.

Conclusion: The Arabic National League of Nursing simulation evaluation scales demonstrated strong validity and reliability, and these instruments could be used as evaluation instruments in EMS institutions in Saudi Arabia.

7.2 Introduction

Simulation-based learning (SBL; INACSL 2016) has been a cornerstone in emergency medicine education (Birtill et al. 2021) and is essential for students' acquisition of relevant concepts and clinical skills. Underpinned by experiential learning theory (Kolb 1984), simulation has been reported to enhance comprehension and the capacity to assimilate knowledge and skills (Al Gharibi and Arulappan 2020; Lateef et al. 2021), as well as the clinical competence of healthcare learners during their hospital duties (Al Khasawneh et al. 2021; Haukedal et al. 2018). Ezekowitz et al. (2017) reported that procedural skill training, particularly for healthcare professionals such as paramedics, depends on learning and practising skills under the direct supervision of qualified practitioners in work-related situations or through the use of simulation. Standardised patients, simulator models, role play, and various levels of fidelity in simulation technology are all considered when creating an educational simulation (Mills et al. 2016). Educators, university and hospital administrators, and clinical personnel each play important roles in ensuring that simulation is a viable and reliable educational tool (Adamson et al. 2013; Franklin et al. 2014). To reassure stakeholders of the value of simulation within healthcare, a robust evaluation approach utilising rigorous and credible methodology is necessary (Fealy et al. 2019).

Kirkpatrick's (1996) four-level evaluation model has been extensively used in evaluation research (Smith et al. 2018). The first of Kirkpatrick's four levels is the reaction to (or satisfaction with) a learning event (Kirkpatrick and Kirkpatrick 2016); it indicates the extent to which learners are satisfied with the training, and whether they believe it is valuable or relevant to their learning needs. The second level evaluates the increase in the learner's knowledge gained from the training. Level 3, behavioural change, is a more advanced outcome that evaluates whether the simulation skills will be transferred to the workplace and whether the learner will perform well in a clinical setting (Kirkpatrick and Kirkpatrick 2016). Level 4 evaluation involves assessing changes in outcomes or results. It is frequently a long-term transformation that requires extensive research due to many unknown variables, including learner maturation (Kirkpatrick and Kirkpatrick 2016).

A review of the literature on SBL revealed that the most popular evaluation approach considers the two first levels of evaluation: reaction and learning. It has been argued that evaluating the efficacy of simulated teaching should not employ knowledge assessment alone (Maruca et al. 2018). Indeed, reaction, measured through learners' perceptions of the experience and affective measures, such as confidence and self-efficacy, is a commonly used evaluation approach, either on its own or in combination with learning outcomes. A positive link between simulated experience and reaction and learning has been used to demonstrate the effectiveness of SBL. The impact on learning has been shown by improvements in knowledge, the performance of skilled tasks, and critical thinking (Almeida et al. 2018; Al Gharibi and Arulappan 2020; Kiernan 2018).

A recent review noted that there is a lack of valid and reliable evaluation tools for SBL in undergraduate emergency medical services (EMS) education (McKenna et al. 2015), with few suitable and acceptable methods available for evaluating the training of baccalaureate paramedic students (Cant and Cooper 2017). Reierson et al. (2020) reported that many studies used non-peer-reviewed, unpublished evaluation tools, mostly from 'grey' literature. Despite the extensive use of these measures, the lack of psychometric evidence of their reliability and validity raises concerns about the soundness of their widespread use (Franklin et al. 2014). By contrast, various tools have been developed and are extensively used in other fields of healthcare education, such as nursing.

The National League of Nursing (NLN) and the Jeffries Simulation Framework for Nursing Education (Jeffries 2005) developed a set of measures that have been extensively cited in SBL research. These measures were developed to help facilitators incorporate simulation into nursing education, with the goal of improving SBL quality. The framework describes the requirements for three key domains of simulation creation: simulation design characteristics (objectives, fidelity, problem solving, student support, and debriefing), educational practices (active learning, feedback, student/faculty interaction, collaboration, high expectations, diverse learning, and time on task), and outcomes (learning, knowledge, skill performance, learner satisfaction, critical thinking, and self-confidence) (Jeffries and Rodgers 2015). This approach has been successfully implemented in many studies reporting the planning, performance, and evaluation of nursing education simulations (Groom et al. 2014; Hallmark et al. 2014; Levett-Jones and Lapkin 2014; LaFond and Van Hulle Vincent 2013; O'Donnell et al. 2014).

The NLN also created the three most popular evaluation questionnaires: the Simulation Design Scale (SDS), the Educational Practices Questionnaire (EPQ), and the Student Satisfaction and Self-Confidence in Learning Scale (SSCL) (Adamson et al. 2013; Franklin et al. 2014; Jeffries and Rodgers 2015). These instruments have been extensively used by universities globally in dental, medical, and healthcare settings (Unver et al. 2017), mainly because of their simplicity, comprehensiveness, low cost, and effectiveness. These questionnaires have many advantages, including their ability to be used in large samples and cover a wide range of issues (Reierson et al. 2020). Such an approach can also allow for the generalisation of results obtained from large samples. The SDS, EPQ, and SSCL have been used to examine students' perceptions of high-fidelity simulation (HFS) (National League of Nursing, 2020a). In a research study (Jeffries and Rizzolo, 2006), Cronbach's alpha was 0.92 for the SDS, 0.86 for the EPQ, and 0.87 for the SCLS (National League of Nursing, 2020a).

Franklin et al. (2014) were among the first to examine the psychometric properties of these questionnaires. They assessed the validity and reliability of SDS and EPPS among 2200 American novice nursing students and found that both measures were sufficiently reliable, valid, and suitable for use in educational research. Cronbach's alpha for the overall SDS was 0.96, and the correlations among the theoretical factors were between 0.67 and 0.89. Cronbach's alpha for the total EPQ was 0.95, and the correlations among the conceptual factors were between 0.77 and 0.86. Four other studies (Almeida et al. 2016; Liaw et al. 2015; Franklin et al. 2020; Tosterud et al. 2013; Unver et al. 2017; Reierson 2020; Fountain and Alfred 2009) also reported using these instruments, but unlike the other studies discussed here, the instruments were translated into the native language of the participants. For example, Almeida et al. (2016) translated the SSCL into Portuguese and tested its psychometric properties among Portuguese and Brazilian degree-level and non-degree-level nurses. Similarly, Chan et al. (2015) tested SSCL psychometric properties among practising Chinese nurses in an advanced life support course and found the questionnaire to be a reliable and valid tool. Using Cronbach's alpha on the English version, Fountain and Alfred (2009) reported an internal consistency of 0.91 for the SDS and 0.84 for the EPQ. Unver et al. (2015) translated the instruments into Turkish and reported that the SDS and EPQ were valid and reliable in that language, with Cronbach's alpha values of 0.73–0.86 for the SDS and 0.61–0.86 for the EPQ. Reierson (2020) reported that Cronbach's alpha was >0.7 for the SDS and EPQ, indicating acceptable internal consistency in the Norwegian version.

The use of common international standards, which include universal pedagogical terminology and standardised evaluation, is an important part of developing robust simulation interventions. Reflecting on the findings from the previous two studies that form this thesis thus far, the potential limitation of using an English version of the measures when the native language of the participants is Arabic is highlighted as a research gap. Research suggests that it is critical to use validated instruments in the participants' native language when performing evidence-based evaluations (Harkness et al. 2010). Credible and reliable international scales are therefore needed in the native language of the participants.

A recent study at a nursing college in Saudi Arabia examined the factor structure, psychometric properties, and reliability of Arabic versions of the SDS, the EPQ, and the SSCL among Saudi baccalaureate nursing students (Grande et al. 2022). The study included 1035 nursing students from 3 universities. The findings revealed that the number of extracted components in the exploratory factor analysis (EFA) matched the subscales of the three nursing simulation instruments. The study generated three-factor solutions contrary to the original four-factor EPQ. All the scales and subscales had favourable perceptions. In all three questionnaires, the alpha score was >0.7, denoting an acceptable reliability score.

The extent to which these measures are suitable in the context of EMS education in Saudi Arabia remains to be established (Reierson et al. 2020). While some institutions use instruments to evaluate and explore Saudi paramedic students' simulation experiences, the validity and reliability of these instruments may not be as robust as those of NLN simulation instruments, particularly when translated into Arabic. This study therefore aims to examine the psychometric properties of the Arabic versions of the three NLN simulation evaluation instruments in an EMS context (paramedic education).

7.3 Study Aims

The aim of this study was to examine the suitability of an Arabic version of an evaluation tool to evaluate the effectiveness of a high-fidelity manikin simulation in EMS education in Saudi Arabia. Using Kirkpatrick's evaluation model. This was achieved by:

1. Examining the validity and reliability of Arabic versions of the SDS, EPQ, and SSCL among Saudi undergraduate paramedic students.
2. Examining the students' perceptions of the simulation design features, the best educational practices, and their' satisfaction and self-confidence in the implementation of high-fidelity manikin simulation.

7.4 Methodology

7.4.1 Research design

A cross-sectional questionnaire study design was used. The study was carried out in two phases: the translation, adaptation to Arabic, and validation of the scales through a team of EMS simulation educators, followed by a quasi-experimental design post-survey.

7.4.2 Setting and sample

The sampling method employed in this study was non-probability convenience sampling, which involved recruiting individuals based on their ease of access and availability. The utilisation of this sample method was deemed appropriate for the research due to anticipated challenges in participant accessibility, given their exams and clinical responsibilities throughout the academic year. However, the majority of research conducted in the field of medical education relies on non-probability sampling methods. This is primarily because probability sampling techniques are more time-consuming and costly. Nonetheless, it is important to acknowledge that non-probability sampling methods may introduce a potential source of bias, as they do not fully capture the characteristics of the entire population being studied. This type of bias is commonly referred to as sampling bias (Tavakol and Sandars 2014).

The sample consisted of undergraduate paramedic students at 11 EMS colleges in Saudi Arabia. An invitation to participate with a link to an online questionnaire was sent via students' university email addresses, WhatsApp, and Telegram (approx. 559 students). The inclusion criteria were students in EMS colleges who had been involved in HFS for at least 10 simulation sessions, and the student's first language had to be Arabic.

A total of 258 (43% of those invited to participate) EMS students responded to the questionnaires. Of these, 208 (80%) were between the ages of 18 and 27 years, and 38 (14%) were aged 28–38 years. The students were predominantly male

(95%), and most were interns (60%). Among the participants, 40% experienced an SBL activity provided by a lecturer with a master's degree (Appendix 37).

Comrey and Lee (2013) proposed a method for determining the sample size in validation studies that involves using a graduated scale to compute the appropriate sample size: 100 = poor, 200 = fair, 300 = good, 500 = very good, and 1,000 = excellent. Moreover, it is strongly suggested to have a minimum of 10 samples from the target population for each item of the instrument when conducting general psychometric analyses, such as scale and item analysis, EFA, and confirmatory factor analysis (CFA) (Bates 2005). Therefore, a minimum of 200 paramedic students were needed to conduct a psychometric study of the translated scale. However, the sample size of this study was 258 students.

7.4.3 Translation of the instruments (cross-cultural adaptation)

The cross-cultural adaptation of a simulation design, educational practices and student satisfaction and self-confidence in learning self-administered questionnaires for use in a new country, culture and/or language requires a unique methodology in order to reach equivalence between the original source and target languages. It is now recognized that if measures are to be used across cultures, the items must not only be translated well linguistically, but also be adapted culturally in order to maintain the content validity of the instrument across different cultures (Beaton et al. 2007). In this way, I can be more confident that I am evaluate the impact of simulation design features, educational practices and student satisfaction and self-confidence in learning on simulation activity in multi-national trials or outcome evaluations. The term "cross-cultural adaptation" is used to encompass a process which looks at both language (translation) and cultural adaptation issues in the process of preparing a questionnaire for use in another setting (Beaton et al. 2007). The content validity of a scale refers to the degree to which the items accurately reflect the notion being assessed. This is a crucial consideration during the creation of a scale (Shea and Fortna 2002). According to Jeffries et al. (2015), the original NLN simulation evaluation scales have high content validity. Content validity was assessed using an expert opinion approach

(Hohmann et al. 2018).Therefore, I followed the cross-cultural adaptation guidelines developed by Beaton et al. (2000) which consist of six steps: (1) forward translation, (2) synthesis of the translations, (3) back translation, (4) expert committee, (5) test of the pre-final version, and (6) submission of documentation to the developers or coordinating committee for appraisal of the adaptation process.

Stage 1

The translation encompassed the forward translation of the SDS, EPQ, and SSCL instruments by bilingual translators (T1 & T2) who were native Arabic speakers. One translator was cognisant of the subjects under examination, whereas the other was not aware to the content. Each translator submitted a written report that emphasised the obstacles encountered and the reasoning behind their decisions.

Stage 2

The synthesis of the two translations was conducted collaboratively with the two translators and me, utilising the original surveys and available Arabic versions to achieve a consensus-based synthesis. I examined the two distinct translations and compiled a document detailing all discrepancies for discussion. A meeting was held between the two translators and me to deliberate on the optimal translation considering the goal of the inquiry or instructional content and the potential audience.

Stage 3

Back-translation was conducted using the synthesised translation produced in Stage 2. Two bilingual translators, whose first language is English, back-translated the work into English and submitted a written report (BT1 & BT2) detailing their approach. These translators were not aware to the original documents, the project's contents, and the potential audience.

Stage 4

A review by an expert committee was performed by a cohort of seven Arabic EMS simulation educators to consolidate all versions and achieve agreement on the version to pre-test.

Stage 5

I pre-tested the translated and culturally adapted application, focusing on its usability and acceptability from the perspective of paramedic students. To assess the items' clarity, I pilot-tested the Arabic versions of SDS, EPQ, and student satisfaction and self-confidence in learning with a sample of 23 paramedic students. The survey results demonstrated that the Arabic versions of the scales were suitable.

Stage 6

The committee responsible for translating the SDS, EPQ, and SSCL conducted an appraisal to ascertain whether the Beaton process was adhered to in the translation and cultural adaptation of the three translated questionnaires. Therefore, there were no more suggestions to refine the questionnaire.

7.4.4 Data analysis

Data analysis was performed using the SPSS package version 27.0 for Windows and IBM SPSS AMOS 26. Descriptive statistics were employed to describe the characteristics of the enlisted participants. The internal reliability and consistency of the translated scales were assessed using Cronbach's alpha coefficient and the corrected item-total correlation. An acceptable level of reliability was defined as Cronbach's alpha values over 0.70 (Norman and Streiner 2008). An item-total correlation of 0.4 or above was judged acceptable, and 0.4 was also used as a benchmark to assess the impact on Cronbach's alpha if the item was deleted (Loiacono and Watson 2002).

The translated simulation evaluation scales were adapted for a new context, requiring the use of EFA. EFA was used since it does not make any assumptions about the underlying structure of the items (Polit and Beck 2019). Prior to the EFA, the acquired data were initially assessed for their suitability using Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sphericity. A KMO score greater than or equal to 0.06 indicates that the sample is sufficient for factor analysis (Tabachnick et al. 2013). A p-value less than 0.05 ($p < 0.05$) in Bartlett's test of sphericity indicates that factor analysis is suitable for the analysis (Tabachnick et al. 2013).

Principal component analysis (PCA) was utilised to derive an empirical synopsis of the gathered data source (Tabachnick et al. 2013). The principal factor method and varimax rotation were employed to assess whether all the items exhibited loadings greater than 0.40 for a single factor. Additionally, this analysis confirmed that the item loadings were theoretically consistent. Factors with item loadings of 0.40 or higher were deemed significant, and factors with eigenvalues above the point of inflection were retained (Polit and Beck 2019).

CFA was used to determine the validity of the construct (Brown and Moore 2012, p. 261). I also used the following indicators to evaluate the fitness of the model for determining validity: Minimum Discrepancy Function by Degrees of Freedom divided (CMIN/DF), root mean square error of approximation (RMSEA), comparative fit index (CFI), and Tucker–Lewis index (TLI) (DiStefano et al. 2018). The acceptable values for the individual components of the model were adopted as follows: CMIN/DF values over 5 indicated a model that achieved a perfect match, while values over 3 indicated a model that achieved a good match. The CFI, NFI, and TLI were measured on a scale from 0 to 1, with a value of 1, indicating a perfect fit.

7.5 Results

7.5.1 Data screening and internal consistency

The data were screened for missing values. No missing values were identified (Appendix 38). Tests of normality (Kolmogrov-Smirnov) were conducted to show that the data collected were not normally distributed (Laerd Statistics, 2013) (Appendix 39). The Cronbach's alpha coefficient was .97 for the three scales, as shown in Table 7, suggesting an acceptable reliability (Tavakol and Sandars 2011). Moreover, the item-total correlation ranged from .70 to .85 for the SDS, from .67 to .88 for the EPQ, and from .65 to .88 for the SSCL (Appendix 40). Therefore, the analysis of items based on correlation suggested that no items needed to be excluded from the scales (Loiacono and Watson 2002).

Table 7: Cronbach's alpha for the SDS, EPQ, and SSCL (n = 258)

	Variable	Number of items	Participants n = 258
			α
SDS	Objectives and information	5	.94
	Support	4	.91
	Problem solving	5	.92
	Feedback	4	.90
	Fidelity	2	.89
	Total	20	**.97**
EPQ	Active learning	11	.96
	Collaboration	2	.84
	Diverse ways of learning	2	.92
	High expectation	2	.86
	Total	17	**.97**

SSCL	Satisfaction with current learning	5	.94
	Self-confidence	8	.95
	Total	13	**.97**

7.5.2 Exploratory factor analysis

The SDS scale (χ^2 = 5214.64; df = 190; p ≤.001) demonstrated the significance of Bartlett's test of sphericity. The KMO for the SDS (0.96) indicated the sample size adequate for factor analysis. An initial analysis using PCA was run and revealed a five-factor structure in the SDS scale with eigenvalues above a Kaiser's criterion of 1, explaining 81.63% of the total variance in the SDS (Table 8). All factors in the SDS scale rated above 0.40 had the same factor structure as the English version (Jeffries and Rizzlo 2006) (Appendix 41).

Table 8: Exploratory factor analysis for SDS factor loadings and communalities (h^2)

Subscales with items	Factor1	Factor2	Factor3	Factor4	Factor5	h^2
Objectives and information						
Q.1		**.69**				.80
Q.2		**.78**				.82
Q.3		**.69**				.83
Q.4		**.64**				.83
Q.5		**.69**				.83
Support						.
Q.6	**.67**					.76
Q.7	**.72**					.83

Q.8	**.66**				.80
Q.9	**.70**				.77
Problem Solving					
Q.10	**.62**				.69
Q.11	**.53**				.76
Q.12		**.73**			.84
Q.13		**.71**			.87
Q.14		**.66**			.86
Feedback/Guided reflection					
Q.15			**.62**		.79
Q.16			**.66**		.83
Q.17			**.68**		.78
Q.18			**.57**		.73
Fidelity (Realism)					
Q.19				**.82**	.92
Q.20				**.74**	.89

The EPQ scale (χ 2 = 4436.10; df = 136; p ≤.001) demonstrated the significance of Bartlett's test of sphericity. The KMO for the EPQ (0.94) was adequate for factor analysis. An initial analysis using PCA was run and revealed a four-factor structure in the EPQ scale with eigenvalues above a Kaiser's criterion of 1, thus explaining 81.55% of the total variance in the EPQ. All factors rated above 0.40 have the same factor structure as the English version (Jeffries and Rizzlo 2006) (see Table 9) (Appendix 41).

Table 9: Exploratory factor analysis for the EPQ factor loadings and communalities (h^2) factors

Subscales with items	Factor1	Factor2	Factor3	Factor4	h^2
Active learning					
Q.1	**.73**				.76
Q.2	**.75**				.73
Q.3	**.82**				.81
Q.4	**.71**				.72
Q.5	**.75**				.82
Q.6	**.74**				.97
Q.7	**.76**				.83
Q.8	**.76**				.83
Q.9	**.62**				.70
Q.10	**.70**				.75
Q.11	**.66**				.78
Collaboration					
Q.12				**.74**	.85
Q.13				**.83**	.88
Diverse learning					
Q.14		**.81**			.92
Q.15		**.76**			.91
High expectations					
Q.16			**.75**		.87
Q.17			**.73**		.84

The SSCL scale (χ 2 = 3587.43; df = 78; p ≤.001) demonstrated the significance of Bartlett's test of sphericity. The KMO for SSCL (0.95) indicated that the sample size was adequate for factor analysis (Appendix 41). An initial analysis using PCA revealed a two-factor structure in the SSCL scale with eigenvalues above a Kaiser's criterion of 1, explaining 80.30% of the total variance in the SSCL. All factors rated above 0.40 have the same factor structure as the English version (Jeffries and Rizzlo 2006) (see Table 10).

Table 10: Exploratory factor analysis for the SSCL factor loadings and communalities (h^2)

Subscales with items	Factor1	Factor2	h^2
Satisfaction with current learning			
Q.1	**.84**		.83
Q.2	**.81**		.79
Q.3	**.81**		.78
Q.4	**.83**		.81
Q.5	**.83**		.81
Self-confidence			
Q.6	**.80**		.77
Q.7	**.74**		.82
Q.8	**.73**		.81
Q.9	**.72**		.80
Q.10		**.82**	.80
Q.11		**.77**	.78
Q.12		**.64**	.76
Q.13		**.62**	.82

7.5.3 Confirmatory factor analysis of SDS, EPQ, and SSCL

CFA was conducted to determine construct validity. CFA supported a five-factor solution for the SDS, a four-factor solution for the EPQ, and a two-factor solution for the SSCL, which is similar to the original questionnaire (see Appendix 42). A shown in Table 11, the scales attained the desired values and indicated a good fit between the model and the data for the SDS, EPQ, and SSCL scales (Appendix 43).

Table 11: Model fit tests for SDS, EPQ, and SSCL

Model fit tests	SDS	EPQ	SSCL
CMIN/DF	2.943	3.364	3.399
RMSEA	.087	.096	.097
CFI	.942	.942	.957
TLI	.924	.922	.939

7.5.4 Correlation analysis

Table 12 clarifies the correlation between paramedic students' perceptions of simulation design, educational practices, and student satisfaction/self-confidence in learning. It was observed the existence of highly significant correlations between all elements of SDS and EPQ (0.870, 0.000), as well as between SDS and SSCL (0.852, 0.000), where p-value was at the < 0.001 level. Furthermore, there were significant correlations between the elements of EPQ and SSCL (0.858, 0.000) at the level of .001 (see Appendix 44).

Table 12: Correlation between paramedic students' perceptions of the simulation design scale, educational practices, and self-confidence in learning.

Variables	SDS	EPQ	SSCL
SDS	1		
EPQ	0.870	1	
	0.000		
SSCL	0.852	0.858	1
	0.000	0.000	

7.5.5 Correlation between SDS, EPQ, and SSCL subscales

A correlation analysis was conducted to determine the strength of the relationship between subscales using Pearson product-moment correlation coefficients (r), as shown in Table 13, and evaluated using SPSS, as detailed in Appendix 45. According to Cohen (1988), correlations are deemed minor if r = .10 to .29, moderate if r = .30 to .49, and big if r = .50 to 1.0. The significant findings included a strong correlation between the simulation design subscales and educational practices subscales, and students' satisfaction and self-confidence (Appendix 45).

Table 13. Correlation between satisfaction and self-confidence with EPQ subscales and SDS subscales (n = 258)

Simulation design and educational practices subscales	Satisfaction	Self-Confidence
Objectives	0.776	0.724
Support	0.783	0.715
Problem solving	0.799	0.753
Feedback	0.779	0.742
Fidelity	0.728	0.674
Active learning	0.810	0.758
Collaboration	0.693	0.659
Diverse ways of learning	0.782	0.789
High expectations	0.798	0.749

Student's evaluation of simulated design features and educational practices

Table 14 presents the students' ratings of their experiences with high-fidelity manikin simulation (Appendix 46). With the lowest possible rating of 1 and the highest being 5, the findings indicated that on average, students indicated satisfaction with the simulation design features of their experience (M = 3.74, SD ± 0.98). Moreover, the feedback subscale, concerning the teacher's provision of effective feedback to their students in a timely manner had the lowest rating (M = 3.70). Based on the findings in Table 13, there was a large correlation between feedback and students' satisfaction and self-confidence during the high-fidelity manikin simulation session. This could mean that paramedic students had problems receiving feedback, which affected their satisfaction and self-confidence. Students derive advantages from both active involvement and observation during high-fidelity manikin simulation experiences when they receive effective feedback (Schriber et al. 2020).

Similarly, students' ratings on the EPQ indicate overall satisfaction with the educational practices during their high-fidelity manikin simulation. Average ratings on the subscales ranged between M = 3.65 (active learning) and M = 3.88 (collaboration), indicating overall positive perceptions of their experiences. Based on the findings in Table 13, there was a large correlation between active learning and students' satisfaction and self-confidence during the high-fidelity manikin simulation session. This could mean that paramedic students did not receive active learning, which might have affected their satisfaction and self-confidence. Active learning activities within the simulation lab has been shown to yield a notable and beneficial influence on students (Walters et al. 2017).

Ratings on the self-confidence scales were fairly similar, with an average rating of M = 3.86 and, again, with an above-average rating of satisfaction (M = 3.89) and self-confidence (M = 3.82, SD ± 1.07). The mean total (M = 3.86) was higher than that in Mohammed and Mohammed (2022, M = 3.34).

A noteworthy finding was the small standard deviation of the three translated subscales, ranging between .98 and 1.17, which indicates that the data were clustered around a narrower range of values (Bland 2015). However, a smaller standard deviation means greater consistency, predictability, and quality (more reliable) (Wachs 2009). Moreover, in terms of the open-ended questions regarding the most challenging aspect of the simulation sessions, students paid attention to a lack of resources, which negatively affected their clinical skills. Other challenges identified by the participants included a lack of training to maximise the usefulness of the HFS session. In addition, the students pointed out that due to the shortage of simulation duration, they did not fully practice and improve their clinical skills.

Table 14: Descriptive statistics and student ratings of SDS, EPQ, and SSCL

	Variable	N items	Students n = 258	
			Mean	SD
SDS	Objectives	5	3.79	1.08
	Support	4	3.72	1.08
	Problem solving	5	3.73	1.05
	Fidelity	2	3.75	1.17
	Feedback	4	3.70	1.02
	Total	**20**	**3.74**	**.98**
EPQ	Active learning	11	3.65	1.02
	Collaboration	2	3.88	1.12
	Diverse ways of learning	2	3.67	1.16
	High expectation	2	3.87	1.03
	Total	**17**	**3.70**	**0.97**
SSCL	Satisfaction	5	3.82	1.07
	Self-Confidence	8	3.89	.99
	Total	**13**	**3.86**	**.99**

7.6 Discussion

The aim of this study was to examine the suitability of an Arabic version of the NLN survey to evaluate the effectiveness of high-fidelity manikin simulations. Using Kirkpatrick's evaluation model, with a specific focus on Level 1, the main focus was on examining the extent to which learners were satisfied with the simulated educational experience in EMS education in Saudi Arabia. The focus of the study was on examining the psychometric properties of the instrument, as well as ascertaining their ability to examine students' perceptions of the simulation design features, the best educational practices, and their satisfaction and self-confidence in the implementation of high-fidelity manikin simulation.

The findings indicate that the Arabic version is culturally comparable and maintains semantic consistency. The process of translating and then translating back the surveys is a primarily qualitative method of obtaining a semantic translation that preserves the meaning of the original items and does not compromise their validity. In addition, it can be used to evaluate the effectiveness of high-fidelity manikin simulation activities in EMS education in Saudi Arabia.

This study was the first in Saudi Arabia to examine the reliability and validity of the simulation design scale, the educational practices questionnaires, and student's satisfaction and self-confidence in EMS education in Saudi Arabia. The results of my research indicate that the Arabic versions of the questionnaires exhibit strong internal consistency, as evidenced by an overall Cronbach's alpha exceeding 0.95 for each of the three surveys. This aligns with the alpha values of the original questionnaires (National League of Nursing, 2020a). However, if alpha is too high, it may suggest that some items are redundant, as they test the same question but in a different guise (Streiner 2003). Moreover, the inter-item correlations of the three questionnaires ranged from 0.65 to 0.88; therefore, none of the items needed to be excluded from the scales (Polit and Beck 2019). This finding is similar to that of a study in China (Gill 2020). The psychometric assessment of SDS, EPQ, and SSCL revealed a five-factor solution for SDS, a four-factor solution for EPQ, and a two-factor solution for SSCL. The results provided evidence for the congruence between the number of components extracted and the number of dimensions in previous studies (National League of Nursing, 2020a; Reierson et al. 2020; Unver et al. 2017). However, the item-factor structure differed from the original item-subscales.

In this study, the overall student programme outcome evaluation of the high-fidelity manikin simulation was very satisfactory, as has been reported by other studies (Thidemann and Soderhamn 2013; Almeida et al. 2016; Basak et al. 2016; Al Khasawneh et al. 2020; Gill 2020; Farrés -Tarafa et al. 2020; Farrés -Tarafa et al. 2021; Zalewska and Zarzycka 2022). In the evaluation of the simulation design features, the subscale with the highest rating was the objectives. The findings indicate that the students comprehended the main objectives of simulation, which were to enhance introspection and the capacity to cultivate clinical judgment. Additionally, the data revealed that the teachers played a facilitating role in this process. This study did not assess the potential impact of teachers' enabling behaviours on scores. Conducting additional research would be beneficial to identify effective strategies for enhancing the abilities of clinical educators and tutors to create advanced learning opportunities (Phillips et al. 2017). It would also be valuable to determine the most effective mentoring and facilitating approaches from the perspective of students (Thurling et al. 2017; Warburton et al. 2016). The findings of this study contribute to providing undergraduate paramedic students with high-quality simulation experiences (Warburton et al. 2016). The lowest-rated subscale was feedback. According to Nicol and Macfarlane-Dick (2006), to achieve success in formative assessment and enhance student learning in higher education, it is essential to have a principle of effective feedback practice that supports the development of students' clinical skills. To acquire a comprehensive understanding of a clinical skill, it is necessary to identify and expose all the various components of the talent to both students and teachers (Hill et al. 2012).

In the evaluation of the educational practices, the subscale with the highest rating was collaboration. The fact that this subscale had the highest rating in the evaluation is not unexpected, as simulation designs can greatly enhance the learning experience by incorporating collaboration with others and adopting an interdisciplinary approach (New et al. 2015; Berndt et al. 2015). However, the lowest rating was obtained for the subscale of diverse ways of the findings of other studies (Unver et al. 2017; Román-Cereto et al. 2022).

The students assigned the highest overall rating on the evaluation questionnaire to student satisfaction and self-confidence, while the lowest scores were given to the educational practices questions. The discrepancy between the lowest scores obtained in the questionnaire on educational practices and the conclusions of other studies (Unver et al. 2017; Román-Cereto et al. 2022) is noteworthy.

7.7 Theoretical and Practical Implications

This study aimed to develop an Arabic version of the SDS, EPQ, and SSCL at EMS colleges in Saudi Arabia. Moreover, this is the first study on EMS education that considers it. Therefore, the findings of the study contribute to the body of existing literature. A cross-sectional questionnaire study design was used. The study was based on Kirkpatrick's model (Level 1). The objectives were to examine the suitability of an Arabic version of an evaluation tool to evaluate the effectiveness of a high-fidelity manikin simulation.

In terms of Kirkpatrick's evaluation, which concerns whether students are satisfied with the simulation design features and the educational practices during the high-fidelity manikin simulation sessions, the findings indicate that students are satisfied. Moreover, the findings indicate that the SDS, EPQ, and SSCL are reliable and valid for use as evaluation instruments in EMS education in Saudi Arabia. Furthermore, the Arabic versions described here could be adapted to meet the cultural and educational needs of paramedic students in Arab countries, allowing them to evaluate their simulation learning experiences.

The adoption of a valid and reliable instrument to evaluate important and valuable teaching and learning aids, such as simulation, is regarded as a major accomplishment in EMS education. To assess the instrument's intended purpose effectively, it is essential that it be translated into the native language of the learners. Having three distinct yet related simulation instruments that are valid and reliable can enhance the simulation experience by assisting EMS students in deciding which learning outcomes should be achieved and how they should be achieved. Using these three NLN Arabic-version tools as a guide, educators can successfully analyse and resolve any issues or errors that arise during the high-fidelity manikin simulation process.

7.8 Limitations

This study has some limitations. First, the participants were restricted to Saudi Arabia, but students from all places in the Arabic world were preferred. Second, during the psychometric analysis of the original and translated NLN simulation evaluation measures, there was no established standard for assessing the EPQ, SDS, and SSCL scales (Unver et al. 2017; Gill 2020). Third, further investigation is necessary to evaluate the degree to which the findings derived from the HFS may be applied to real-world prehospital settings. Finally, additional research is needed to investigate the relationship between satisfaction outcomes and the acquisition of clinical competencies (García-Mayor et al. 2021).

7.9 Conclusion

This study makes a significant contribution to EMS education because it provides a greater understanding of the value and limitations of the SDS, EPQ, and SSCL scales. These measures have been widely used to evaluate simulation outcomes, with the assumption that they have acceptable psychometric properties. This study adds robust evidence based on statistical techniques to support the use of these instruments and to help ensure that judgments made about simulations are valid and reliable. Moving forward, researchers should have greater confidence in the validity and reliability of the SDS, EPQ, and SSCL scales.

As the first Arabic translation of the NLN simulation scales, this study paves the way for a greater understanding of the simulation experiences of Saudi EMS students and other Arabic-speaking countries. My research simultaneously validated three distinct NLN questionnaires for students. In addition, all validated questionnaires exhibited a high level of validity and a satisfactory level of reliability for use in EMS institutions in Saudi Arabia and other Arabic-speaking countries.

CHAPTER 8: Summary of Findings and Theoretical and Practical Implications

8.1 Summary of Findings

The aim of this thesis was to propose an evaluation framework for high fidelity manikin simulation in EMS education in Saudi Arabia. This proposed evaluation framework will evaluate the high fidelity manikin simulation outcomes, input, and process by examining the faculty and students perceptions regard their satisfaction , preparation and challenges to identify their learning needs and provide a reliable and valid translated evaluation tool to be used in EMS institutions. The findings from the literature review identified a clear gap in EMS education (Chapter 3). Moreover, the literature review identified that the majority of previous studies have focused on the nursing discipline. Furthermore, the literature review findings identified that the faculty and students were satisfied with the implementation of simulation in healthcare education but the faculty and students faced challenges, and there was a lack of reliable and valid evaluation tools regarding the evaluation of high-fidelity manikin simulation. Therefore, to address these gaps in EMS education, there is a need to develop a theoretical framework to evaluate the effectiveness of high-fidelity manikin simulations in EMS education in Saudi Arabia. Previous studies (Hollema 2015; Unver et al. 2017; Peierson et al. 2020; Pawłowicz et al. 2020; Zalewska et al. 2020; Zalewska et al. 2022; Jin et al. 2022; Martínez-Arce et al. 2023) have used the Jeffries simulation framework, which is underpinned on the Kirkpatrick evaluation model, to evaluate programme outcomes (Jeffries 2021). The outcome evaluation sought to determine whether the HFS worked. However, although outcome evaluations can provide important information about whether a specific intervention has the desired effect, they tend to neglect the complex nature of HFS activity and the processes that lead to outcomes, longer-term outcomes, and unintended outcomes. Previous studies (Reid et al. 2012; Zhang et al. 2017; Wighus et al. 2018; Tjoflåt et al. 2021; Park et al. 2021) have evaluated the programme by seeking to answer how and whether HFS worked. However, these studies did not use a specific programme evaluation model. Therefore, I combined an outcome evaluation (Kirkpatrick evaluation model

(Level 1) and a programme evaluation model (CIPP) to evaluate the programme outcomes, input, and process. These two models were used in Studies 1 and 2 to examine faculty and students' satisfaction, preparedness, and challenges during the HFS sessions, whereas only the Kirkpatrick evaluation model was used to examine students' satisfaction in Study 3. Tables 17 and 18 present the results obtained for all the studies in relation to the thesis research questions, as highlighted in Chapter 1.

Table 15: Summary findings of Studies 1 and 2

	Chapter 5 (Study 1)		**Chapter 6 (Study 2)**	
	Quantitative findings (Faculty n = 32) (students n = 57)	**Qualitative findings** (Faculty n = 9) (students n = 16)	**Quantitative findings** (Faculty n = 40) (students n = 210)	**Qualitative findings** (Faculty n = 10) (students n = 17)
Thesis questions 1–2				
What are EMS faculty and paramedic student's perceptions of high-fidelity manikin simulation in EMS education in Saudi Arabia?	Both faculty and students were satisfied with the presence and importance of the simulation design features and the best educational practices in the high-fidelity simulation sessions.		Both faculty and students were satisfied with the simulation design features and best educational practices in the high-fidelity simulation sessions before and during the COVID-19 pandemic.	
What are faculty and paramedic students' perceptions of preparation, implementation and challenges to identify		Both faculty and students had similar challenges, such as:		Both faculty and students had a similar challenges before and during the

learning needs in EMS education in Saudi Arabia?	1. Institutional issues 2. Support needs 3. Assessment and feedback	COVID-19 pandemic such as: 1. Institutional issues 2. Support needs 3. Teaching during the COVID-19 pandemic

8.2 Studies 1 and 2 Findings (Thesis Questions 1-2)

The aim of Study 1 was to evaluate the effectiveness of high-fidelity manikin simulation in an EMS college in Saudi Arabia. This was done by considering both outcome and programme evaluation using questionnaires and semi-structured interviews to collect data. The quantitative results provided useful insights, showing that overall, students, and faculty were satisfied with the implementation of high-fidelity Manikin simulation education. The qualitative findings provided more meaningful data on what worked and what did not and the potential challenges faculty and students face in HFS education to identify their learning needs.

As shown in Table 15, both faculty and students were satisfied with the presence and importance of simulation design features and best educational practices. This finding is similar to those of previous studies in which faculty and students were also satisfied with their HFS sessions (Conejo 2010; Franklin et al. 2014; Unver et al. 2017). However, in the outcome evaluation for the simulation design scale, the students reported a lower rating for the fidelity (realism) of the HFS. This finding contradicts a previous study in which the students were generally satisfied with the simulation design features but rated the support as the lowest (Al Khasawneh et al. 2020). By contrast, the paramedic students reported a higher rating for the support subscale during the simulation activity. However, findings from the interviews conducted with students suggest that despite the general rating of satisfaction with support, students in fact mentioned a lack of support as a challenge in the learning experience.

The students rated the diverse ways of learning the highest on the evaluation of the best educational practices in the simulation activity. This finding is similar to that of another study in Poland, where the students rated the subscale of diverse ways of learning as the highest (Zalewska and Zarzycka 2022). However, this finding contradicts a previous study (Zapko et al. 2018). Further, the students rated collaboration as the lowest. This finding aligns with a previous study in Spain examining best educational practices from the students' perspectives (Román-Cereto et al. 2022).

As shown in Table 15, both faculty and students identified institutional issues, support needs, and assessment and feedback as challenges during their HFS sessions. These findings are similar to those of previous studies conducted in the UK, South Korea, China, Norway, and Sub-Saharan Africa, where faculty and students faced challenges related to institutional issues, lack of preparedness, lack of support, and lack of debriefing at the end of HFS sessions (Lee et al. 2015; Ahmed et al. 2016; Ray 2017; Mulli et al. 2022).

By contrast, Study 2 gathered evaluative data from various EMS institutions rather than one and capitalised on the opportunity to evaluate the impact of the COVID-19 pandemic on the teaching of the high-fidelity manikin simulation in EMS colleges in Saudi Arabia to generalise the findings at the national level. The results are summarised in Table 15.

Contrary to expectations, both faculty and students were satisfied with the implementation of high-fidelity manikin simulation before and during the COVID-19 pandemic. This finding is similar to those of previous studies (Conejo 2010; Franklin et al. 2014; Unver et al. 2017; Mohammed and Mohammed 2020 Alkhasawneh et al. 2021). There was a significant difference in the students' perceptions of the simulation design features (before and during the COVID-19 pandemic), with the students rating their experiences of collaboration before the COVID-19 pandemic as lower than their experiences during the COVID-19 pandemic. However, this finding contradicts the findings from the interviews conducted, in which students mentioned uncomfortable conditions related to social distance as a challenge in the learning experience. Moreover, there was a significant difference in the student's perceptions of the educational practices (before and during the COVID-19 pandemic), where the students rated their experiences of diverse ways of learning during the COVID-19 pandemic lower than their experiences before the COVID-19 pandemic. This finding was not surprising because the social distance limited the student's ability to practice and improve their clinical skills during the HFS session during the COVID-19 pandemic. However, there was a significant difference in the faculty's perceptions of the simulation design features (before and during the COVID-19 pandemic), as the faculty rated their experiences of fidelity before the COVID-19 pandemic lower than their experiences during the COVID-19 pandemic. This finding contradicts the findings from the interviews with faculty; in fact, the faculty mentioned that the time of the simulation was shortened. This hindered the students from gaining hands-on experience with the HFS, which affected their clinical skills.

The study also evaluated the challenges that both faculty and students faced during their high-fidelity manikin simulation activities before and during the COVID-19 pandemic. Both faculty and students faced similar challenges in all EMS institutions in Saudi Arabia. Faculty and students mentioned that they were not prepared to implement high-fidelity manikin simulation sessions before the COVID-19 pandemic because of a lack of briefing, preparedness, and training. This finding is similar to those of previous studies that mentioned a lack of briefing, preparedness, and training as obstacles (Ahmed et al. 2016; Zhang 2017; Tjoflat et al. 2021). The preparation stage in simulation is related to identifying the simulation team, identifying whether the simulation will or will not be videotaped, and identifying the materials needed. In this sense, Brewer (2011) found that the planning process can be systematically divided for each scenario to prevent it from becoming excessively burdensome. However, it is important to note that preparing for even a single simulation can be time-consuming. Despite the use of robust preparation, the scenario frequently undergoes development and evolution over time, necessitating more modifications (Holland et al. 2008). Hence, to successfully implement simulation practices, stakeholders should engage in the early stages before the scheduled simulation. If this is the case, the likely cause of this phenomenon can be attributed to a limited comprehension of the potential benefits offered by simulation practices. It is important to recognise that simulation is not merely an additional work to be included in instructional methods but a valuable tool that can enhance teaching delivery. Wilson and Wittmann-Price (2018, p. 91) emphasised that the simulation should include the participation of all relevant educational stakeholders and should obtain essential administrative support, encompassing financial resources and necessary materials. One of the essential responsibilities entails the provision of instruction to stakeholders, including learners, educators, and simulation technicians, regarding the utilisation of high-fidelity manikin simulations as an educational approach (Wilson and Wittmann-Price 2018, p. 161).

The feature of briefing in simulation activities is derived from the concept of introducing the scenario, which prepares both learners and instructors to participate in the active learning experience of the simulation. According to Riley (2008, p. 73), it is important for learners to have a clear comprehension of the anticipated requirements at the initiation of the simulated activity. This includes discerning elements that can be effectively simulated and those that cannot be feasibly replicated, which can be effectively addressed by providing a concise orientation and briefing session before engaging in the activity. Notably, if the teacher does not demonstrate a belief in the efficacy of simulation as a learning tool, the learners are likely to adopt a similar perspective.

Many researchers have illustrated briefing needs in simulation activities; for example, Hellaby (2013, p. 28) argued that the purpose of a briefing is to cultivate a secure learning environment, define the anticipated objectives of the session, provide guidelines for appropriate conduct, and acquaint the learners with the simulation location and equipment. Further, Husebo et al. (2012) argued that the briefing step, despite its significance, is sometimes overlooked, but it is a crucial opportunity to evaluate whether the learners possess a comprehension of the instructions and to provide clarification if required. Additionally, it emphasises the need to clarify the exact elements that will be addressed in the simulation and to help mitigate any potential ambiguity or confusion (Husebo et al. 2012). Moreover, Crawford et al. (2019, p. 119) recommended utilising a written or recorded briefing strategy for every scenario, particularly for those that include high-stakes evaluation. This will aid a student in developing a sense of confidence in meeting the expectations and requirements of a specific setting. Akselbo and Aune (2023, p. 5) confirmed that pre-briefing activities serve the purpose of creating a psychologically secure learning environment in two ways: (1) facilitating the establishment of a shared cognitive framework among learners and equipping them with the necessary knowledge and understanding to engage with the educational material presented in the simulation-based experience (preparedness) and (2) communicating essential guidelines for the simulation-based encounter (preparation session).

Existing research further suggests that an effective structure for the briefing process is crucial to effectively achieving the desired learning results. Meakim et al. (2013, p. S7) suggested steps for conducting a briefing encompass an introduction to the equipment, environment, responsibilities, time allocation, objectives, and patient circumstances. The pre-briefing session in the high-fidelity manikin simulation is designed to establish the atmosphere and expectations for the forthcoming educational encounter. The pre-simulation briefing encompasses various essential elements. The activities encompassed in this process are the evaluation of the session's goals and objectives, the establishment of a fiction contract agreement with paramedic students, the provision of logistical information pertaining to the session, and the commitment to treat the students with due respect. The aforementioned components aim to establish a psychologically secure environment for paramedic trainees, fostering a sense of ease and facilitating the process of making and learning from mistakes. According to Hughes and Hughes (2019), the absence of psychological safety inside the simulation lab setting can hinder students' ability to maximise their learning experience fully.

Sunderland (2017) posited that faculty members engaged in the development and implementation of simulated learning scenarios should have received training and undertaken evaluation in this particular pedagogical approach. Thus, professional standards for educators are currently being widely embraced in conjunction with the growing implementation of regulations and quality assurance measures. Thus, EMS educators must possess an awareness of these transformations and be equipped to adopt a lifelong learning stance towards their personal growth and advancement (Forrest and McKimm 2013, p. 4). Formal training for EMS educators is required by standards of best practice, guidelines, and regulations. The literature identifies a relationship between the effective training of simulation educators and the higher achievement of expected learner outcomes (Beroz 2017). Unintended or negative consequences for paramedic students can occur if EMS educators are not adequately trained in the use of high-fidelity manikin simulations (Kolbe and Rudolph 2018). Paige et al. (2020) identified the areas where educators need training to implement effective simulation, such as debriefing, coaching, scenario design, evaluation of learning, feedback, and simulation standards. Faculty and students also mentioned that they faced challenges regarding the objectives and the structure of the high-fidelity manikin simulation sessions before the COVID-19 pandemic because of a lack of support needs and equipment malfunctions. This finding is similar to those of previous studies that mentioned lack of objectives and lack of support as obstacles (). Moreover, the faculty and students mentioned new challenges during the high-fidelity manikin simulation during the COVID-19 pandemic, such as uncomfortable conditions and the duration of the session, which affected their high-fidelity manikin simulation sessions. This finding aligns with previous studies (Aldridge et al. 2021; Tabbakhian 2021).

8.3 Study 3 Findings (Thesis Question 3)

The previous two studies utilised an English version of the NLN, which consists of three scales that were extensively used in several countries and have strong reliability and validity (Unver et al.2017; Reierson et al.2020; Martinez-Arce et al.2023). Although the English version was found to be reliable and valid in the studies thus far, it can be argued that if the survey were to be used more extensively in Arabic-speaking countries to evaluate simulation-based learning, it should be made available in Arabic. The results are summarised in table 16.

The findings of this study showed that the three translated scales were reliable and valid for use as evaluation instruments during the high-fidelity manikin simulation. The findings were similar to those of previous studies (Franklin et al. 2014; Unver et al. 2017; Reierson et al. 2020; Martinez-Arce et al. 2023). Moreover, paramedic students were satisfied with the simulation design features and best educational practices during their HFS sessions. The findings are similar to those of the previous two studies in this thesis and previous studies in the nursing discipline (Thidemann and Soderhamn 2013; Almeida et al. 2016; Basak et al. 2016; Al Khasawneh et al. 2020; Gill 2020; Farres-Tarafa et al. 2020; Farres-Tarafa et al. 2021; Zalewska and Zarzycka 2022).

The adoption of translated valid and reliable instrument to evaluate important and valuable teaching and learning aids, such as simulation, is regarded as a major accomplishment in EMS education. To assess the instrument's intended purpose effectively, it is essential that it be translated into the native language of the learners. Having three distinct yet related simulation instruments that are valid and reliable can enhance the simulation experience by assisting EMS students in deciding which learning outcomes should be achieved and how they should be achieved. Using these three NLN Arabic-version tools as a guide, educators can successfully analyse and resolve any issues or errors that arise during the high-fidelity manikin simulation process.

Table 16: Summary findings of Study 3

Chapter 7 (Study 3)	
Thesis questions 3	**Quantitative findings (students n = 258)**

Develop a psychometrically sound tool to evaluate High Fidelity manikin Simulation in Arabic?	Students were satisfied with the simulation design features and the best educational practices inside the HFS sessions. Moreover, the findings indicate that the three translated SD, EPQ, and SSCL are reliable and valid.

8.4 Theoretical Implications

This thesis has several theoretical implications that extend previous research on the evaluation of simulation activities (Franklin et al. 2014; Hollema 2015; Unver et al. 2017; Peierson et al. 2020; Pawłowicz et al. 2020; Zalewska et al. 2020; Zalewska et al. 2022; Jin et al. 2022; Martínez-Arce et al. 2023; Reid et al. 2012; Zhang et al. 2017; Wighus et al. 2018; Tjoflåt et al. 2021; Park et al. 2021). First, it combined both outcome and programme evaluation to address whether HFS worked and why and how it worked. Second, it examined both faculty and students as stakeholders. Third, it evaluated the implementation of high-fidelity manikin simulation sessions before and during the COVID-19 pandemic. Fourth, it provides EMS colleges with reliable and valid Arabic evaluation tools for maximising the usefulness of HFS activities. Finally, this thesis addresses the gap in EMS education in Saudi Arabia.

In terms of Kirkpatrick's evaluation, which concerns whether the faculty and students were satisfied with the simulation design features and the educational practices during the high-fidelity Manikin simulation sessions, the findings indicate that both faculty and students were satisfied with the three studies. Moreover, the three translated evaluation tools were reliable and valid. In terms of input evaluation, which encompasses the preparedness and readiness for implementing high-fidelity manikin simulation in addition to the structure and curriculum of HFS sessions, the results indicate that faculty and students had a lack of preparedness to run the simulation activity in Studies 1 and 2. Moreover, the faculty and students believed that they were facing a lack of briefing in terms of the objectives of the simulation, lack of training, checking the needed equipment, establishing the ambiance for the forthcoming educational encounter for the implementation of high-fidelity Manikin simulation sessions, and needed guidance. Furthermore, in terms of process evaluation, which concerns whether high-fidelity Manikin simulation sessions were delivered as intended, implementation issues, the need for senior colleagues, and equipment malfunctions in simulation sessions were major challenges in Studies 1 and 2.

8.5 Practical Implications

As this thesis is an evaluative study aimed at informing change, its findings can be used to make improvements at the EMS colleges where the study was conducted. The following approaches can be implemented to improve the educational value of high-fidelity Manikin simulation sessions:

1- **Faculty and student preparedness**
The faculty and students were not prepared for how they should deliver sessions. Although the faculty understood the simulation concept, they were unaware of their personal roles or effective practical attitudes in conducting the sessions, as most of their recommendations for improving simulation sessions were about factors related to objectives and equipment. Moreover, students should be prepared to help them identify the simulation aspects before running the simulation. The simulation unit should liaison with the faculty development unit at the school to address faculty and student preparedness (Acton et al. 2015; Jeffries et al. 2015; Ahmed et al. 2016; Herlihy 2022).

2- **Faculty and students briefing before the simulation activity**
The faculty and students mentioned that there was a lack of briefing before running the simulation sessions. Although the faculty seek their colleagues' help, briefing is vital for a successful simulation. The simulation unit should liaison with the medical education unit at the school to improve faculty and student briefing before the simulation session (Kolbe et al. 2015; Druliolle 2017; Halamek et al. 2019; Hughes and Hughes 2019; Tyerman et al. 2019).

3- Faculty training

The faculty reported that they did not have training on how to use high-fidelity manikin simulations. Therefore, teachers might need a training course to improve their teaching during the high-fidelity Manikin simulation sessions. Faculty can acquire training by participating in simulation educator training courses provided by different simulation programmes, attending workshops at conferences, or pursuing fellowship training or graduate degrees in simulation (Acton et al. 2015; Jeffries et al. 2015; Kim et al. 2017; Seethamraju et al.2022).

4- Establishing clear learning objectives

The objectives of the high-fidelity Manikin simulation sessions were not clearly stated. The simulation unit should develop broad but focused learning objectives linked to real-life practice for high-fidelity manikin simulation sessions, which would function as a guide for the faculty in delivering the sessions and motivating students (Page-Cutrara 2014; Munangatire and Naidoo 2017; Hui et al. 2021).

5- Functioning of equipment

The students and faculty believed that the equipment had malfunctions. Therefore, it would be reasonable to have a basic understanding of the functioning of equipment and technology before the simulation sessions (Davis et al. 2014; Roh et al. 2016).

6- Multidisciplinary teamwork

A multidisciplinary approach is needed to address the administrative and technical challenges that faculty and students face in a high-fidelity manikin simulation environment. The medical education unit should conduct meetings with relevant stakeholders in different departments and committees to address difficulties in running simulation activities, as administration-controlled factors play an essential role in the success of HFS (Najjuma et al. 2020; Nyeinan and Gregory 2020).

8.6 Thesis Strengths and Limitations

The limitations of each study are discussed in their respective chapters. This section aims to describe the overarching strengths and limitations of the thesis and the methodology of this body of work as a whole.

A key strength of this series was obtaining data from different EMS colleges in Saudi Arabia. Collecting data from various sources allowed me to utilise different research methodologies, such as mixed methods for methodological triangulation (i.e. involving the use of both qualitative and qualitative methods) and cross-sectional quantitative design. Another strength of this thesis is that it provides new knowledge about the evaluation of high-fidelity manikin simulation in EMS education in Saudi Arabia and is therefore a foundation for future research on the topic. Furthermore, the studies in Chapters 4 and 5 involved the use of different data sources, such as students and teachers, which are important for data triangulation. Another strength of this thesis relates to providing Arabic reliable and valid evaluation surveys, including the SDS, EPQ, and SSCL, to EMS education colleges, which might help in quality assurance. However, it is worth noting that these instruments should be used with limitations because they can evaluate HFS outcomes but not its inputs and processes.

The limitations of this thesis started with a lack of existing research focused on HFS in EMS education globally, which led me to use other research from different healthcare disciplines. Another limitation was the shortage of students and EMS simulation educators working in high-fidelity manikin simulation labs. For example, for 10 EMS faculty members at an EMS college, there could be only two EMS teachers working on the simulation unit. Non-probability convenience sampling and long questionnaires are considered another limitation in this thesis that may affect the generalisability and reliability of the results. In addition, the interviews were conducted in English, which was not the participant’s first language and is considered another limitation. The data from Studies 1 and 2 were collected during the COVID-19 pandemic, which hindered my ability to collect more data. Finally, the female paramedic students and EMS simulation educators were not willing to participate in the interview, which limited capturing their perspectives about the preparedness and challenges that may face in the high-fidelity manikin simulation sessions. Therefore, the overall interpretations of EMS education in Saudi Arabia are limited.

8.8 Recommendations for Future Research

Additional studies should be pursued in accordance with the findings of this thesis. The faculty and students evaluated were not prepared to implement HFS sessions. Another study is needed to determine successful and unsuccessful facilitation methods for HFS. Furthermore, certain support issues were identified as obstacles to HFS. Consequently, subsequent research should investigate the impact of the learning environment on HFS. This was an evaluative thesis on HFS activities based on the perceptions of faculty and students. Another evaluative study can be undertaken by assessing the perspectives of deans, heads of departments, heads of simulation units, and simulation specialists regarding HFS activities. The involvement of all stakeholders and a comparison of several instructional strategies for HFS are necessary for a holistic evaluation. The study validated the students' concerns about the lack of faculty involvement during the debriefing of the second study. A future study should identify the competences and skills necessary for teachers to engage effectively in debriefing. Furthermore, faculty members identified a lack of training as a challenge during the HFS sessions. Therefore, future studies could identify specific training that could improve faculty skills in implementing HFS sessions.

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Appendices

Appendix 1: Simulation Design Scale (SDS) (study 1 and 2)

Simulation Design Scale (Student Version) (SDS-S) (study 1)

In order to measure if the best simulation design elements are being used in your simulation, please complete the survey below as you perceive it. There are no right or wrong answers, only your perceived amount of agreement or disagreement. Please use the following code to answer the questions.

<table>
<tr><td colspan="8">Use the following rating system when assessing the simulation design elements:

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.</td><td colspan="4">Rate each item based on how important that item is to you.

1 – Not Important
2 – Somewhat Important

3 – Neutral
4 – Important
5 – Very Important</td></tr>
<tr><td>Item</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>NA</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Objectives and Information</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>The faculty gave enough information at the beginning of the simulation labs to provide direction and encouragement.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>I clearly understood the purpose and objectives of the simulation labs.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>The simulation labs provided enough information in a clear</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

manner for me to problem-solve the situation.											
There was enough information provided to me during the simulation labs.											
The cues were appropriate and geared to promote my understanding											

Support											
Support was offered in a timely manner.											
My need for help was recognized.											
I felt supported by faculty during the simulation labs.											
Overall, the faculty supported the learning process for me.											
Problem Solving											
Independent problem solving was facilitated.											
I was encouraged to explore all possibilities of the simulation labs.											

The simulation labs was designed for my specific level of knowledge and skills.										
The simulation labs allowed me the opportunity to prioritize paramedic assessments and care.										
The simulation labs provided me an opportunity to set goals for my patient.										
Feedback/Guided Reflection										
Feedback provided was constructive.										
Feedback was provided in a timely manner.										
The simulation labs allowed me to analyze my own behaviors and actions.										
There was an opportunity after the simulation labs to obtain guidance/feedback from the faculty in order to build knowledge to another level.										
Fidelity (Realism)										
The scenario resembled a real-life situation.										
Real life factors, situations, and variables were built into the simulation scenario.										

Simulation Design Scale (Teacher Version) (SDS-T) (Study 1)

In order to measure if the best simulation design elements are being used in your simulation, please complete the survey below as you perceive it. There are no right or wrong answers, only your perceived amount of agreement or disagreement. Please use the following code to answer the questions.

<table>
<tr><td colspan="8">Use the following rating system when assessing the simulation design elements:

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.</td><td colspan="4">Rate each item based on how important that item is to you.

1– Not Important
2– Somewhat Important
3– Neutral

4– Important
5– Very Important</td></tr>
<tr><td>Item</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>NA</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Objectives and Information</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>I (the teacher) gave enough information at the beginning of the simulation to provide direction and encouragement.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Learners clearly understood the purpose and objectives of the simulation.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>The simulation provided enough information in a clear manner for learners to problem-solve the situation.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>I (the teacher) provided enough information to learners during the simulation.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

I (the teacher) provided cues that were appropriate and geared to promote learners' understanding.											
Support											
I (the teacher) offered support to the learners in a timely manner.											
I (the teacher) recognized when learners needed help.											
My (the teacher) assistance supported the learners during the simulation.											
Overall, I (the teacher) supported the learning process for learners.											
Problem Solving											
Independent problem solving was facilitated for learners.											
Learners were encouraged to explore all possibilities of the simulation.											
The simulation was designed for the learners' specific level of knowledge and skills.											
The simulation allowed learners the opportunity the prioritize nursing assessments and care.											

The simulation allowed learners the opportunity to set goals for the patient.											
Feedback/Guided Reflection											
I (the teacher) provided constructive feedback.											
I (the teacher) provided feedback in a timely manner.											
The simulation allowed learners to analyze their behavior and actions.											
There was an opportunity after the simulation for learners to obtain guidance/feedback from me (the teacher) in order to build knowledge to another level.											
Fidelity (Realism)											
The scenario resembled a real-life situation.											
Real life factors, situations, and variables were built into the simulation scenario.											

Simulation Design Scale (Teacher Version) (SDS-S) (study 2)

<u>A survey of Teachers' perceptions of High Fidelity Simulation in Emergency Medicine Education</u>

I can confirm that I have read the information provided about the study and consent to take part by completing this questionnaire (Click)

Section 1 - Demographics

Age

Gender

Current educational role

Instituation name

Number of years experience

Clinical role

Section 2 - Simulation Design Scale (Teacher Version) (SDS-S)

In order for us to understand your perceptions of simulation design elements used in high fidelity simulation teaching, please rate the extent to which you agree with the statements and how important these are to you. There are no right or wrong answers, only your perceived amount of agreement or disagreement.

Use the following rating system when assessing the simulation design elements before and during Covid-19 and how important that item is to you:

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

Importance scale:

1– Not Important
2– Somewhat Important

3– Neutral
4– Important
5– Very Important

	Before covid-19					During covid-19					importance				
Item	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Objectives and Information															
1. I gave enough information at the beginning of the simulation to provide direction															

and encouragement.															
2. Learners clearly understood the purpose and objectives of the simulation.															
3. The simulation provided enough information in a clear manner for learners to problem-solve the situation.															
4. I provided enough information to learners during the simulation.															
5. I provided cues that were appropriate and geared to promote															

learners' understanding.															
Support															
6. I offered support to the learners in a timely manner..															
7.I recognized when learners needed help.															
8. My assistance supported the learners during the simulation.															
9.Overall, I supported the learning process for learners.															
Problem Solving															
10.Independent problem solving															

was facilitated for learners.															
11. Learners were encouraged to explore all possibilities of the simulation.															
12. The simulation was designed for the learners' specific level of knowledge and skills.															
13. The simulation allowed learners the opportunity the prioritize nursing assessments and care.															

14. The simulation allowed learners the opportunity to set goals for the patient.															
Feedback/Guided Reflection															
15. I provided constructive feedback.															
16. I provided feedback in a timely manner.															
17. The simulation allowed learners to analyze their behavior and actions.															

18.There was an opportunity after the simulation for learners to obtain guidance/feedback from me in order to build knowledge to another level.															
Fidelity (Realism)															
19. The scenario resembled a real-life situation.															
20. Real life factors, situations, and variables were built into the simulation scenario.															

Simulation Design Scale (Student Version) (SDS-S) (study 2)

A survey of students' perceptions of High Fidelity Simulation in Emergency Medicine Education

I can confirm that I have read the information provided about the study and consent to take part by completing this questionnaire (Click)

Section 1: Demographics

Age

Gender

Years of study

Institution

Section 2: Simulation Design Scale (Student Version) (SDS-S)

In order for us to understand your perceptions of simulation design elements in your high fidelity simulation teaching, please rate the extent to which you agree with the statements and how important these are to you. There are no right or wrong answers, only your perceived amount of agreement or disagreement.

Use the following rating system when assessing the simulation design elements before and during Covid-19 and how important that item is to you: 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 Importance scale: 1– Not Important 2– Somewhat Important 3– Neutral

4– Important 5– Very Important															
	Before covid-19					During covid-19					importance				
Item	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Objectives and Information															
1. The faculty gave enough information at the beginning of the simulation to provide direction and encouragement.															
2. I clearly understood the purpose and															

objectives of the simulation.															
3.The simulation labs provided enough information in a clear manner for me to problem-solve the situation.															
4. There was enough information provided to me during the simulation labs.															
5. The cues were appropriate and geared to promote my understanding															
Support															

6. Support was offered in a timely manner.															
7. My need for help was recognized.															
8. I felt supported by faculty during the simulation labs.															
9. Overall, the faculty supported the learning process for me.															
Problem Solving															
10. Independent problem solving was facilitated.															
11. I was encouraged to															

explore all possibilities of the simulation labs.														
12. The simulation labs was designed for my specific level of knowledge and skills.														
13. The simulation labs allowed me the opportunity to prioritize paramedic assessments and care.														
14. The simulation labs provided me an opportunity to set goals for my patient.														

Feedback/Guided Reflection															
15. Feedback provided was constructive.															
16. Feedback was provided in a timely manner.															
17. The simulation labs allowed me to analyze my own behaviors and actions.															
18. There was an opportunity after the simulation labs to obtain guidance/feedback from the faculty in order to build															

knowledge to another level.															
Fidelity (Realism)															
19. The scenario resembled a real-life situation.															
20. Real life factors, situations, and variables were built into the simulation scenario.															

Appendix 2: Educational Practices Questionnaire (study 1 and 2)

Educational Practices Questionnaire (Student Version) (EPQ-S) (Study 1)

In order to measure if the best practices are being used in your simulation, please complete the survey below as you perceive it. There are no right or wrong answers, only your perceived amount of agreement or disagreement. Please use the following code to answer the questions.

Use the following rating system when assessing the 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.	Rate each item based on how important that item is to you. 1 – Not Important 2 – Somewhat Important 3 – Neutral 4 – Important 5 – Very Important

Item	1	2	3	4	5	NA	1	2	3	4	5
Active Learning											
1. I had the Opportunity during the simulation labs activity to discuss the ideas and concepts taught in the course with the faculty and other students.											
2. I actively participated in the debriefing session after the simulation labs.											

3. I had the opportunity to put more thought into my comments during the debriefing session.										
4. There were enough opportunities during the simulation labs to find out if I clearly understand the material.										
5. I learned from the comments made by the faculty before, during or after the simulation labs .										
6. I received cues during the simulation labs in a timely manner.										
7. I had the chance to discuss the simulation labs objectives with my teachers.										
8. I had the opportunity to discuss ideas and concepts taught in the simulation labs with my instructors.										
9. The instructors were able to respond to the individuals needs of learners during the simulation labs.										
10. Using simulation labs activities made my learning time more productive.										
11. Using simulation activities was a productive use of the learners' time.										
Collaboration										

12. I had the chance to work with my peers during the simulation labs.											
13. During the simulation, My peers and I had to work on the clinical simulation together.											
Diverse Ways of Learning											
14. The simulation labs offered a variety of ways in which to learn the material.											
15. The simulation labs offered a variety of ways of assessing learning.											
High Expectations											
16. The objectives of the simulation labs experience were clear and easy to understand.											
17. My instructors communicated the goals and expectations to accomplish during the simulation labs.											

Educational Practices Questionnaire (Teacher Version) (EPSS-T) (Study 1)

In order to measure if the best practices are being used in your simulation, please complete the survey below as you perceive it. There are no right or wrong answers, only your perceived amount of agreement or disagreement. Please use the following code to answer the questions.

<table>
<tr><td colspan="7">Use the following rating system when assessing the 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.</td><td colspan="5">Rate each item based on how important that item is to you.

1– Not Important
2– Somewhat Important

3– Neutral
4– Important
5– Very Important</td></tr>
<tr><td>Item</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>NA</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Active Learning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1. Opportunities are provided during the simulation activity to discuss the ideas and concepts taught in the course with the teacher and other students.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2. Students and teacher(s) actively participated in the debriefing session after the simulation.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3. Students have the opportunity to put more thought into their comments during the debriefing session.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4. Students have enough opportunities during the simulation to find out if they clearly understand the material.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>5. I (the teacher) have the opportunity during the simulation to find out if students clearly understand the material.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

6. Students appear to have learned from the comments made by me (the teacher) before, during, or after the simulation.											
7. I (the teacher) provided cues to the learners during the simulation in a timely manner.											
8. Students have the opportunity to discuss the simulation objectives with me (the teacher).											
9. Students have the opportunity to discuss ideas and concepts taught in the simulation with me (the teacher).											
10. I (the teacher) was able to respond to the individual needs of learners during the simulation.											
11. Using simulation activities was a productive use of the learners' time.											
Collaboration											
12. Learners have the chance to work with their peers during the simulation.											
13. During the simulation, learners and their peers had to work on the clinical simulation together.											
Diverse Ways of Learning											
14. The simulation offered a variety of ways in which to learn the material.											

15. This simulation offered a variety of ways of assessing learning.										
High Expectations										
16. The objectives of the simulation experience were clear and easy to understand.										
17. I (the teacher) communicated the goals and expectations to accomplish during the simulation.										

Educational Practices Questionnaire (Student and teacher Version) (study 2).

Educational Practices Questionnaire (Student Version) (EPSS-T)

In order for us to understand your perceptions of your learning in high fidelity simulation settings, please tell us the extent to which you agree with the statements and how important these are to you by completing this survey. There are no right or wrong answers, only your perceived amount of agreement or disagreement.

Use the following rating system when assessing the simulation design elements before and during Covid-19 and how important that item is to you:

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

Importance scale: 1– Not Important 2– Somewhat Important 3– Neutral 4– Important 5– Very Important															
	Before covid-19					During covid-19					importance				
Item	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Active Learning															
1. I had the Opportunity during the simulation labs activity to discuss the ideas and concepts taught in the course with the															

faculty and other students.															
2. I actively participated in the debriefing session after the simulation labs.															
3. I had the opportunity to put more thought into my comments during the debriefing session.															
4. There were enough opportunities during the simulation labs to find out if I clearly understand the material.															

5. I learned from the comments made by the faculty before, during or after the simulation labs .															
6. I received cues during the simulation labs in a timely manner.															
7. I had the chance to discuss the simulation labs objectives with my teachers.															
8. I had the opportunity to discuss ideas and concepts taught in the simulation labs with my instructors.															

9. The instructors were able to respond to the individuals needs of learners during the simulation labs.															
10. Using simulation labs activities made my learning time more productive.															
11. Using simulation activities was a productive use of the learners' time.															
Collaboration															
12. I had the chance to work with my peers															

during the simulation labs.															
13. During the simulation, my peers and I had to work on the clinical simulation together.															
Diverse Ways of Learning															
14. The simulation labs offered a variety of ways in which to learn the material.															
15. The simulation labs offered a variety of ways of assessing learning.															

High Expectations															
16. The objectives of the simulation labs experience were clear and easy to understand.															
17. My instructors communicated the goals and expectations to accomplish during the simulation labs.															

Educational Practices Questionnaire (Teacher Version) (EPSS-S)

So we can understand your perceptions of the various educational practices used in high fidelity simulation teaching, please rate the extent to which you agree with the statement and how important these are to you. There are no right or wrong answers, only your perceived amount of agreement or disagreement.

Use the following rating system when assessing the educational practices elements before and during Covid-19 and how important that item is to you:

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

Importance scale:

1– Not Important

2– Somewhat Important

3– Neutral

4– Important

5– Very Important

	Before covid-19					During covid-19					importance				
Item	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

Active Learning															
1. Opportunities were provided during the simulation activity to discuss the ideas and concepts taught in the course with the teacher and other students.															
2. Students and teacher(s) actively participated in the debriefing session after the simulation.															
3. Students have the opportunity to put more thought into their comments during the debriefing session.															

4. Students have enough opportunities during the simulation to find out if they clearly understand the material.															
5. I have the opportunity during the simulation to find out if students clearly understand the material.															
6. Students appear to have learned from the comments made by me before, during, or after the simulation.															
7. I provided cues to the learners															

during the simulation in a timely manner.															
8. Students have the opportunity to discuss the simulation objectives with me .															
9. Students have the opportunity to discuss ideas and concepts taught in the simulation with me .															
10. I was able to respond to the individual needs of learners during the simulation.															
11. Using simulation															

activities was a productive use of the learners' time.															
Collaboration															
12. Learners have the chance to work with their peers during the simulation.															
13. During the simulation, learners and their peers had to work on the clinical simulation together.															
Diverse Ways of Learning															
14. The simulation offered a variety of															

ways in which to learn the material.															
15. This simulation offered a variety of ways of assessing learning.															
HighExpectations															
16. The objectives of the simulation experience were clear and easy to understand.															
17.I communicated the goals and expectations to accomplish during the simulation.															

Appendix 3: Translated Simulation Design Scale (SDS) (study 3) (Student Version)

تحسين تصميم المحاكاة (نسخة الطالب) (**SDS-S**)

بغية قياس ما إذا كان يتم استخدام أفضل عناصر تصميم المحاكاة في المحاكاة التي تستخدمها، نحن نرجو منك استكمال الاستبيان أدناه على النحو الذي تراه. لا توجد إجابات توصف بأنها صواب أو خطأ، المطلوب فقط هو مقدار ما تراه أنت من اتفاق أو اختلاف مع العبارة. يرجى استخدام النظام التالي في الإجابة على الأسئلة.

<table>
<tr><td colspan="5">قم بتقييم كل عنصر على أساس مدى أهمية هذا العنصر لك.

6 – ليس مهما
7 – مهم إلى حد ما
8 - محايد
9 – مهم
10 – مهم جدا</td><td colspan="7">استخدم نظام التصنيف التالي عند تقييم عناصر تصميم المحاكاة:

6 – أختلف بشدة مع العبارة
7 – أختلف مع العبارة
8 – غير محدد – أنت لا تتفق مع العبارة أو لا تختلف معها
9 – أتفق مع العبارة
10 – أتفق بشدة مع العبارة
NA – لا تنطبق؛ العبارة لا تنطبق على نشاط المحاكاة الذي تم تنفيذه.</td></tr>
<tr><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>NA</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>العنصر</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>الأهداف والمعلومات</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1. قدمت الكلية معلومات كافية في بداية معامل المحاكاة بغية توفير التوجيه والتشجيع.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2. لقد فهمت بوضوح الغرض من معامل المحاكاة وأهدافها.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>3. وفرت معامل المحاكاة لي معلومات كافية على نحو واضح لكي أتمكن

من إصلاح المشكلة الناجمة عن الوضع.</td></tr>
</table>

4. تم توفير معلومات كافية لي خلال معامل المحاكاة.											
5. الإشارات كانت مناسبة وتم تهيئتها على نحو يعزز فهمي للموضوع											

الدعم											
6. كان يتم عرض الدعم في الوقت المناسب.											
7. كان يتم الاهتمام باحتياجي للمساعدة.											
8. كنت أشعر بأني مدعوم من الكلية خلال معامل المحاكاة.											
9. وبوجه عام، كان أعضاء هيئة التدريس يدعمون عملية التعلم المقدم لي.											
حل المشكلات											
10. كان يتم تسهيل حل المشكلات المستقلة.											
11. كان يتم تشجيعي على أن استكشف كافة الاحتمالات في معامل المحاكاة.											
12. تم تصميم معامل المحاكاة على نحو يناسب المستوى الخاص بي من المعرفة والمهارات.											
13. سمحت معامل المحاكاة لي بفرصة ترتيب أولويات المسعفين من حيث تقييم الحالة وتقديم الرعاية لها.											

14. وفرت معامل المحاكاة لي فرصة تحديد الأهداف لصالح مريضي.											
ملاحظات على الأداء/ الانعكاس الموجه											
15. الملاحظات المقدمة عن الأداء كانت بناءة.											
16. كان يتم عرض الملاحظات على الأداء في الوقت المناسب.											
17. أتاحت معامل المحاكاة لي فرصة تحليل سلوكي الشخصي وتصرفاتي.											
18. تم إتاحة فرصة بعد معامل المحاكاة للحصول على الإرشاد/الملاحظات على الأداء من هيئة التدريس بغية بناء المعرفة اللازمة لمستوى آخر.											
الأمانة (الواقعية)											
19. السيناريو كان مشابها لموقف واقعي من الحياة.											
20. تم تضمين عناصر ومواقف ومتغيرات من الحياة الواقعية في سيناريو المحاكاة.											

Appendix 4: Translated Satisfaction and Self-Confidence in Learning (SSCL)

SA	A	UN	D	SD	الرضا عن التعلم الحالي
5	4	3	2	1	1. طرائق التدريس المستخدمة في هذه المحاكاة كانت مفيدة وفعالة.
5	4	3	2	1	2. وفرت المحاكاة لي تشكيلة متنوعة من المواد والأنشطة التعليمية هدفها تعزيز قدرتي على تعلم المنهج الجراحي الطبي.
5	4	3	2	1	3. لقد استمتعت بطريقة تدريس معلمي للمحاكاة.
5	4	3	2	1	4. مواد التدريس المستخدمة في هذه المحاكاة كانت تحفيزية وساعدتني في أن أتعلم.
5	4	3	2	1	5. كانت الطريقة التي استخدمها المعلم (المعلمين) في تدريس المحاكاة مناسبة للطريقة التي أتعلم بها.
SA	**A**	**UN**	**D**	**SD**	**الثقة الذاتية في اكتساب المعلومات**
5	4	3	2	1	6. أنا واثق أنني مستمر في إتقان محتوى نشاط المحاكاة الذي يقدمه لي معلمي.
5	4	3	2	1	7. أنا واثق من أن هذه المحاكاة نجحت في تغطية الجوانب الحرجة من المحتوى والتي تنطوي على أهمية فيما يخص إتقان منهج الجراحة
5	4	3	2	1	8. أنا واثق من أنني أكتسب ما يلزم من المهارات والمعرفة من هذه المحاكاة لكي أتمكن من تأدية المهام الضرورية في النشاطات السريرية
5	4	3	2	1	9. استخدم معلمي مواردا مفيدة في تدريس المحاكاة
5	4	3	2	1	10. أنا مسؤول بصفتي طالب أن أتعلم كل ما أحتاج إلى معرفته من نشاط المحاكاة هذا.
5	4	3	2	1	11. أنا أعرف كيف أحصل على المساعدة عندما أعجز عن استيعاب المفاهيم التي تغطيها هذه المحاكاة.
5	4	3	2	1	12. أنا أعرف كيف أستخدم أنشطة المحاكاة في تعلم الجوانب الحرجة من هذه المهارات.
5	4	3	2	1	13. إن المعلم هو المسؤول عن إخباري بما أحتاج إليه لكي أتعلم من محتوى نشاط المحاكاة خلال أوقات الدرس.

Appendix 5: Translated Educational Practices Questionnaire (EPQ)

استبيان عن الممارسات التعليمية (نسخة الطالب) (**EPSS-S**)

بغية قياس ما إذا كان قد تم استخدام أفضل الممارسات في المحاكاة التي تستخدمها، نحن نرجو منك استكمال الاستبيان أدناه على النحو الذي تراه. لا توجد إجابات توصف بأنها صواب أو خطأ، المطلوب فقط هو مقدار ما تراه أنت من اتفاق أو اختلاف مع العبارة. يرجى استخدام النظام التالي في الإجابة على الأسئلة.

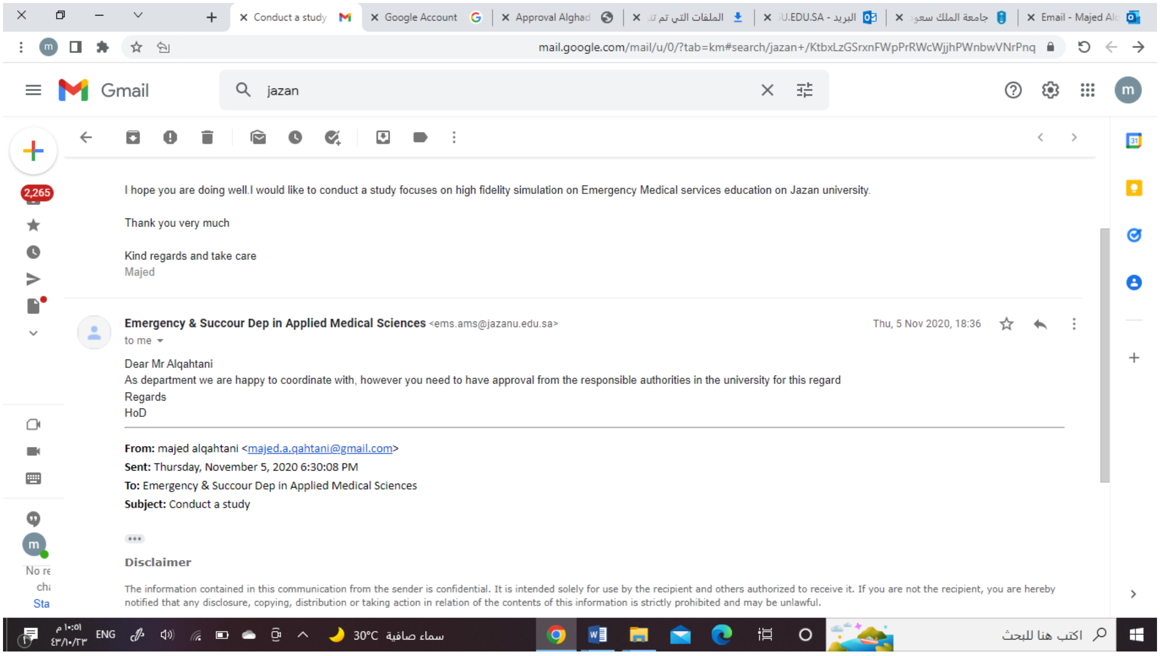
قم بتقييم كل عنصر على أساس مدى أهمية هذا العنصر لك. 1– ليس مهما 2 – مهم إلى حد ما 3- محايد 4– مهم 5 – مهم جدا	استخدم نظام التصنيف التالي عند تقييم الممارسات التعليمية: 1 – أختلف بشدة مع العبارة 2 – أختلف مع العبارة 3 – غير محدد – أنت لا تتفق مع العبارة أو لا تختلف معها 4 – أتفق مع العبارة 5– أتفق بشدة مع العبارة NA – لا تنطبق؛ العبارة لا تنطبق على نشاط المحاكاة الذي تم تنفيذه.

5	4	3	2	1	NA	5	4	3	2	1	العنصر
											التعلم الإيجابي
											1. حصلت على الفرصة خلال أنشطة معامل المحاكاة لمناقشة الأفكار والمفاهيم التي يتم تدريسها في الدورة مع هيئة التدريس والطلاب الآخرين.
											2. شاركت بشكل نشط في جلسة استخلاص المعلومات بعد معامل المحاكاة.
											3. حصلت على فرصتي لكي أفكر بشكل أكبر في تعليقاتي خلال جلسة استخلاص المعلومات.
											4. كان هناك ما يكفي من الفرص خلال معامل المحاكاة لمعرفة ما إذا كنت قد فهمت المادة بوضوح.

5. لقد تعلمت من الملاحظات التي أدلى بها أعضاء هيئة التدريس قبل وخلال وبعد معامل المحاكاة.											
6. تلقيت تلميحات خلال معامل المحاكاة في الوقت المناسب.											
7. حصلت على الفرصة اللازمة لمناقشة أهداف معامل المحاكاة مع أساتذتي.											
8. حصلت على الفرصة اللازمة لمناقشة الأفكار والمفاهيم التي يتولى المدربون تدريسها لي في معامل المحاكاة.											
9. تمكن المدربون من الاستجابة للاحتياجات الفردية للدارسين خلال معامل المحاكاة.											
10. سمح استخدام أنشطة معامل المحاكاة بأن يصبح وقت اكتساب المعلومات الخاص بي أكثر إنتاجية.											
11. كان استخدام أنشطة المحاكاة استخداما مثمرا لوقت الدارسين.											
التعاون											
12. أتيحت لي فرصة العمل مع أقراني خلال معامل المحاكاة.											
13. خلال المحاكاة، كان لزاما أن أعمل أنا وأقراني على المحاكاة السريرية معا.											
طرق التعلم المتنوعة											
14. أتاحت لنا معامل المحاكاة تشكيلة متنوعة من الطرق يمكننا باستخدامها أن ندرس المادة.											
15. أتاحت لنا معامل المحاكاة تشكيلة متنوعة من الطرق يمكننا باستخدامها تقييم التعلم.											

التوقعات الكبيرة											
16. كانت أهداف تجربة معامل المحاكاة واضحة وسهلة الفهم.											
17. قام المدربون بإبلاغنا بالأهداف والتوقعات المطلوب تحقيقها خلال معامل المحاكاة.											

Appendix 6: Gate Keepers Approvals



COLLEGE OF APPLIED MEDICAL SCIENCES
CLINICAL AFFAIRS
3129 ☎ 95189

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11 November 2020

To Whom It May Concern:

Study Title: High Fidelity Simulation in Emergency Medicine Services (EMS) Educati
in Saudi Arabia: Examination of the challenges, implementation and training needs o
faculty and students.

I am writing this letter to certify that Emergency Medical Services, College of Appli
Medical Sciences, King Saud bin Abdulaziz University for Health Sciences is ready
facilitate the data collection of the above-mentioned research.

Best regards.

[redacted]
Associate Dean, Clinical Affairs
Chairman, Emergency Medical Services Department - Riyadh
Assistant Professor, Emergency Medical Services
King Saud bin Abdulaziz University for Health Sciences
Tel. № [redacted]
Email: [redacted]

VISION

رؤيـــة العربيةالسعودية

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المملكة العربية السعودية

KINGDOM OF SAUDI ARABIA جَامِعَةُ أمّ القُرىٰ

Majed Abdullah ALQAHTANI

Centre for Medical Education, School of Medicine, Cardiff University, CF14 4YS

[redacted]

Subject: Approval to conduct a study in Umm AL-Qura University, Department of Emergency Medical Services (EMS).

Study Title: High Fidelity Simulation in Emergency Medicine Services (EMS) Education in Saudi Arabia:

Examination of the challenges, implementation and training needs of faculty and students.

I am writing this letter to certify that Umm AL-Qura University, Department of Emergency Medical

Services (EMS) is ready to facilitate your data collection.

[redacted]

Head of Emergency Medicine Services department.

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جامعة الملك سعود (034)
هاتف 50 92 805 11 966+
فاكس 10 02 806 11 966+

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King Saud University
كلية الأمير سلطان بن عبدالعزيز
äjJlhJld-uhJIUI-old-U

Majed Abdullah ALQAHTANI

Centre for Medical Education, School of Medicine, Cardiff University, CF14 4YS

Email: AlqahtaniMA3@cardiff.ac.uk

Subject: Approval to conduct a study in King Saud University, Prince Sultan bin Abdulaziz

College Of Emergency Medical Services (EMS).

Study Title: Faculty and students perceptions Of High Fidelity Simulation: A study at an Emergency Medical Services school in King Saud University, Saudi Arabia.

I am writing this letter to certify that Prince Sultan bin Abdulaziz College of EMS, King Saud

University is ready to facilitate your data collection.

[redacted]

Prince Sultan bin AbdulazizC

Chairman, Basic Sciences Department

Majed Abdullah ALQAHTANI

Centre for Medical Education, School of Medicine, Cardiff University, CF14 4YS

Email: [redacted]

Subject: Approval to conduct a study in EMS department at Al-Ghad International College for Applied Medical Sciences- Dammam

Study Title: High Fidelity Simulation in Emergency Medicine Services (EMS) Education in Saudi Arabia: Examination of the challenges, implementation and training needs of faculty and students.

I am writing this letter to certify that EMS department at Al-Ghad International College for Applied Medical Sciences- Dammam is ready to facilitate your data collection.

[redacted]

Head of EMS Dept.

وزارة التعليم
Ministry of Education
043

جامعة الإمام عبدالرحمن بن فيصل
IMAM ABDULRAHMAN BIN FAISAL UNIVERSITY

المملكة العربية السعودية
Kingdom of Saudi Arabia

Deanship of Scientific Research | عمادة البحث العلمي

To whom it may concern,

We would like to inform you that the Deanship of Scientific Research at Imam Abdulrahman bin Faisal University has no objection to conduct a questionnaire on faculty members and students at the university to collect data for a scientific study entitled “Simulation in Emergency Medicine Services (EMS) Education in Saudi Arabia :Examination of the challenges, implementation and training needs of faculty and students ", by Majed Abdullah Alqahtani. It was approved by IAU's SCRELC (Institutional Review Board) to publish the questionnaire.

NOTE: This letter was written upon the request of the researcher.

Best Regards,,

Dean of Scientific Research

[redacted]

جامعة الإمام عبدالرحمن بن فيصل
IMAM ABDULRAHMAN BIN FAISAL UNIVERSITY
043 1 33 105

Al-Ghad International Medical Science Colleges

كليات الغد الدولية للعلوم الصحية

Under Supervision of
Ministry of Education
Al-Madinah

تحت إشراف
وزارة التعليم
المدينة المنورة

25-Oct.-2021

To: Majed Abdullah ALQAHTANI
Centre for Medical Education, School of Medicine, Cardiff University, CF14 4YS
Email: AlqahtaniMA3@cardiff.ac.uk

Dear Mr. Majed,

RE: High Fidelity Simulation in Emergency Medicine Services (EMS) Education in Saudi Arabia: Examination of the challenges, implementation and training needs of faculty and students.

I am pleased to provide you with our permission to conduct the above mentioned study in the department of Emergency Medical Services (EMS) at our College in Medina. We are happy to facilitate your data collection process through the dissemination of your questionnaire links.

I wish you success in your studies

Regards

[redacted]

Head; Scientific Research Unit

Alghad International Colleges for Applied Medical Sciences / Medina

Majed Abdullah ALQAHTANI

Centre for Medical Education, School of Medicine, Cardiff University, CF14 4YS

Email: [redacted]

Subject: Approval to conduct a study in Alghad International Colleges for Medical Sciences...

Study Title: High Fidelity Simulation in Emergency Medicine Services (EMS) Education in Saudi Arabia: Examination of the challenges, implementation and training needs of faculty and students.

I am writing this letter to certify that Alghad International Colleges for Medical Sciences is ready to facilitate your data collection.

[redacted]

Dean of Tabuk branch, Alghad International Colleges for Medical Sciences.

اوافق

[redacted]

Al-Ghad International Medical Science Colleges

كليات الغد الدولية للعلوم الصحية

Under Supervision of
Ministry of Education
Al-Madinah

تحت إشراف
وزارة التعليم
المدينة المنورة

25-Oct.-2021

To: Majed Abdullah ALQAHTANI
Centre for Medical Education, School of Medicine, Cardiff University, CF14 4YS
Email: AlqahtaniMA3@cardiff.ac.uk

Dear Mr. Majed,

RE: High Fidelity Simulation in Emergency Medicine Services (EMS) Education in Saudi Arabia: Examination of the challenges, implementation and training needs of faculty and students.

I am pleased to provide you with our permission to conduct the above mentioned study in the department of Emergency Medical Services (EMS) at our College in Medina. We are happy to facilitate your data collection process through the dissemination of your questionnaire links.

I wish you success in your studies

Regards

[redacted]

Head; [redacted]ch Unit

Alghad International Colleges for Applied Medical Sciences / Medina

Appendix 7: Consent Form (Study 1)

PARTICIPANT INFORMATION SHEET & CONSENT FORM

Study title:

Faculty and students' perceptions of High Fidelity Simulation: A study at Emergency Medical Services school in King Saud University, Saudi Arabia.

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish.

My name is Majed Alqahtani, a postgraduate research student in medical education and a staff member in the Medical Education Department at King Saud University. I am conducting research to examine faculty and students perceptions in terms of preparation and barriers for implementing high fidelity simulation at College of Emergency Medical Services at King Saud University. This is part of my PhD study, which is also beneficial for our college's Medical Education Department.

Please do not hesitate to ask me if there is anything that is not clear or if you would like more information.

This study will examine faculty and students perceptions in terms of preparation and barriers for implementing high fidelity simulation characteristics. The findings are aimed to help our college's Medical Education Department.

You have been chosen because you are a faculty or student at prince sultan college for emergency medical services , which is the area of my research. I believe that your participation will help us to gain better understanding of HFS setting.

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form.

- If you decide to take part, **you are still free to withdraw at any time and without giving a reason**.
- If you decide to take part in this research, Participation will involve the completion of an on-line **anonymous questionnaire** and you will be asked to provide consent to take part, and after doing this you will be able to complete the questionnaire that should take no more than 10 minutes of your time to complete .

- There will be also a 30 to 45-minute **face to face** interview with questions related to your experience in HFS setting
- I want to inform you that the interview will be audiotaped and anonymised transcript produced as it is crucial for analysis.

Regarding the confidentiality

- Please be assured that the data will be **confidential**, your **name will not be identified,** and the audiotape of the interviews will be deleted and the anonymised transcripts used in the analysis.

- All results will be presented as aggregated themes and anonymised quotations.

- The data will be kept at Cardiff University for no longer than five years. In addition, there will be no discussing the issues that arise from the interviews with others in a way that might identify individuals, and the data will not use for any other purposes.

After deciding to take part in this study, there is a consent form you need to sign. Then, I will interview you, at a time convenient for you, by asking questions that explore your experience in high fidelity simulation.

A summary report of the themes will be available on request in August 2020. The results will also be made available to our College in order to help inform the best ways we can support faculty and student students. I would like to reassure you that if the study published or presented you will not be identified.

The research is conducted under the supervision of Dr Michal Tombs , Senior Lecturer in Medical Education, ,Postgraduate Medical and Dental Education , Cardiff University (email [redacted]) .

Contact for Further Information

For further information, please contact me via

Email: [redacted]

[redacted] Version:1

Title of Project:

Faculty and students perceptions in terms of preparations and barriers for implementing high fidelity simulation at King Saud emergency medical services college, Saudi Arabia.

Name of Researcher: Majed Abdullah R Alqahtani

Please initial box

1. I confirm that I have read and understand the information sheet

☐ (Version 1) for the above study and have had the opportunity to ask questions.

2. I understand that my participation is voluntary and that I am free to withdraw at any time, ☐ without giving any reason.

4. I agree to take part in the above study. ☐

Name of Participant	Date	Signature
Name of Person taking consent	Date	Signature
(if different from researcher)		
Researcher		Signature
Majed Alqahtani		Majed Alqahtani

Version: 1

Appendix 8: Consent Form (Study 2)

CONSENT FORM

Title of research project: High Fidelity Simulation in Emergency Medicine Services (EMS) Education in Saudi Arabia: Examination of the challenges, implementation and training needs of faculty and students.

SREC reference and committee:

Name of Chief/Principal Investigator:

Please initial box

I confirm that I have read the information sheet for the above research project.	
I confirm that I have understood the information sheet for the above research project and that I have had the opportunity to ask questions and that these have been answered satisfactorily.	
I understand that my participation is voluntary and I am free to withdraw at any time without giving a reason and without any adverse consequences (e.g. to medical care or legal rights, if relevant) up until the point that data are anonymised.	
I understand that data collected during the research project may be looked at by individuals from Cardiff University or from regulatory authorities, where it is relevant to my taking part in the research project. I give permission for these individuals to have access to my data.	
I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be held in accordance with all applicable data protection legislation and in strict confidence, unless disclosure is required by law or professional obligation.	
I understand who will have access to personal information provided, how the data will be stored and what will happen to the data at the end of the research project.	

I consent to being audio recorded/ video recorded/ having my photograph taken for the purposes of the research project and I understand how it will be used in the research.	
I understand that anonymised excerpts and/or verbatim quotes from my interview and questionnaire may be used as part of the research publication.	
I understand how the findings and results of the research project will be written up and published.	
I agree to take part in this research project.	

_____________ ____________________ __________________________

Name of participant (print) Date Signature

Majed Alqahtani____________ _______ __________________________

Name of person taking consent (print) Date Signature

_________PhD Research Student_________________

Role of person taking consent

(print)

THANK YOU FOR PARTICIPATING IN OUR RESEARCH

Appendix 9: Consent Form (Study 3)

CONSENT FORM

Title of research project: The Development of an Arabic version of the Simulation Design Scale, Educational Practices Questionnaire, and Satisfaction and Self-Confidence in Learning Scale

SREC reference and committee:

Name of Chief/Principal Investigator:

	Please initial box
I confirm that I have read the information sheet for the above research project.	
I confirm that I have understood the information sheet for the above research project and that I have had the opportunity to ask questions and that these have been answered satisfactorily.	
I understand that my participation is voluntary and I am free to withdraw at any time without giving a reason and without any adverse consequences (e.g. to medical care or legal rights, if relevant) up until the point that data are anonymised.	
I understand that data collected during the research project may be looked at by individuals from Cardiff University or from regulatory authorities, where it is relevant to my taking part in the research project. I give permission for these individuals to have access to my data.	
I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be held in accordance with all applicable data protection legislation and in strict confidence, unless disclosure is required by law or professional obligation.	
I understand who will have access to personal information provided, how the data will be stored and what will happen to the data at the end of the research project.	

I consent to being audio recorded/ video recorded/ having my photograph taken for the purposes of the research project and I understand how it will be used in the research.	
I understand that anonymised excerpts and/or verbatim quotes from my interview and questionnaire may be used as part of the research publication.	
I understand how the findings and results of the research project will be written up and published.	
I agree to take part in this research project.	

Majed Alqahtani ____________ _______ __________________________

Name of person taking consent (print) Date Signature

_________PhD Research Student________________

Role of person taking consent

(print)

THANK YOU FOR PARTICIPATING IN OUR RESEARCH

Appendix 10: Cardiff University Ethics (Study 1)

School of Medicine
Yr Ysgol Meddygaeth

Cardiff University Main Building
Heath Park
Cardiff CF14 4XN Wales, UK
Prifysgol Caerdydd
Prif Adeilad
Parc y Mynydd Bychan
Caerdydd CF14 4XN
Cymru, Y Deyrnas Unedig

Monday 3rd February 2020

Majed Alqahtani,

MSc Medical Education,
Postgraduate Taught Studies,

Centre for Medical Education, School of Medicine Cardiff University.

Dear Majed

Re: Faculty and students' perceptions of High Fidelity Simulation: A study at Emergency Medical Services school in King Saud University, Saudi Arabia.

SMREC Reference Number: 20/17

This application was reviewed by the Committee in January 2020.

Ethical Opinion

On review, I can confirm that ethical approval is granted for this study on the condition that appropriate local ethical or gatekeeper approval is also in place. Also, please ensure that your Cardiff University email address is used for all correspondence related to the study.

Please provide the Committee Secretary, Mrs Claire Evans, written confirmation of local approval via email.

Conditions of Approval

The Committee must be notified of any proposed amendments to the methodology and protocols outlined in your submission. Also, any serious or unexpected adverse reactions that may arise during the course of the study must be reported to the Committee. As a condition of this approval, the Committee retains the right to audit and review the study for our own records.

Documents Considered

Document Type:	Version:	Date Considered:
Application	09/01/2020	January 2020
Project Proposal	No Date or Version	January 2020

Appendix 1: Email from King Saud University	30/12/2019	January 2020
Appendix 2: Simulation Design Scale	No Date or Version	January 2020
Appendix 3: Educational Practices Questionnaire	No Date or Version	January 2020
Appendix 4: Simulation Design Scale (Teacher)	No Date or Version	January 2020
Appendix 5: Education Practices Questionnaire (Teacher)	No Date or Version	January 2020
Appendix 6: Interview Schedule (Faculty)	No Date or Version	January 2020
Appendix 7: Interview Schedule (students)	No Date or Version	January 2020
Appendix 8: Participant Information Sheet	V1	January 2020
Appendix 9: Consent Form	V1	January 2020
Appendix 10: Project Timeline	No Date or Version	January 2020

With best wishes for the success of your study.

[redacted]

[redacted]

[redacted]

Appendix 11: Cardiff University Ethics (Study 2)

School of Medicine
Yr Ysgol Meddygaeth

Cardiff University Main Building
Heath Park
Cardiff CF14 4XN Wales, UK
Prifysgol Caerdydd

Dear Majed

Research project title: High Fidelity Simulation in Emergency Medicine Services (EMS) Education in Saudi Arabia: Examination of the challenges, implementation and training needs of faculty and students.
SREC reference: SMREC 20/13

The School of Medicine Research Ethics Committee ('Committee') reviewed the above application electronically on Wednesday 20th January 2021. A revised application was considered on Thursday 11th February 2021 and Monday 15th February 2021.

Ethical Opinion

The Committee gave a favourable ethical opinion of the above application on the basis described in the application form, protocol and supporting documentation.

Additional approvals

This letter provides an ethical opinion only. You must not start your research project until all appropriate approvals are in place.

Amendments

Any substantial amendments to documents previously reviewed by the Committee must be submitted to the Committee via email to Claire Evans (EvansCR9@cardiff.ac.uk) for consideration and cannot be implemented until the Committee has confirmed it is satisfied with the proposed amendments.

You are permitted to implement non-substantial amendments to the documents previously reviewed by the Committee but you must provide a copy of any updated documents to the Committee via email to Claire Evans (EvansCR9@cardiff.ac.uk) for its records.

Monitoring requirements

The Committee must be informed of any unexpected ethical issues or unexpected adverse events that arise during the research project. In addition to this, the Committee request an end of project report sent to the Committee via email to Claire Evans (EvansCR9@cardiff.ac.uk). This must be sent along with confirmation that your research project has ended and sent within the three months of the research project completion.

Documents reviewed by Committee

The documents reviewed by the Committee were:

Document Version Date
Application Form - -
Appendix 1: Approval Emails and Letters - -
Appendix 2: Teacher Survey (with invitation to interview) - -
Appendix 3: Student survey - -
Appendix 5: Interview Schedule (faculty) - -
Appendix 7: Interview Schedule (students) - -
Appendix 8: Interview Schedule (lab technicians) - -
Appendix 9: Interview Schedule (Directors, deans, head of departments) - -
Appendix 9: Participant Information Sheet (Interview & Online Questionnaire) - -
Appendix 10: Consent Form V1 -
Appendix 11: Timescale - - References - -

Documents (continued)

Application Form - -
Appendix 1: Approval Emails and Letters - -
Appendix 2: Teacher Survey (with invitation to interview) - -
Appendix 3: Student survey - -
Appendix 5: Interview Schedule (faculty) - -
Appendix 7: Interview Schedule (students) - -
Appendix 8: Interview Schedule (lab technicians) - -
Appendix 9: Interview Schedule (Directors, deans, head of departments) - -
Appendix 9: Participant Information Sheet (Interview & Online Questionnaire) - -
Appendix 10: Consent Form - -
Appendix 11: Timescale - -
References - -
Application Form - -
Appendix 1: Approval Emails and Letters - -
Appendix 2: Teacher Survey (with invitation to interview) - -
Appendix 3: Student survey - -
Appendix 5: Interview Schedule (faculty) - -
Appendix 7: Interview Schedule (students) - -
Appendix 8: Interview Schedule (lab technicians) - -
Appendix 9: Interview Schedule (Directors, deans, head of departments) - -
Appendix 9: Participant Information Sheet (Interview & Online Questionnaire) - -
Appendix 10: Consent Form - -
Appendix 11: Timescale - -
References - -

Complaints/Appeals

If you are dissatisfied with the decision made by the Committee, please contact the Chair of the Committee via the Committee Secretary (EvansCR9@cardiff.ac.uk) in the first instance to discuss your complaint. If this discussion does not resolve the issue, you are entitled to refer the matter to the Head of School for further consideration. The Head of School may refer the matter to the University Research Integrity and Ethics Committee (URIEC), where this is appropriate. Please be advised that URIEC will not normally interfere with a decision of the Committee and is concerned only with the general principles of natural justice, reasonableness and fairness of the decision.

Please use the Committee reference number on all future correspondence.

The Committee reminds you that it is your responsibility to conduct your research project to the highest ethical standards and to keep all ethical issues arising from your research project under regular review.

You are expected to comply with Cardiff University's policies, procedures and guidance at all times, including, but not limited to, its Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data and our Research Integrity and Governance Code of Practice.

Yours sincerely,

[redacted]

[redacted]
Chair, School of Medicine Research Ethics Committee

Cc Dr Michal Tombs

Appendix 12: Cardiff University Ethics (Study 3)

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

School of Medicine
Yr Ysgol Meddygaeth

Majed Alqahtani

Centre for Medical Education

School of Medicine

Cardiff University

Dear Majed

Research project title: The development of an Arabic version evaluation tool of Simulated Based Learning in

Emergency Medicine Services (EMS) Education

SREC reference: SMREC 22/42

The School of Medicine Research Ethics Committee ('Committee') reviewed the above application at the meeting held on Wednesday 18th May 2022.

Ethical Opinion

The Committee gave a favourable ethical opinion of the above application on the basis described in the application form, protocol and supporting documentation, **subject to the conditions** specified below.

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the research project.

1. Please revise the Consent Form so that participants are asked to tick, and not initial their consent, and remove the request for the participant's name and signature if the survey is to be undertaken anonymously.
2. Revise the recruitment mechanism as outlined in Q5.1 as the Committee agreed that it would be best practice for the Universities administrative teams to email their faculty and students on your behalf rather than releasing all the email addresses to you directly.

Whilst the Committee does not propose to conduct a further review of your application/revised research project documents following implementation of the conditions above, you should notify the Committee once all conditions have been met and provide copies of any revised documentation with updated version numbers before the research commences.

Additional approvals

This letter provides an ethical opinion only. You must not start your research project until all appropriate approvals are in place.

Amendments

Any substantial amendments to documents previously reviewed by the Committee must be submitted to the Committee via email to Claire Evans (EvansCR9@cardiff.ac.uk) for consideration and cannot be implemented until the Committee has confirmed it is satisfied with the proposed amendments.

You are permitted to implement non-substantial amendments to the documents previously reviewed by the Committee but you must provide a copy of any updated documents to the Committee via email to Claire Evans (EvansCR9@cardiff.ac.uk) for its records.

Monitoring requirements

The Committee must be informed of any unexpected ethical issues or unexpected adverse events that arise during the research project. In addition to this, the Committee request an end of project report sent to the Committee via email to Claire Evans (EvansCR9@cardiff.ac.uk). This must be sent along with confirmation that your research project has ended and sent within the three months of the research project completion.

Documents reviewed by Committee

The documents reviewed by the Committee were:

Document	Version	Date
Application	-	-
Permissions letter from King Saud University	-	-

Complaints/Appeals

If you are dissatisfied with the decision made by the Committee, please contact the Chair of the Committee via the Committee Secretary (EvansCR9@cardiff.ac.uk) in the first instance to discuss your complaint. If this discussion does not resolve the issue, you are entitled to refer the matter to the Head of School for further consideration. The Head of School may refer the matter to the University Research Integrity and Ethics Committee (URIEC), where this is appropriate. Please be advised that URIEC will not normally interfere with a decision of the Committee and is concerned only with the general principles of natural justice, reasonableness and fairness of the decision.

Please use the Committee reference number on all future correspondence.

The Committee reminds you that it is your responsibility to conduct your research project to the highest ethical standards and to keep all ethical issues arising from your research project under regular review.

You are expected to comply with Cardiff University's policies, procedures and guidance at all times, including, but not limited to, its Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data and our Research Integrity and Governance Code of Practice.

Yours sincerely,

[redacted]

Appendix 13: Interview guide for faculty

Demographics (will be kept separate)

Introductory statement:

The interview will be divided into four main parts, the focus of which is on preparation of faculty and readiness to teach in HFS settings. In each part, I will ask you to reflect on your clinical teaching.

At this stage, I wish to turn the tape on for recording. The recording will be transcribed. I want to assure you again that the recording will be confidential.

Recorder on

Can you please tell me how long you have worked as a tutor in undergraduate EMS education?

What is your highest degree earned?

Can you please tell me about your previous experience of teaching when you used simulation? What were the modules or courses? (e.g. EMT, Peds, etc.)

How long have you been using simulations as a teaching tool with ems students?

CIPP (Input and Process)	Questions
Part 1: Input evaluation (HFS readiness and preparation)	Reflecting back to when you started using simulation in your teaching, how prepared did you feel for the role?

	What did you do in order to prepare yourself for the implementation of simulation in your teaching? What did faculty do in order to help you prepare for implementing simulation in your teaching? Reflecting on your experiences, is there anything that you could have done to ensure you were better prepared? Is there anything faculty could have done to help you feel better prepared for your role as a teacher in simulated settings? How do you prepare for a simulation session with your students? What information is important for you to provide to students before they begin a simulation experience? What steps or processes do you think about when you implement simulation with students? How do you orient and prepare students for the simulation experience?
Part 2: Process evaluation (Implementations of plan and objectives)	Reflecting back to your experience of teaching in simulated settings, can you think of times where you have come across situations that were particularly challenging? Please give as many examples as possible:

	What happened? Who was involved (without naming names)? What were the consequences for you as a teacher? What were the consequences for your learners? Is there anything that you or faculty could do to ensure these are addressed and to overcome such challenges?

Appendix 14: Interview guide for student

Demographics (will be kept separate)

Introductory statement:

The interview will be divided into four main parts, the focus of which is on preparation of faculty and readiness to teach in HFS settings. In each part, I will ask you to reflect on your clinical teaching.

At this stage, I wish to turn the tape on for recording. The recording will be transcribed. I want to assure you again that the recording will be confidential.

Recorder on

Can you please tell me how long you have worked as a tutor in undergraduate EMS education?

What is your highest degree earned?

Can you please tell me about your previous experience of teaching when you used simulation? What were the modules or courses? (e.g. EMT, Peds, etc.)

How long have you been using simulations as a teaching tool with ems students?

CIPP (Input and Process)	Questions
Part 1: Input evaluation (HFS readiness and preparation)	Reflecting back to when you started using simulation in your teaching, how prepared did you feel for the role?

	What did you do in order to prepare yourself for the implementation of simulation in your teaching? What did faculty do in order to help you prepare for implementing simulation in your teaching? Reflecting on your experiences, is there anything that you could have done to ensure you were better prepared? Is there anything faculty could have done to help you feel better prepared for your role as a teacher in simulated settings? How do you prepare for a simulation session with your students? What information is important for you to provide to students before they begin a simulation experience? What steps or processes do you think about when you implement simulation with students? How do you orient and prepare students for the simulation experience?
Part 2: Process evaluation (Implementations of plan and objectives)	Reflecting back to your experience of teaching in simulated settings, can you think of times where you have come across situations that were particularly challenging? Please give as many examples as possible:

	What happened? Who was involved (without naming names)? What were the consequences for you as a teacher? What were the consequences for your learners? Is there anything that you or faculty could do to ensure these are addressed and to overcome such challenges?

Appendix 15: Demographics for faculty (study 1)

In which types of courses have you used simulations? (e.g. OB, Peds, etc.)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	airway,trauma	1	3.1	3.1	3.1
	cardio,mental,critical thinking	1	3.1	3.1	6.3
	clinical decision,medical emergencies	1	3.1	3.1	9.4
	critical care	1	3.1	3.1	12.5
	critical care,emt,medicsl,trauma,peds	1	3.1	3.1	15.6
	ems,trauma	1	3.1	3.1	18.8
	emt	1	3.1	3.1	21.9
	emt ,airway,peds,patient assessment	1	3.1	3.1	25.0
	emt,cardio,peds,critical care	1	3.1	3.1	28.1
	emt,cardiology	1	3.1	3.1	31.3
	emt,cardiology,critical care	1	3.1	3.1	34.4
	emt,critical care	1	3.1	3.1	37.5
	emt,critical care,pharma	1	3.1	3.1	40.6
	emt,medical	1	3.1	3.1	43.8
	emt,patient assessment,pharma,medical	1	3.1	3.1	46.9
	emt,peds,airway	1	3.1	3.1	50.0
	emt,peds,cardio,trauma	1	3.1	3.1	53.1
	emt,pharma,cardio,medicaltrauma	1	3.1	3.1	56.3
	emt,trauma	1	3.1	3.1	59.4
	many courses	1	3.1	3.1	62.5
	medical,cardio,patient assessment	1	3.1	3.1	65.6
	medical,cardio,peds,mental health	1	3.1	3.1	68.8
	medical,emt,cardio,critical care	1	3.1	3.1	71.9
	medical,pharma	1	3.1	3.1	75.0

	medical,pharma,trauma,emt	1	3.1	3.1	78.1
	peds,cardio,medical	1	3.1	3.1	81.3
	peds,critical care	1	3.1	3.1	84.4
	pharm,medical,trauma,cardiology	1	3.1	3.1	87.5
	pharma,cardiolology,emt	1	3.1	3.1	90.6
	trauma,airway	1	3.1	3.1	93.8
	trauma,emt,obstetrics,patient assessment	1	3.1	3.1	96.9
	trauma,medical,	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

How many high-fidelity human patient simulation experiences (with SimMan or a similar manikin) have you been involved in during your emergency medical services education?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	9.4	9.4	9.4
	2	7	21.9	21.9	31.3
	3	5	15.6	15.6	46.9
	4	4	12.5	12.5	59.4
	5	7	21.9	21.9	81.3
	9	2	6.3	6.3	87.5
	11	2	6.3	6.3	93.8
	13	1	3.1	3.1	96.9
	15	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

Age?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	3.1	3.1	3.1
	2	6	18.8	18.8	21.9
	3	5	15.6	15.6	37.5
	4	5	15.6	15.6	53.1
	5	7	21.9	21.9	75.0
	6	1	3.1	3.1	78.1

	7	1	3.1	3.1	81.3
	9	2	6.3	6.3	87.5
	10	1	3.1	3.1	90.6
	12	1	3.1	3.1	93.8
	13	1	3.1	3.1	96.9
	15	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

Appendix 16: Demographics for students (Study 1)

What year of study are you currently at?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	14	24.6	24.6	24.6
	2	22	38.6	38.6	63.2
	3	12	21.1	21.1	84.2
	4	9	15.8	15.8	100.0
	Total	57	100.0	100.0	

In which types of courses have you used simulations? (e.g. OB, Peds, etc.)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		9	15.8	15.8	15.8
	airway,cardio,medical,trauma	1	1.8	1.8	17.5
	airway,patient assessment	1	1.8	1.8	19.3
	airway,patient assessment,pharma	1	1.8	1.8	21.1
	all the courses	2	3.5	3.5	24.6
	cardi,medical,trauma,ob,pharma,pt assessment,	1	1.8	1.8	26.3
	cardio,trauma	1	1.8	1.8	28.1
	cardio,trauma,critical care,pharma	1	1.8	1.8	29.8
	emt	1	1.8	1.8	31.6
	emt ,patient assessment,pharma	1	1.8	1.8	33.3
	EMT,AIRQAY	1	1.8	1.8	35.1
	emt,airway,medical,trauma	1	1.8	1.8	36.8
	emt,airway,patient assessment	2	3.5	3.5	40.4
	emt,airway,pharma,cardio,trauma,medical,critical care	1	1.8	1.8	42.1
	emt,airway,pharma,medicaltrauma	1	1.8	1.8	43.9

	emt,cadio,medical,trauma,pharma	1	1.8	1.8	45.6
	emt,iv,intubation	1	1.8	1.8	47.4
	emt,pa	1	1.8	1.8	49.1
	emt,patient assessment	2	3.5	3.5	52.6
	emt,trauma,medical,pharma	1	1.8	1.8	54.4
	iv,trauma	1	1.8	1.8	56.1
	many courses	3	5.3	5.3	61.4
	many courses such as critical care,ob,emt,cardio	1	1.8	1.8	63.2
	many of the modules	1	1.8	1.8	64.9
	many things such as intubation,delivery	1	1.8	1.8	66.7
	medical,emt,airway,pharma	1	1.8	1.8	68.4
	medical,trauma,critical care,critical thinkinf	1	1.8	1.8	70.2
	medical,trauma,iv	1	1.8	1.8	71.9
	medical,trauma,pharma	2	3.5	3.5	75.4
	medical,trauma,pharma,iv,ob	1	1.8	1.8	77.2
	most of the courses	4	7.0	7.0	84.2
	most of the subjects	1	1.8	1.8	86.0
	ob,iv,intubation,patient assessment	1	1.8	1.8	87.7
	patient assesment,trauma ,cardio,med	1	1.8	1.8	89.5
	patient assessment,ob,pharma,iv	1	1.8	1.8	91.2
	patient assessment,pharma,cadio,medical,trauma,critical thin	1	1.8	1.8	93.0
	peds	1	1.8	1.8	94.7
	pharma,airway,patient assessment	1	1.8	1.8	96.5
	PULMONARY,EMT,CARDIO	1	1.8	1.8	98.2
	trauma,critical thinkining	1	1.8	1.8	100.0
	Total	57	100.0	100.0	

How many high-fidelity human patient simulation experiences (with SimMan or a similar manikin) have you been involved in during your emergency medical services education?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	1.8	2.0	2.0
	3	2	3.5	4.1	6.1
	4	4	7.0	8.2	14.3
	5	1	1.8	2.0	16.3
	10	1	1.8	2.0	18.4
	30	1	1.8	2.0	20.4
	50	1	1.8	2.0	22.4
	60	1	1.8	2.0	24.5
	70	27	47.4	55.1	79.6
	80	1	1.8	2.0	81.6
	100	9	15.8	18.4	100.0
	Total	49	86.0	100.0	
Missing	System	8	14.0		
Total		57	100.0		

Age?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	19	1	1.8	1.8	1.8
	20	7	12.3	12.3	14.0
	21	11	19.3	19.3	33.3
	22	10	17.5	17.5	50.9
	23	17	29.8	29.8	80.7
	24	4	7.0	7.0	87.7
	25	4	7.0	7.0	94.7
	26	3	5.3	5.3	100.0
	Total	57	100.0	100.0	

Appendix 17: Missing values for study 1

Warnings

There are no missing values. MPATTERN is not produced.
There are no missing values. TPATTERN is not produced.

Univariate Statistics

	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
SDSPO	89	3.6337	.57514	0	.0	4	0
SDSIO	89	4.1938	.49988	0	.0	2	0
EPQPO	89	3.8387	.56362	0	.0	3	0
EPQIO	89	4.1890	.45053	0	.0	2	4

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

Appendix 18: Test for normality (study 1)

One-Sample Kolmogorov-Smirnov Test

			SDSPO	SDSIO	EPQPO	EPQIO
N			89	89	89	89
Normal Parameters[a,b]	Mean		3.6337	4.1938	3.8387	4.1890
	Std. Deviation		.57514	.49988	.56362	.45053
Most Extreme Differences	Absolute		.095	.122	.092	.148
	Positive		.056	.079	.073	.137
	Negative		-.095-	-.122-	-.092-	-.148-
Test Statistic			.095	.122	.092	.148
Asymp. Sig. (2-tailed)[c]			.046	.002	.058	<.001
Monte Carlo Sig. (2-tailed)[d]	Sig.		.044	.002	.057	.000
	99% Confidence Interval	Lower Bound	.038	.001	.051	.000
		Upper Bound	.049	.004	.063	.000

Appendix 19: Cronbach alpha for SDS (PO), SDS (IO), EPQ (PO) and EPQ (IO) (study 1)

Case Processing Summary

		N	%
Cases	Valid	57	100.0
	Excluded[a]	0	.0
	Total	57	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.769	20

Case Processing Summary

		N	%
Cases	Valid	57	100.0
	Excluded[a]	0	.0
	Total	57	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.869	20

Case Processing Summary

		N	%
Cases	Valid	57	100.0
	Excluded[a]	0	.0
	Total	57	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.885	17

Case Processing Summary

		N	%
Cases	Valid	57	100.0
	Excluded[a]	0	.0
	Total	57	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.707	17

Case Processing Summary

		N	%
Cases	Valid	32	100.0
	Excluded[a]	0	.0
	Total	32	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.750	20

Case Processing Summary

		N	%
Cases	Valid	32	100.0
	Excluded[a]	0	.0
	Total	32	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.876	20

Case Processing Summary

		N	%
Cases	Valid	32	100.0
	Excluded[a]	0	.0
	Total	32	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.808	17

Case Processing Summary

		N	%
Cases	Valid	32	100.0
	Excluded[a]	0	.0
	Total	32	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.856	17

Appendix 20: Exploratory factor analysis for SDS (study 1)

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.623
Bartlett's Test of Sphericity	Approx. Chi-Square	549.162
	df	190
	Sig.	<.001

Communalities

	Initial	Extraction
Q1 OI1	1.000	.565
Q2 OI2	1.000	.824
Q3 OI3	1.000	.660
Q4 OI4	1.000	.636
Q5 OI5	1.000	.532
Q7 S1	1.000	.563
Q8 S2	1.000	.483
Q9 S3	1.000	.616
Q10 S4	1.000	.538
Q11 PS1	1.000	.584
Q12 PS2	1.000	.650
Q13 PS3	1.000	.630
Q14 PS4	1.000	.598
Q15 PS5	1.000	.585
Q16 F1	1.000	.734
Q17 F2	1.000	.629
Q18 F3	1.000	.848
Q19 F4	1.000	.622
Q20 R1	1.000	.663
Q21 R2	1.000	.594

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.081	20.406	20.406	4.081	20.406	20.406	2.821	14.106	14.106
2	2.411	12.056	32.462	2.411	12.056	32.462	2.285	11.425	25.531
3	1.872	9.359	41.821	1.872	9.359	41.821	2.117	10.586	36.118
4	1.634	8.171	49.992	1.634	8.171	49.992	2.080	10.398	46.516
5	1.346	6.728	56.721	1.346	6.728	56.721	1.642	8.208	54.723
6	1.211	6.053	62.773	1.211	6.053	62.773	1.610	8.050	62.773
7	.981	4.905	67.678						
8	.942	4.709	72.387						
9	.814	4.070	76.457						
10	.740	3.700	80.157						
11	.632	3.161	83.318						
12	.570	2.848	86.166						
13	.514	2.569	88.735						
14	.501	2.504	91.239						
15	.431	2.153	93.391						
16	.367	1.835	95.226						
17	.327	1.637	96.863						
18	.255	1.275	98.138						
19	.231	1.154	99.292						
20	.142	.708	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component					
	1	2	3	4	5	6
Q41 OI4	.831	.101		.226	.210	-.129-
Q40 OI3	.802		.194			.300
Q38 OI1	.699	.238	.116			.351
Q45 S3	.578	.187	.103	.409	.171	-.269-
Q55 F4	.473	.473	.276		.132	
Q43 S1	.437	.387	.209	.398	.217	-.231-
Q44 S2		.858			.102	.265
Q46 S4		.805		.147	.174	
Q66 R2	.278	.666	.350	.170		-.137-
Q56 R1	.460	.594		.185	-.136-	
Q51 PS5	.104	-.195-	.766			.138
Q50 PS4	.150		.760	.122	.116	
Q48 PS2	-.242-	.287	.597		.518	.203
Q47 PS 1	.198	.191	.581	.155	-.352-	.118
Q53 F2	.166	.148		.831		
Q52 F1	.143	.119		.775	.148	.164
Q54 F3	.123	.164	.444	.510		.186
Q39 OI2	.335	.154			.783	
Q49 PS3	.108	.135	.350	.181		.708
Q42 OI5		.442	-.209-	.192	.382	.491

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 11 iterations.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.783
Bartlett's Test of Sphericity	Approx. Chi-Square	772.904
	df	190
	Sig.	<.001

Communalities

	Initial	Extraction
Q38 OI1	1.000	.697
Q39 OI2	1.000	.764
Q40 OI3	1.000	.779
Q41 OI4	1.000	.812
Q42 OI5	1.000	.672
Q43 S1	1.000	.643
Q44 S2	1.000	.826
Q45 S3	1.000	.649
Q46 S4	1.000	.718
Q47 PS 1	1.000	.575
Q48 PS2	1.000	.808
Q49 PS3	1.000	.692
Q50 PS4	1.000	.638
Q51 PS5	1.000	.660
Q52 F1	1.000	.693
Q53 F2	1.000	.748
Q54 F3	1.000	.534
Q55 F4	1.000	.554
Q56 R1	1.000	.628
Q66 R2	1.000	.692

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.284	31.419	31.419	6.284	31.419	31.419	3.192	15.961	15.961
2	2.233	11.166	42.585	2.233	11.166	42.585	3.116	15.580	31.541
3	1.844	9.219	51.803	1.844	9.219	51.803	2.556	12.779	44.320
4	1.235	6.176	57.980	1.235	6.176	57.980	2.158	10.788	55.108
5	1.172	5.862	63.842	1.172	5.862	63.842	1.408	7.042	62.150
6	1.015	5.075	68.916	1.015	5.075	68.916	1.353	6.766	68.916
7	.874	4.368	73.284						
8	.702	3.512	76.796						
9	.693	3.467	80.263						
10	.595	2.974	83.238						
11	.552	2.762	85.999						
12	.494	2.470	88.469						
13	.474	2.370	90.839						
14	.395	1.977	92.816						
15	.349	1.744	94.560						
16	.308	1.540	96.100						
17	.236	1.181	97.282						
18	.225	1.125	98.407						
19	.196	.979	99.385						
20	.123	.615	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component					
	1	2	3	4	5	6
Q9 S3	.762	.168				
Q10 S4	.688	.206				.121
Q8 S2	.655		.173			-.104-
Q7 S1	.617	.130			.345	.199
Q14 PS4	.510		.417	.113	.376	
Q2 OI2		.848	.102		.215	.177
Q3 OI3	.206	.731				-.273-
Q5 OI5	.197	.671	.163			
Q4 OI4		.536	-.123-	-.303-		.485
Q15 PS5			.748		-.120-	
Q13 PS3	-.108-	.281	.663	.314		
Q11 PS1	.351	.193	.629	-.160-		
Q12 PS2	.430		.568	-.161-	.340	
Q18 F3		.132	-.125-	.891		.128
Q16 F1	.340			.738	.225	
Q17 F2	-.289-		.157	.568	.372	-.243-
Q19 F4		-.107-	.218	.293	.678	-.128-
Q1 OI1	.190	.129	-.198-		.667	.169
Q20 R1		.101			.163	.789
Q21 R2	.212			.227	-.224-	.658

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 9 iterations.

Appendix 21: Exploratory factor analysis for EPQ (study 1)

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.591
Bartlett's Test of Sphericity	Approx. Chi-Square	419.886
	df	136
	Sig.	<.001

Communalities

	Initial	Extraction
Q22 AL1	1.000	.475
Q23 AL2	1.000	.653
Q24 AL3	1.000	.495
Q25 AL4	1.000	.568
Q26 AL5 I	1.000	.701
Q27 AL6	1.000	.673
Q28 AL7	1.000	.749
Q29 AL8	1.000	.622
Q30 AL9	1.000	.683
Q31 AL10	1.000	.774
Q31 AL11	1.000	.436
Q32 C1	1.000	.815
Q33 C2	1.000	.773
Q34 DL1	1.000	.833
Q35 DL 2	1.000	.770
Q36 HE1	1.000	.680
Q37 HE2	1.000	.519

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.757	22.099	22.099	3.757	22.099	22.099	2.206	12.974	12.974
2	1.853	10.897	32.996	1.853	10.897	32.996	2.144	12.614	25.588
3	1.701	10.006	43.002	1.701	10.006	43.002	1.786	10.508	36.096
4	1.483	8.722	51.724	1.483	8.722	51.724	1.757	10.335	46.431
5	1.241	7.299	59.023	1.241	7.299	59.023	1.666	9.801	56.233
6	1.185	6.972	65.995	1.185	6.972	65.995	1.660	9.762	65.995
7	.951	5.592	71.587						
8	.843	4.956	76.543						
9	.742	4.363	80.905						
10	.644	3.790	84.696						
11	.560	3.297	87.992						
12	.543	3.194	91.186						
13	.422	2.480	93.665						
14	.356	2.091	95.757						
15	.314	1.845	97.602						
16	.228	1.343	98.944						
17	.179	1.056	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component					
	1	2	3	4	5	6
Q25 AL4	.667	.123	.201	.191	-.109-	-.137-
Q22 AL1	.652				.142	.149
Q30 AL9	.611	.439	-.105-			.315
Q24 AL3	.581	.127	.172	-.177-	.283	
Q31 AL11	.496	.222	.307			.211
Q28 AL7	.353	.783				
Q29 AL8		.741	.115	-.166-	.160	
Q23 AL2		.696		.175		.366
Q33 C2			.870			
Q32 C1	.148		.816		.175	.303
Q34 DL1				.898		-.118-
Q35 DL 2	-.131-			.863		
Q31 AL10	.349		-.123-		.739	.298
Q27 AL6			.339		.698	-.244-
Q26 AL5 I	-.199-	.444			.673	
Q36 HE1	.110	.117	.181	.126		.778
Q37 HE2				-.195-		.680

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 9 iterations.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.785
Bartlett's Test of Sphericity	Approx. Chi-Square	624.760
	df	136
	Sig.	<.001

Communalities

	Initial	Extraction
Q67 AL1	1.000	.654
Q68 AL2	1.000	.721
Q69 AL 3	1.000	.634
Q70 AL 4	1.000	.667
Q71 AL 5	1.000	.467
Q72 AL 6	1.000	.732
Q73 AL 7	1.000	.475
Q74 AL 8	1.000	.612
Q75 AL 9	1.000	.408
Q76 AL10	1.000	.696
Q77 AL 11	1.000	.642
Q79 C2	1.000	.720
Q78 C1	1.000	.753
Q80 DL1	1.000	.510
Q81 DL2	1.000	.498
Q82 HE1	1.000	.763
Q83 HE2	1.000	.448

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.688	33.461	33.461	5.688	33.461	33.461	3.170	18.645	18.645
2	1.975	11.620	45.081	1.975	11.620	45.081	3.090	18.178	36.823
3	1.483	8.724	53.805	1.483	8.724	53.805	2.155	12.676	49.499
4	1.252	7.362	61.167	1.252	7.362	61.167	1.984	11.668	61.167
5	.999	5.875	67.042						
6	.967	5.689	72.731						
7	.806	4.739	77.470						
8	.677	3.980	81.450						
9	.623	3.666	85.116						
10	.501	2.950	88.066						
11	.393	2.311	90.376						
12	.364	2.142	92.519						
13	.339	1.995	94.514						
14	.274	1.613	96.127						
15	.255	1.498	97.626						
16	.223	1.313	98.938						
17	.180	1.062	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Q78 C1	.836	.224		
Q79 C2	.799			.280
Q83 HE2	.601	.102	.223	.164
Q80 DL1	.599	.129	.268	.251
Q81 DL2	.534	.131		.433
Q72 AL 6		.824	.203	
Q74 AL 8	.160	.743		.172
Q70 AL 4	.225	.708	-.193-	.277
Q67 AL1	.446	.630	.105	-.217-
Q71 AL 5		.551	.297	.264
Q75 AL 9	.171	.544	.287	
Q69 AL 3		.115	.774	.148
Q76 AL10	.253	.150	.768	.140
Q82 HE1	.451	.372	.622	-.185-
Q68 AL2			.363	.761
Q77 AL 11	.260	.120		.743
Q73 AL 7	.410	.276	.211	.431

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 6 iterations.

Appendix 22: Faculty and students descriptive for SDS (presence and importance) (study 1).

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Objectives	57	1.00	5.00	3.6807	.79987
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Support	57	1.00	5.00	3.7105	.98515
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Problemsolving	57	1.60	5.00	3.6386	.94675
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Feadback	57	1.00	5.00	3.4649	1.10441
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Fidelity	57	1.00	5.00	3.2193	1.48209
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SDS1	57	1.40	4.55	3.5868	.59870
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Objectives2	57	1.00	5.00	4.1965	.63639
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Support2	57	1.00	5.00	4.4693	.55314
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Problemsolving2	57	1.40	5.00	3.9158	.85101
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Feedback2	57	1.00	5.00	4.1140	.70722
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
fidelity2	57	1.00	5.00	4.6228	.65657
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SDS2	57	1.20	4.90	4.2070	.52025
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Objectives	32	1.80	5.00	3.9187	.77686
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Support	32	1.00	5.00	4.0859	.81964
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Problemsolving	32	1.00	5.00	3.9125	.84691
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Feedback	32	1.00	4.75	2.9766	.93187
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Fidelity	32	2.00	5.00	3.4687	.63421
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SDS	32	1.90	4.55	3.7172	.52940
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Objectives2	32	2.00	5.00	4.0375	.69919
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Support2	32	3.25	5.00	4.2578	.60403
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Problemsolving2	32	3.40	5.00	4.1875	.48709
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Feedback2	32	3.00	5.00	4.1641	.54109
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Fidelity2	32	2.50	5.00	4.2969	.60721
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SDS2	32	3.15	5.00	4.1703	.46850
Valid N (listwise)	32				

Appendix 23: Faculty and students descriptive for EPQ (presence and importance) (study 1).

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EPQ	57	1.59	4.71	3.7606	.54572
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ActiveLearning	57	1.00	4.91	3.7081	.63931
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Collaboration	57	1.00	5.00	3.3158	1.43499
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Diversewaysoflearning	57	1.00	5.00	4.2895	1.02185
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Highexpectation	57	1.00	5.00	3.9649	1.10945
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EPQ2	57	1.00	5.00	4.1798	.48341
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Activelearning2	57	1.00	5.00	4.0016	.48880
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Collaboration2	57	1.00	5.00	4.5877	.71416
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
DiverseLearning2	57	1.00	5.00	4.5351	.63989
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Highexpectation2	57	1.00	5.00	4.4035	.69075
Valid N (listwise)	57				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ActiveLearning	32	3.55	5.00	4.2216	.38909
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Collaboration	32	1.00	5.00	4.1094	1.16905
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Diversewaysoflearning	32	1.00	5.00	3.7344	1.00791
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Highexpectaion	32	3.00	5.00	4.1250	.63500
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EPQ2	32	3.62	5.00	4.2040	.38286
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Activelearning2	32	3.55	5.00	4.2216	.38909
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Collaboration2	32	3.00	5.00	4.0313	.68318
Valid N (listwise)	32				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Highexpectation2	32	3.30	5.00	4.1250	.51180
Valid N (listwise)	32				

Appendix 24: Interview guide for faculty (study 2)

Demographics (will be kept separate)

Introductory statement:

The interview will be divided into four main parts, the focus of which is on preparation of faculty and readiness to teach in HFS settings. In each part, I will ask you to reflect on your clinical teaching.

At this stage, I wish to turn the tape on for recording. The recording will be transcribed. I want to assure you again that the recording will be confidential.

Recorder on

Can you please tell me how long you have worked as a tutor in undergraduate EMS education?

What is your highest degree earned?

Can you please tell me about your previous experience of teaching when you used simulation? What were the modules or courses? (e.g. EMT, Peds, etc.)

How long have you been using simulations as a teaching tool with ems students?

CIPP (Input and Process)	**Questions**
Part 1: Input evaluation (HFS readiness and preparation)	Reflecting back to when you started using simulation in your teaching, how prepared did you feel for the role? What did you do in order to prepare yourself for the

	implementation of simulation in your teaching? What did faculty do in order to help you prepare for implementing simulation in your teaching? Reflecting on your experiences, is there anything that you could have done to ensure you were better prepared? Is there anything faculty could have done to help you feel better prepared for your role as a teacher in simulated settings? How do you prepare for a simulation session with your students? What information is important for you to provide to students before they begin a simulation experience? What steps or processes do you think about when you implement simulation with students? How do you orient and prepare students for the simulation experience?
Part 2: Process evaluation (Implementations of plan and objectives)	Reflecting back to your experience of teaching in simulated settings, can you think of times where you have come across situations that were particularly challenging? Please give as many examples as possible:

	What happened? Who was involved (without naming names)? What were the consequences for you as a teacher? What were the consequences for your learners? Is there anything that you or faculty could do to ensure these are addressed and to overcome such challenges? Reflecting back to the past few months of your role as an educator, in what way did the pandemic impact high fidelity simulation? What did you have to do differently? How did you cope with the changes that took place? With these changes in place, have you come across any challenges or barriers to teaching your students ? Please provide some examples and detail. Reflecting back on your experiences during the pandemic, what suggestions you may have on how high fidelity simulation can be improved in the current situation?

	Reflecting back on your experiences during the pandemic, have you observed any good practices and examples of high fidelity simulation that can be carried forward once face to face teaching can be resumed. Are there any other points you would like to mention? Thank you very much for spending time with me in this interview. I will give you the results when they are ready. Recorder off

Appendix 25: Interview guide for student (study 2)

Demographics (will be kept separate) **Introductory statement:** The interview will be divided into four main parts, the focus of which is on preparation of faculty and readiness to teach in HFS settings. In each part, I will ask you to reflect on your clinical teaching. At this stage, I wish to turn the tape on for recording. The recording will be transcribed. I want to assure you again that the recording will be confidential. **Recorder on** Can you please tell me how long you have worked as a tutor in undergraduate EMS education? What is your highest degree earned? Can you please tell me about your previous experience of teaching when you used simulation? What were the modules or courses? (e.g. EMT, Peds, etc.) How long have you been using simulations as a teaching tool with ems students?

CIPP (Input and Process)	**Questions**
Part 1: Input evaluation (HFS readiness and preparation)	Reflecting back to when you started using simulation in your teaching, how prepared did you feel for the role? What did you do in order to prepare yourself for the

	implementation of simulation in your teaching? What did faculty do in order to help you prepare for implementing simulation in your teaching? Reflecting on your experiences, is there anything that you could have done to ensure you were better prepared? Is there anything faculty could have done to help you feel better prepared for your role as a teacher in simulated settings? How do you prepare for a simulation session with your students? What information is important for you to provide to students before they begin a simulation experience? What steps or processes do you think about when you implement simulation with students? How do you orient and prepare students for the simulation experience?
Part 2: Process evaluation (Implementations of plan and objectives)	Reflecting back to your experience of teaching in simulated settings, can you think of times where you have come across situations that were particularly challenging? Please give as many examples as possible:

	What happened? Who was involved (without naming names)? What were the consequences for you as a teacher? What were the consequences for your learners? Is there anything that you or faculty could do to ensure these are addressed and to overcome such challenges? Reflecting back to the past few months of your studies, in what way did the pandemic impact the use of simulation? What did you have to do differently? How did you cope with the changes that took place? With these changes in place, have you come across any challenges or barriers to learning in simulated settings? Please provide some examples and detail. Reflecting back on your experiences during the pandemic, what suggestions you may have on how high fidelity simulation can be improved in the current situation?

	Reflecting back on your experiences during the pandemic, have you observed any good practices and examples of high fidelity simulation that can be carried forward once face to face teaching can be resumed. Are there any other points you would like to mention? Thank you very much for spending time with me in this interview. I will give you the results when they are ready. Recorder off.

Appendix 26: Demographics for faculty (study 2)

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	24-33	21	51.2	52.5	52.5
	34-44	13	31.7	32.5	85.0
	44+	6	14.6	15.0	100.0
	Total	40	97.6	100.0	
Missing	System	1	2.4		
Total		41	100.0		

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	32	78.0	80.0	80.0
	Female	8	19.5	20.0	100.0
	Total	40	97.6	100.0	
Missing	System	1	2.4		
Total		41	100.0		

Current educational role

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Professor	1	2.4	2.5	2.5
	Associate Professor	1	2.4	2.5	5.0
	Assistant Professor	8	19.5	20.0	25.0
	Lecturer	23	56.1	57.5	82.5
	Demonstrator	5	12.2	12.5	95.0
	Other	2	4.9	5.0	100.0
	Total	40	97.6	100.0	
Missing	System	1	2.4		
Total		41	100.0		

University name

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Prince Sultan bin Abdulaziz for ems /King Saud University	14	34.1	35.0	35.0
	Emergency Medical Services Department/Imam Abdulrahman bin Faisal University	3	7.3	7.5	42.5
	Emergency Medical Services Department/Umm AL-Qura University	2	4.9	5.0	47.5
	Emergency Medical Services Department/Umm AL-Qura University (ALQunfudah)	1	2.4	2.5	50.0
	Emergency Medical Services Department/King Saud bin Abdulaziz University for Health Sciences	4	9.8	10.0	60.0
	Emergency Medical Services Departments/Al-Ghad International Colleges	6	14.6	15.0	75.0
	Other	10	24.4	25.0	100.0
	Total	40	97.6	100.0	
Missing	System	1	2.4		
Total		41	100.0		

Appendix 27: Demographics for students (study 2)

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-27	206	97.6	98.1	98.1
	28-38	3	1.4	1.4	99.5
	38+	1	.5	.5	100.0
	Total	210	99.5	100.0	
Missing	System	1	.5		
Total		211	100.0		

Years of study

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	First year	10	4.7	4.8	4.8
	Second year	24	11.4	11.4	16.2
	Third year	76	36.0	36.2	52.4
	Intern	100	47.4	47.6	100.0
	Total	210	99.5	100.0	
Missing	System	1	.5		
Total		211	100.0		

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	187	88.6	89.0	89.0
	Female	23	10.9	11.0	100.0
	Total	210	99.5	100.0	
Missing	System	1	.5		
Total		211	100.0		

University name

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Prince Sultan bin Abdulaziz for ems /King Saud University	38	18.0	18.1	18.1
	Emergency Medical Services Department/Imam Abdulrahman bin Faisal University	22	10.4	10.5	28.6
	Emergency Medical Services Department/Umm AL-Qura University	14	6.6	6.7	35.2
	Emergency Medical Services Department/Umm AL-Qura University (ALQunfudah)	15	7.1	7.1	42.4
	Emergency Medical Services Department/Almaarefa University	1	.5	.5	42.9
	Emergency Medical Services Department/King Saud bin Abdulaziz University for Health Sciences	49	23.2	23.3	66.2
	Emergency Medical Services Departments/Al-Ghad International Colleges	32	15.2	15.2	81.4
	Other	39	18.5	18.6	100.0
	Total	210	99.5	100.0	
Missing	System	1	.5		
Total		211	100.0		

Appendix 28: Missing values (study 2)

Warnings

There are no missing values. MPATTERN is not produced.
There are no missing values. TPATTERN is not produced.

Univariate Statistics

	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
SDSB	250	3.8579	.97737	0	.0	7	0
SDSD	250	3.7546	1.05678	0	.0	0	0
EPQB	250	3.9412	.94391	0	.0	6	0
EPQD	250	3.8374	.97655	0	.0	7	0

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

Appendix 29: Normality test (study 2)

Double-click to activate

le Kolmogorov-Smirnov Test

			SDSB	SDSD	EPQB	EPQD
N			250	250	250	250
Normal Parameters[a,b]	Mean		3.8579	3.7546	3.9412	3.8374
	Std. Deviation		.97737	1.05678	.94391	.97655
Most Extreme Differences	Absolute		.121	.132	.144	.131
	Positive		.121	.119	.131	.117
	Negative		-.114-	-.132-	-.144-	-.131-
Test Statistic			.121	.132	.144	.131
Asymp. Sig. (2-tailed)[c]			<.001	<.001	<.001	<.001
Monte Carlo Sig. (2-tailed)[d]	Sig.		.000	.000	.000	.000
	99% Confidence Interval	Lower Bound	.000	.000	.000	.000
		Upper Bound	.000	.000	.000	.000

Appendix 30: Reliability of the SDS and EPQ (Student and Faculty) (study 2)

SDS scales (before and during the COVID-19) (students surveys)

Reliability Statistics

Cronbach's Alpha	N of Items
.972	20

Reliability Statistics

Cronbach's Alpha	N of Items
.975	19

EPQ (before and during the COVID-19) (students surveys)

Reliability Statistics

Cronbach's Alpha	N of Items
.977	17

Reliability Statistics

Cronbach's Alpha	N of Items
.974	17

SDS scales (before and during the COVID-19) (faculty surveys)

Reliability Statistics

Cronbach's Alpha	N of Items
.975	20

Reliability Statistics

Cronbach's Alpha	N of Items
.970	20

EPQ scales (before and during the COVID-19) (faculty surveys)

Reliability Statistics

Cronbach's Alpha	N of Items
.945	17

Reliability Statistics

Cronbach's Alpha	N of Items
.955	17

Item total correlation for SDS scale (Before the COVID-19)

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1 OI1	73.63	336.969	.766	.972
Q2 OI2	73.46	340.114	.749	.972
Q3 OI3	73.59	336.783	.819	.971
Q4 OI4	73.59	339.036	.786	.972
Q5 OI5	73.56	337.370	.794	.971
Q7 S1	73.45	339.396	.840	.971
Q8 S2	73.49	339.238	.806	.971
Q9 S3	73.51	337.112	.816	.971
Q10 S4	73.43	338.061	.832	.971
Q11 PS1	73.53	339.432	.809	.971
Q12 PS2	73.54	338.072	.826	.971
Q13 PS3	73.50	340.124	.784	.972
Q14 PS4	73.46	340.367	.782	.972
Q15 PS5	73.67	342.424	.712	.972
Q16 F1	73.57	340.178	.787	.972
Q17 F2	73.49	338.226	.845	.971
Q18 F3	73.49	339.078	.822	.971
Q19 F4	73.47	338.048	.793	.971
Q20 R1	73.45	343.151	.725	.972
Q21 R2	73.46	341.752	.719	.972

Item total correlation for SDS scale (during the COVID-19)

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1 OI1 D	71.77	377.642	.801	.976
Q2 OI2 D	71.69	382.376	.777	.976
Q3 OI3D	71.81	377.717	.814	.976
Q4 OI4D	71.84	379.302	.792	.976
Q5 OI5D	71.77	379.777	.796	.976
Q7 S1D	71.69	375.559	.860	.975
Q8 S2D	71.62	379.791	.824	.975
Q9 S3D	71.65	375.976	.869	.975
Q10 S4D	71.62	376.338	.857	.975
Q11 PS1D	71.71	378.947	.821	.975
Q12 PS2D	71.63	381.906	.797	.976
Q13 PS3	71.55	386.602	.694	.977
Q14 PS4	71.51	385.335	.720	.976
Q15 PS5D	71.62	377.748	.845	.975
Q16 F1D	71.59	379.781	.844	.975
Q17 F2D	71.63	377.932	.872	.975
Q18 F3D	71.66	377.478	.855	.975
Q19 F4D	71.72	375.146	.858	.975
Q20 R1D	71.52	380.721	.790	.976
Q21 R2D	71.61	381.667	.774	.976

Item total correlation for EPQ scale (Before the COVID-19)

Item-Total Statistics

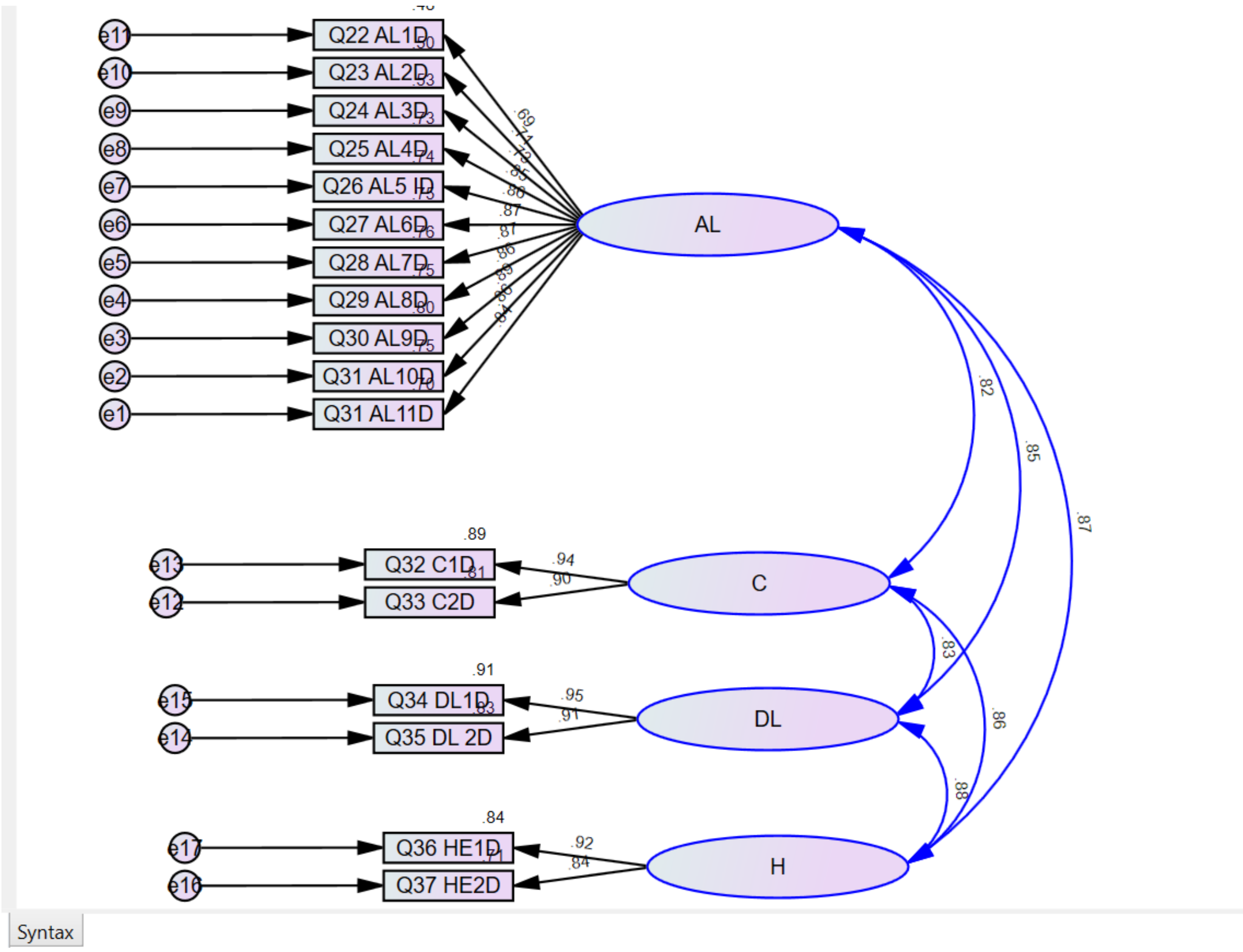
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q22 AL1	55.62	167.815	.869	.967
Q23 AL2	55.70	167.808	.858	.967
Q24 AL3	55.64	169.075	.862	.967
Q25 AL4	55.68	168.673	.810	.968
Q26 AL5 I	55.56	168.314	.842	.968
Q27 AL6	55.56	168.438	.869	.967
Q28 AL7	55.61	168.165	.839	.968
Q29 AL8	55.53	170.366	.830	.968
Q30 AL9	55.58	170.178	.845	.968
Q31 AL10	55.59	169.391	.805	.968
Q31 AL11	55.55	169.174	.818	.968
Q32 C1	55.52	171.474	.696	.970
Q33 C2	55.37	170.367	.811	.968
Q36 HE1	55.49	172.995	.723	.970
Q37 HE2	55.44	172.123	.753	.969

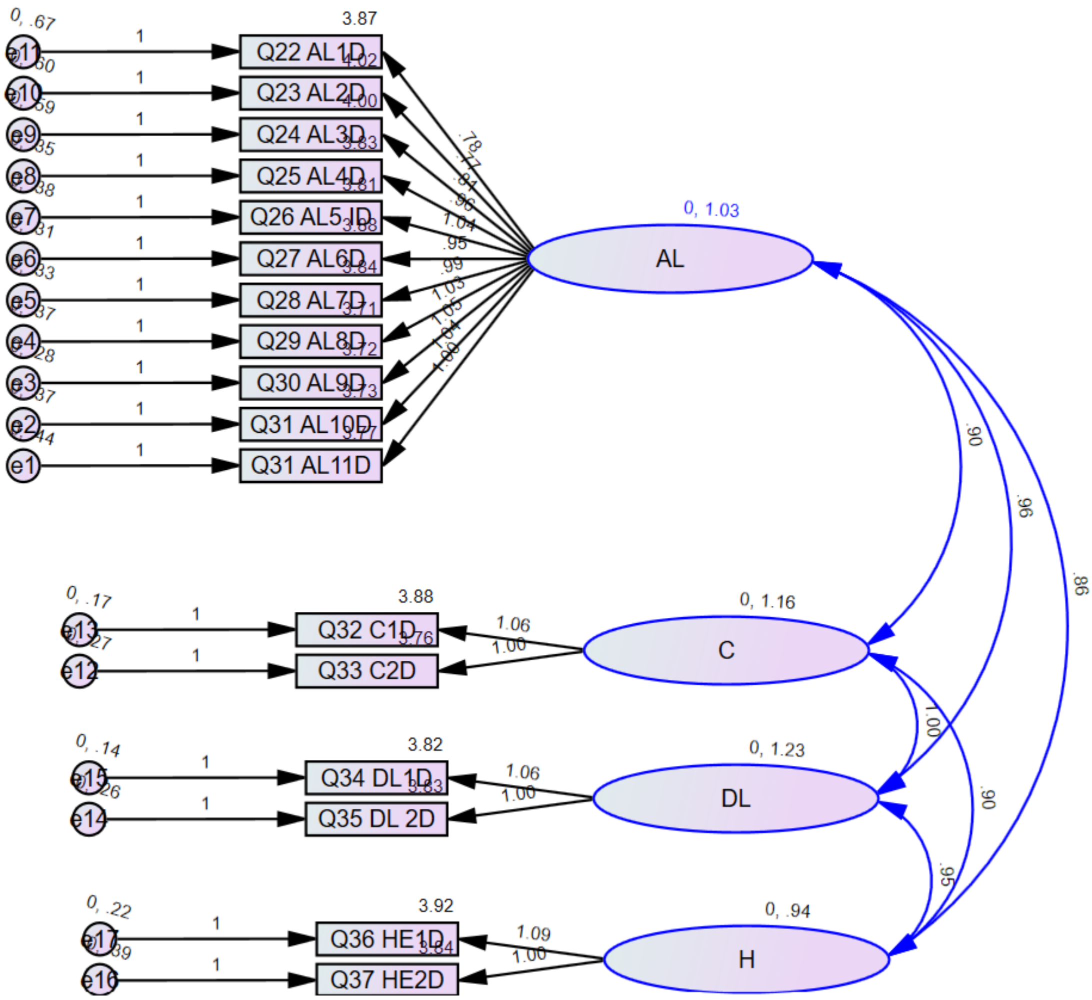
Item total correlation for EPQ scale (During the COVID-19)

Item-Total Statistics

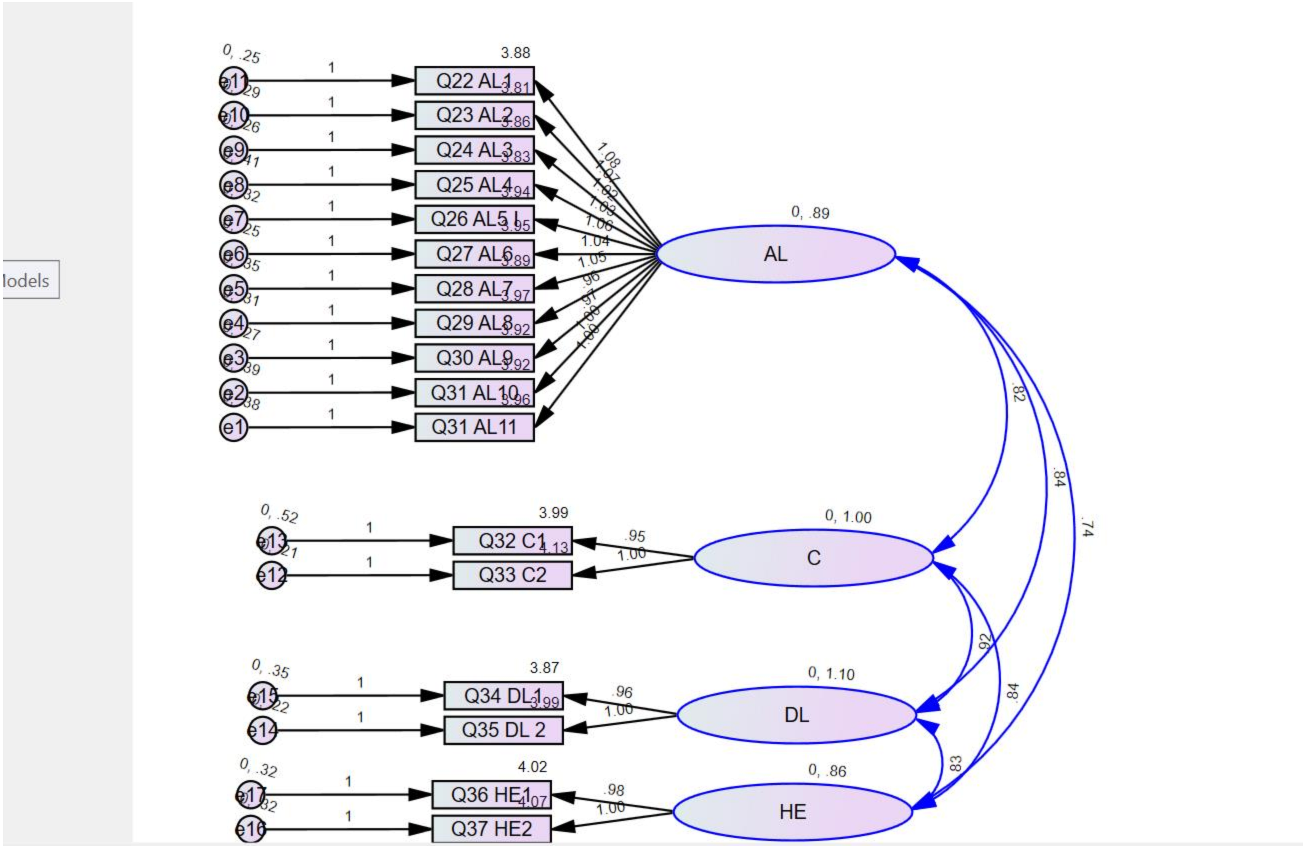
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q22 AL1D	61.13	252.483	.702	.971
Q23 AL2D	61.00	252.929	.710	.971
Q24 AL3D	61.02	251.487	.738	.970
Q25 AL4D	61.20	247.831	.828	.969
Q26 AL5 ID	61.21	244.645	.856	.969
Q27 AL6D	61.13	247.604	.855	.969
Q28 AL7D	61.19	247.148	.840	.969
Q29 AL8D	61.31	246.275	.824	.969
Q30 AL9D	61.31	245.751	.852	.969
Q31 AL10D	61.30	246.161	.818	.969
Q31 AL11D	61.24	247.151	.794	.970
Q32 C1D	61.13	247.074	.807	.969
Q33 C2D	61.26	248.716	.772	.970
Q34 DL1D	61.21	244.987	.843	.969
Q35 DL 2D	61.20	246.346	.813	.969
Q36 HE1D	61.10	247.805	.818	.969
Q37 HE2D	61.18	249.395	.777	.970

Appendix 31: Confirmatory factor analysis for the SDS scale and EPQ scale (study 2)





Q22 AL1D
Q23 AL2D
Q24 AL3D
Q25 AL4D
Q26 AL5 ID
Q27 AL6D
Q28 AL7D
Q29 AL8D
Q30 AL9D
Q31 AL10D
Q31 AL11D
AL
0, 1.03
Q32 C1D
Q33 C2D
C
0, 1.16
Q34 DL1D
Q35 DL 2D
DL
0, 1.23
Q36 HE1D
Q37 HE2D
H
0, .94



AL
C
DL
HE
Q22 AL1
Q23 AL2
Q24 AL3
Q25 AL4
Q26 AL5 I
Q27 AL6
Q28 AL7
Q29 AL8
Q30 AL9
Q31 AL10
Q31 AL11
Q32 C1
Q33 C2
Q34 DL1
Q35 DL 2
Q36 HE1
Q37 HE2
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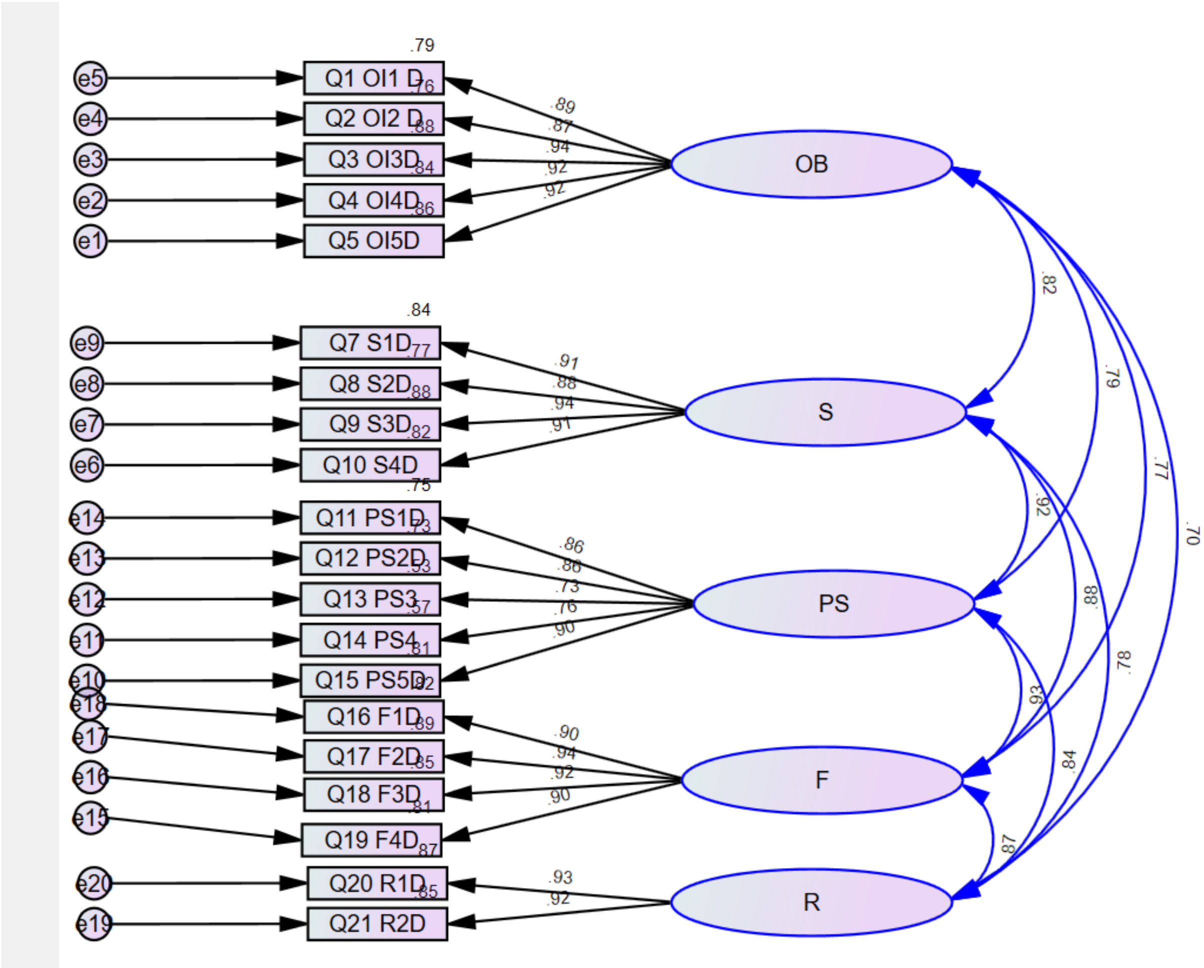
.82
.84
.74
.92
.84
.83


Q1 OI1 D
Q2 OI2 D
Q3 OI3D
Q4 OI4D
Q5 OI5D
Q7 S1D
Q8 S2D
Q9 S3D
Q10 S4D
Q11 PS1D
Q12 PS2D
Q13 PS3
Q14 PS4
Q15 PS5D
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Q17 F2D
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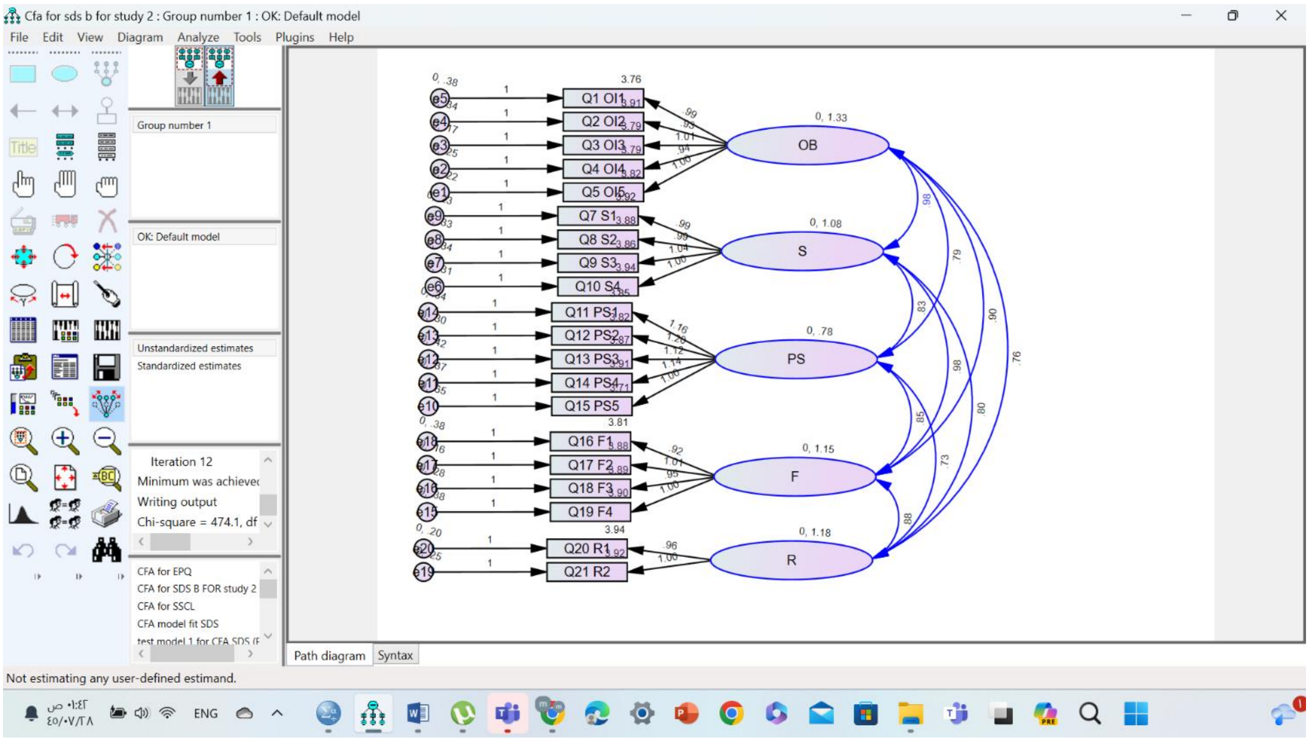
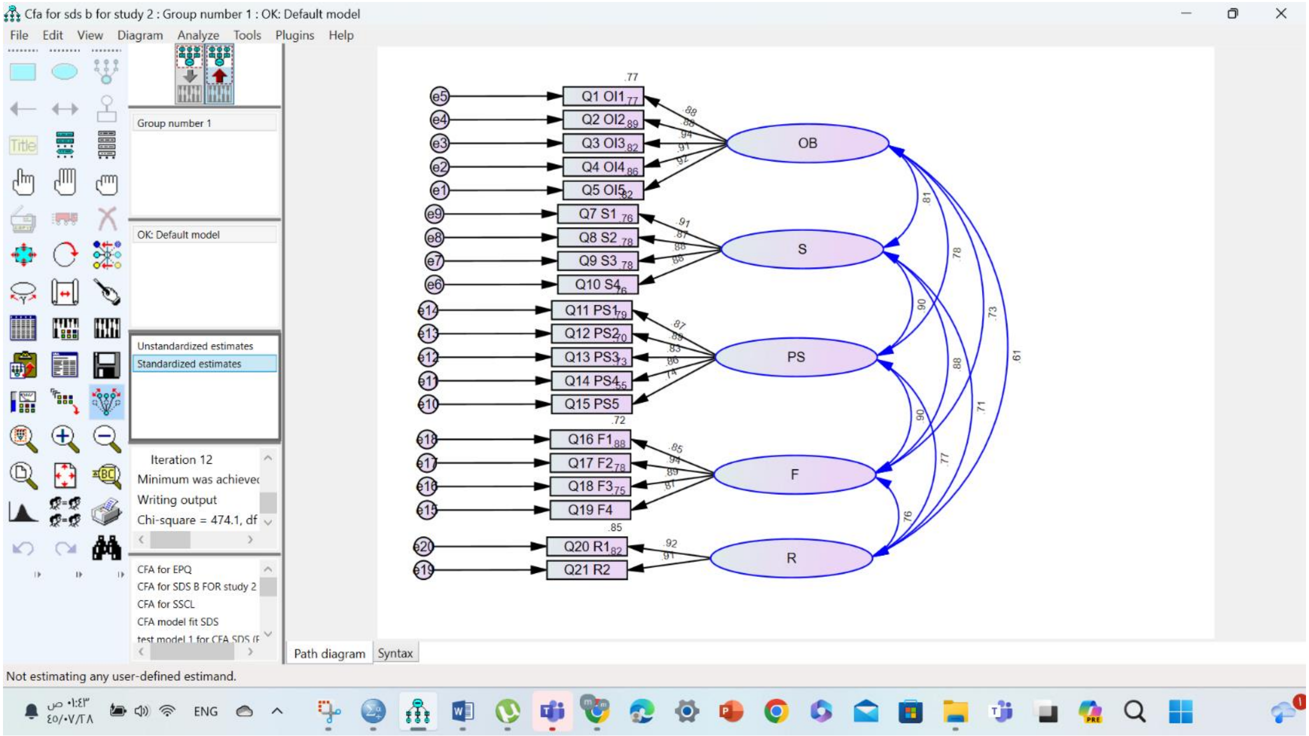
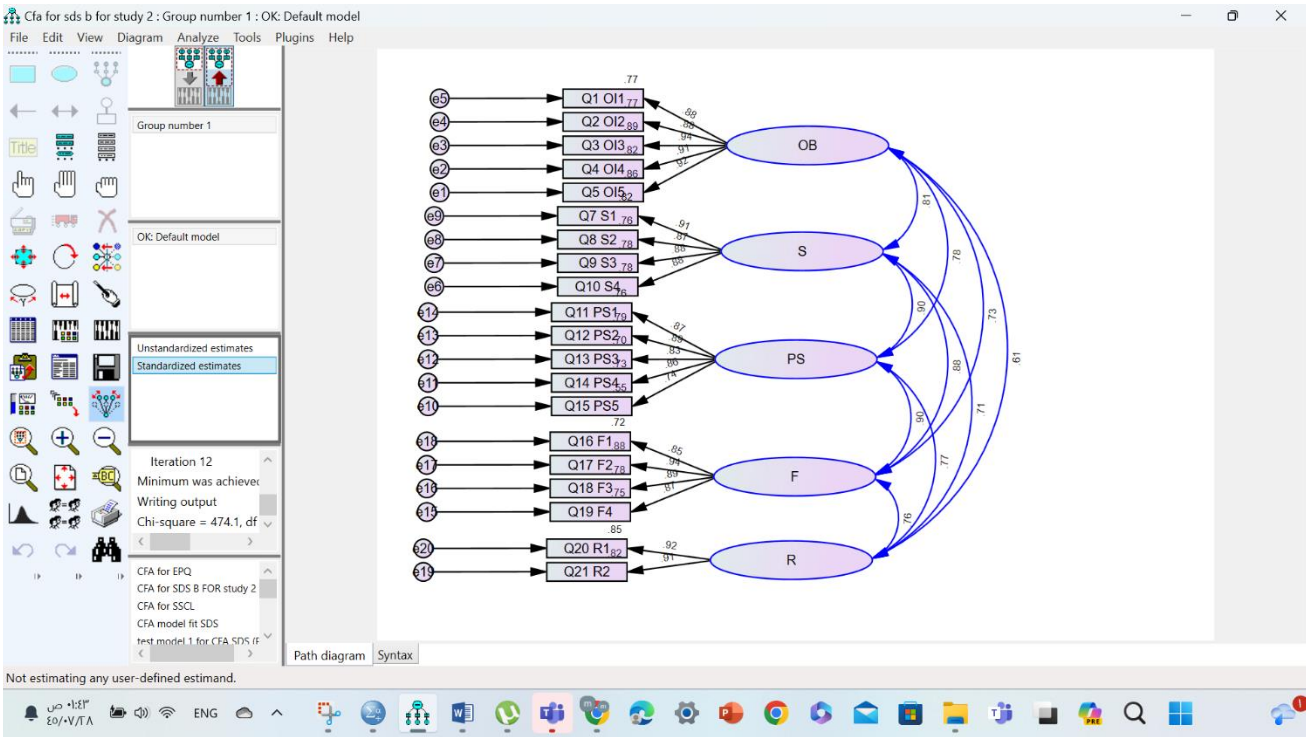
Q20 R1D
Q21 R2D
OB
S
PS
F
R

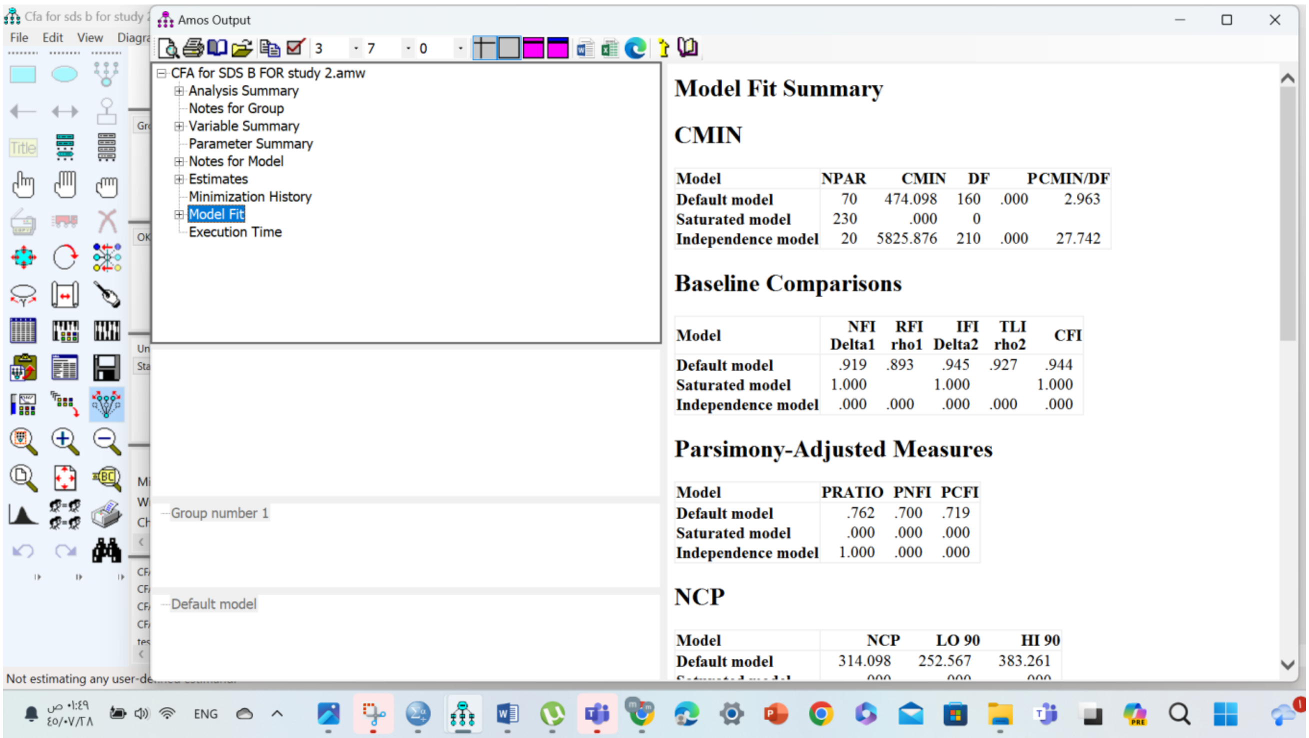

Cfa for sds b for study 2 : Group number 1 : OK: Default model
File Edit View Diagram Analyze Tools Plugins Help
Group number 1
OK: Default model
Unstandardized estimates
Standardized estimates
Iteration 12
Minimum was achieved
Writing output
Chi-square = 474.1, df
CFA for EPQ
CFA for SDS B FOR study 2
CFA for SSCL
CFA model fit SDS
Path diagram
Syntax
Not estimating any user-defined estimand.
OB
S
PS
F
R


Cfa for sds b for study 2 : Group number 1 : OK: Default model
File Edit View Diagram Analyze Tools Plugins Help
Group number 1
OK: Default model
Unstandardized estimates
Standardized estimates
Iteration 12
Minimum was achievec
Writing output
Chi-square = 474.1, df
CFA for EPQ
CFA for SDS B FOR study 2
CFA for SSCL
CFA model fit SDS
Q1 OI1
Q2 OI2
Q3 OI3
Q4 OI4
Q5 OI5
Q7 S1
Q8 S2
Q9 S3
Q10 S4
Q11 PS1
Q12 PS2
Q13 PS3
Q14 PS4
Q15 PS5
Q16 F1
Q17 F2
Q18 F3
Q19 F4
Q20 R1
Q21 R2
OB
S
PS
F
R
Path diagram
Syntax
Not estimating any user-defined estimand.


Cfa for sds b for study 2 : Group number 1 : OK: Default model
File Edit View Diagram Analyze Tools Plugins Help
Group number 1
OK: Default model
Unstandardized estimates
Standardized estimates
Iteration 12
Minimum was achievec
Writing output
Chi-square = 474.1, df
CFA for EPQ
CFA for SDS B FOR study 2
CFA for SSCL
CFA model fit SDS
Q1 OI1
Q2 OI2
Q3 OI3
Q4 OI4
Q5 OI5
Q7 S1
Q8 S2
Q9 S3
Q10 S4
Q11 PS1
Q12 PS2
Q13 PS3
Q14 PS4
Q15 PS5
Q16 F1
Q17 F2
Q18 F3
Q19 F4
Q20 R1
Q21 R2
OB
S
PS
F
R
Path diagram
Syntax
Not estimating any user-defined estimand.

Appendix 32: Model fit for the SDS scale and EPQ scale (study 2)

Model fit for SDS scale (Before and during the COVID-19)



Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	70	474.098	160	.000	2.963
Saturated model	230	.000	0		
Independence model	20	5825.876	210	.000	27.742

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.919	.893	.945	.927	.944
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.762	.700	.719
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	314.098	252.567	383.261

Model	NCP	LO 90	HI 90
Default model	282.159	223.341	348.632
Saturated model	.000	.000	.000
Independence model	6147.276	5890.340	6410.561

Navigation tree

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	1.776	1.133	.897	1.400
Saturated model	.000	.000	.000	.000
Independence model	25.531	24.688	23.656	25.745

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.084	.075	.094	.000
Independence model	.343	.336	.350	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	582.159	595.054		
Saturated model	460.000	502.368		
Independence model	6397.276	6400.960		

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	70	442.159	160	.000	2.763
Saturated model	230	.000	0		
Independence model	20	6357.276	210	.000	30.273

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.930	.909	.954	.940	.954
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.762	.709	.727
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

Model	NCP	LO 90	HI 90
Default model	282.159	223.341	348.632
Saturated model	.000	.000	.000
Independence model	6147.276	5890.340	6410.561

FMIN

Navigation tree

Model	FMIN	F0	LO 90	HI 90
Default model	1.776	1.133	.897	1.400
Saturated model	.000	.000	.000	.000
Independence model	25.531	24.688	23.656	25.745

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.084	.075	.094	.000
Independence model	.343	.336	.350	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	582.159	595.054		
Saturated model	460.000	502.368		
Independence model	6397.276	6400.960		

Model fit for EPQ scale (Before and during the COVID-19)

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	57	566.904	113	.000	5.017
Saturated model	170	.000	0		
Independence model	17	4888.584	153	.000	31.952

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.884	.843	.905	.870	.904
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.739	.653	.668
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.127	.117	.138	.000
Independence model	.353	.344	.361	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	680.904	689.787		
Saturated model	340.000	366.494		
Independence model	4922.584	4925.233		

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	57	634.511	113	.000	5.615
Saturated model	170	.000	0		
Independence model	17	4821.089	153	.000	31.510

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.868	.822	.889	.849	.888
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.739	.641	.656
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.136	.126	.147	.000
Independence model	.350	.342	.359	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	748.511	757.394		
Saturated model	340.000	366.494		
Independence model	4855.089	4857.738		

Appendix 33: Faculty descriptive for SDS scale (study 2)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SDSB	40	1.00	5.00	4.2254	.83060
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.975	20

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SDSD	40	1.00	5.00	4.2151	.79740
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.970	20

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ObjectivesB	40	1.00	5.00	4.1988	1.06630
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.981	5

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SupportB	40	1.00	5.00	4.3000	.92021
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.942	4

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ProblemsolvingB	40	1.00	5.00	4.3262	.84315
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.953	5

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
FeedbackB	40	1.00	5.00	4.2625	.80254
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.864	4

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
FidelityB	40	1.00	5.00	3.8250	1.08338
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.893	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ObjectivesD	40	1.00	5.00	3.9900	.97008
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.936	5

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SuportD	40	1.00	5.00	4.2250	.90900
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.903	4

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ProblemsolvingD	40	1.00	5.00	4.3262	.84315
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.922	5

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
FeedbackD	210	1.00	5.00	3.6790	1.17911
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.896	4

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
FidelityD	40	1.00	5.00	4.4500	.85335
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.948	2

Ranks

	Group	N	Mean Rank	Sum of Ranks
ObjectivesB	FacultyB	40	36.60	1464.00
	facultyD	40	44.40	1776.00
	Total	80		

Test Statistics[a]

	ObjectivesB
Mann-Whitney U	644.000
Wilcoxon W	1464.000
Z	-1.517-
Asymp. Sig. (2-tailed)	.129

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
SupportB	FacultyB	40	38.92	1557.00
	facultyD	40	42.08	1683.00
	Total	80		

Test Statistics[a]

	SupportB
Mann-Whitney U	737.000
Wilcoxon W	1557.000
Z	-.618-
Asymp. Sig. (2-tailed)	.537

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
ProblemsolvingB	FacultyB	40	40.50	1620.00
	facultyD	40	40.50	1620.00
	Total	80		

Test Statistics[a]

	ProblemsolvingB
Mann-Whitney U	800.000
Wilcoxon W	1620.000
Z	.000
Asymp. Sig. (2-tailed)	1.000

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
FidelityB	FacultyB	40	48.14	1925.50
	facultyD	40	32.86	1314.50
	Total	80		

Test Statistics[a]

	FidelityB
Mann-Whitney U	494.500
Wilcoxon W	1314.500
Z	-3.074-
Asymp. Sig. (2-tailed)	.002

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
FeedbackB	FacultyB	40	40.50	1620.00
	facultyD	40	40.50	1620.00
	Total	80		

Test Statistics[a]

	FeedbackB
Mann-Whitney U	800.000
Wilcoxon W	1620.000
Z	.000
Asymp. Sig. (2-tailed)	1.000

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
SDSB	FacultyB	40	39.58	1583.00
	facultyD	40	41.43	1657.00
	Total	80		

Test Statistics[a]

	SDSB
Mann-Whitney U	763.000
Wilcoxon W	1583.000
Z	-.356-
Asymp. Sig. (2-tailed)	.722

a. Grouping Variable: Group

Appendix 34: Students descriptive for SDS scale (study 2)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ObjectivesB	210	1.00	5.00	3.7390	1.15518
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.954	5

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SupportB	210	1.00	5.00	3.8206	1.09947
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.930	4

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ProblemsolvingB	210	1.00	5.00	3.7381	1.04124
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.913	5

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
FeedbackB	210	1.00	5.00	3.7964	1.10698
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.941	4

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
FidelityB	210	1.00	5.00	3.9548	1.12352
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.912	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SDSB	210	1.00	5.00	3.7879	.98922
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.972	20

Ranks

	Group	N	Mean Rank	Sum of Ranks
ObjectivesB	students	210	210.50	44205.00
	StudentD	210	210.50	44205.00
	Total	420		

Test Statistics[a]

	ObjectivesB
Mann-Whitney U	22050.000
Wilcoxon W	44205.000
Z	.000
Asymp. Sig. (2-tailed)	1.000

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
SupportB	students	210	215.46	45246.50
	StudentD	210	205.54	43163.50
	Total	420		

Test Statistics[a]

	SupportB
Mann-Whitney U	21008.500
Wilcoxon W	43163.500
Z	-.847-
Asymp. Sig. (2-tailed)	.397

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
ProblemsolvingB	students	210	210.57	44220.50
	StudentD	210	210.43	44189.50
	Total	420		

Test Statistics[a]

	ProblemsolvingB
Mann-Whitney U	22034.500
Wilcoxon W	44189.500
Z	-.013-
Asymp. Sig. (2-tailed)	.990

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
FidelityB	students	210	220.78	46364.00
	StudentD	210	200.22	42046.00
	Total	420		

Test Statistics[a]

	FidelityB
Mann-Whitney U	19891.000
Wilcoxon W	42046.000
Z	-1.789-
Asymp. Sig. (2-tailed)	.074

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
FeedbackB	students	210	216.23	45408.50
	StudentD	210	204.77	43001.50
	Total	420		

Test Statistics[a]

	FeedbackB
Mann-Whitney U	20846.500
Wilcoxon W	43001.500
Z	-.977-
Asymp. Sig. (2-tailed)	.329

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
SDSB	students	210	212.25	44572.00
	StudentD	210	208.75	43838.00
	Total	420		

Test Statistics[a]

	SDSB
Mann-Whitney U	21683.000
Wilcoxon W	43838.000
Z	-.295-
Asymp. Sig. (2-tailed)	.768

a. Grouping Variable: Group

Appendix 35: Faculty descriptive for EPQ scale (study 2)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ActivelearningB	40	1.00	5.00	4.0493	.80730
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.950	11

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
CollaborationB	40	1.50	5.00	3.9875	.88786
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.244	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
DiversewaysoflearningB	40	1.00	5.00	4.0250	.83934
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.444	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
HighexpectationB	40	1.50	5.00	4.2375	.82421
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.568	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EPQB	40	1.12	5.00	4.0611	.74217
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.945	17

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ActivelearningD	40	1.00	5.00	3.9761	.86416
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.949	11

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
CollaborationD	40	1.50	5.00	4.2750	.74205
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.698	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
HighexpectationD	40	2.00	5.00	4.2500	.80064
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.604	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EPQD	40	1.24	5.00	4.0915	.76519
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.955	17

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
DiversewaysoflearningD	40	1.50	5.00	4.3750	.77418
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.789	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
HighexpectationD	40	2.00	5.00	4.2500	.80064
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.604	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EPQD	40	1.24	5.00	4.0915	.76519
Valid N (listwise)	40				

Reliability Statistics

Cronbach's Alpha	N of Items
.955	17

Ranks

	Group	N	Mean Rank	Sum of Ranks
ActivelearningB	FacultyB	40	39.05	1562.00
	facultyD	40	41.95	1678.00
	Total	80		

Test Statistics[a]

	Activelearning B
Mann-Whitney U	742.000
Wilcoxon W	1562.000
Z	-.560-
Asymp. Sig. (2-tailed)	.576

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
CollaborationB	FacultyB	40	44.30	1772.00
	facultyD	40	36.70	1468.00
	Total	80		

Test Statistics[a]

	Collaboration B
Mann-Whitney U	648.000
Wilcoxon W	1468.000
Z	-1.502-
Asymp. Sig. (2-tailed)	.133

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
DiversewaysoflearningB	FacultyB	40	46.34	1853.50
	facultyD	40	34.66	1386.50
	Total	80		

Test Statistics[a]

	DiversewaysoflearningB
Mann-Whitney U	566.500
Wilcoxon W	1386.500
Z	-2.317-
Asymp. Sig. (2-tailed)	.021

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
HighexpectationB	FacultyB	40	40.64	1625.50
	facultyD	40	40.36	1614.50
	Total	80		

Test Statistics[a]

	HighexpectationB
Mann-Whitney U	794.500
Wilcoxon W	1614.500
Z	-.055-
Asymp. Sig. (2-tailed)	.956

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
EPQB	FacultyB	40	41.36	1654.50
	facultyD	40	39.64	1585.50
	Total	80		

Test Statistics[a]

	EPQB
Mann-Whitney U	765.500
Wilcoxon W	1585.500
Z	-.332-
Asymp. Sig. (2-tailed)	.740

a. Grouping Variable: Group

Appendix 36: Students descriptive for EPQ scale (study 2)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ActivelearningB	210	1.00	5.00	3.8743	1.01493
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.972	11

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
CollaborationB	210	1.00	5.00	4.0714	1.10226
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.949	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
DiversewaysoflearnignB	210	1.00	5.00	3.9143	1.14176
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.949	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EPQB	210	1.00	5.00	3.9184	.97746
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.977	17

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ActivelearningD	210	1.00	5.00	3.8080	1.00573
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.961	11

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
CollaborationD	210	1.00	5.00	4.0714	1.10226
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.935	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
DiversewaysoflearningD	210	1.00	5.00	3.7190	1.22068
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.936	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
HighexpectationD	210	1.00	5.00	3.8119	1.12139
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.904	2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EOQD	210	1.00	5.00	3.7890	1.00608
Valid N (listwise)	210				

Reliability Statistics

Cronbach's Alpha	N of Items
.974	17

Ranks

	Group	N	Mean Rank	Sum of Ranks
ActivelearningB	students	210	216.20	45401.00
	StudentD	210	204.80	43009.00
	Total	420		

Test Statistics[a]

	ActivelearningB
Mann-Whitney U	20854.000
Wilcoxon W	43009.000
Z	-.968-
Asymp. Sig. (2-tailed)	.333

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
CollaborationB	students	210	222.61	46748.00
	StudentD	210	198.39	41662.00
	Total	420		

Test Statistics[a]

	CollaborationB
Mann-Whitney U	19507.000
Wilcoxon W	41662.000
Z	-2.109-
Asymp. Sig. (2-tailed)	.035

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
DiversewaysoflearningB	students	210	220.07	46215.00
	StudentD	210	200.93	42195.00
	Total	420		

Test Statistics[a]

	DiversewaysoflearningB
Mann-Whitney U	20040.000
Wilcoxon W	42195.000
Z	-1.661-
Asymp. Sig. (2-tailed)	.097

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
HighexpectationB	students	210	221.00	46410.00
	StudentD	210	200.00	42000.00
	Total	420		

Test Statistics[a]

	HighexpectationB
Mann-Whitney U	19845.000
Wilcoxon W	42000.000
Z	-1.830-
Asymp. Sig. (2-tailed)	.067

a. Grouping Variable: Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
EPQB	students	210	218.71	45928.50
	StudentD	210	202.29	42481.50
	Total	420		

Test Statistics[a]

	EPQB
Mann-Whitney U	20326.500
Wilcoxon W	42481.500
Z	-1.390-
Asymp. Sig. (2-tailed)	.165

a. Grouping Variable: Group

Appendix 37: Stuents demographics (study 3)

العمر:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	من 18 سنه إلى 27 سنه	208	80.6	80.6	80.6
	من 28 سنه إلى 38 سنه	38	14.7	14.7	95.3
	أكبر من 38 سنه	12	4.7	4.7	100.0
	Total	258	100.0	100.0	

نوع الجنس:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ذكر	247	95.7	95.7	95.7
	أنثى	11	4.3	4.3	100.0
	Total	258	100.0	100.0	

السنة الدراسية:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	الأولى	1	.4	.4	.4
	الثانية	19	7.4	7.4	7.8
	الثالثة	32	12.4	12.4	20.2
	الرابعة	53	20.5	20.5	40.7
	اخرى	153	59.3	59.3	100.0
	Total	258	100.0	100.0	

أسم الجامعة:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	كليه الأمير سلطان بن عبدالعزيز للخدمات الطبيه الطارئه/جامعه المل	61	23.6	23.6	23.6
	قسم الخدمات الطبيه الطارئه/جامعه الأمام عبدالرحمن بن فيصل	25	9.7	9.7	33.3
	قسم الخدمات الطبيه الطارئه/جامعه أم القرى	15	5.8	5.8	39.1
	قسم الخدمات الطبيه الطارئه/جامعه جازان	43	16.7	16.7	55.8
	قسم الخدمات الطبيه الطارئه/جامعه أم القرى فرع القنفذه	12	4.7	4.7	60.5
	قسم الخدمات الطبيه الطارئه/ كليه المعرفه	2	.8	.8	61.2
	قسم الخدمات الطبيه الطارئه/جامعه الملك سعود بن عبدالعزيز للعلوم ا	16	6.2	6.2	67.4
	قسم الخدمات الطبيه الطارئه /كليات الغد الأهليه العالميه	60	23.3	23.3	90.7
	أخرى	24	9.3	9.3	100.0
	Total	258	100.0	100.0	

Appendix 38: Missing values (study 3)

Univariate Statistics

	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
SDS	258	3.7443	.98679	0	.0	5	0
EPQ	258	3.7099	.97844	0	.0	8	0
SSCL	258	3.8671	.99939	0	.0	10	0

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

Appendix 39: Normality test (study 3)

One-Sample Kolmogorov-Smirnov Test

			SDS	EPQ	SSCL
N			258	258	258
Normal Parameters[a,b]	Mean		3.7443	3.7099	3.8671
	Std. Deviation		.98679	.97844	.99939
Most Extreme Differences	Absolute		.102	.094	.128
	Positive		.102	.094	.128
	Negative		-.098-	-.069-	-.104-
Test Statistic			.102	.094	.128
Asymp. Sig. (2-tailed)[c]			<.001	<.001	<.001
Monte Carlo Sig. (2-tailed)[d]	Sig.		.000	.000	.000
	99% Confidence Interval	Lower Bound	.000	.000	.000
		Upper Bound	.000	.000	.000

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. Lilliefors' method based on 10000 Monte Carlo samples with starting seed 2000000.

Appendix 40: Item total correlations for the SDS, EPQ and SSCL scales (study 3)

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
قدمت الكلية معلومات كافية في بداية معامل المحاكاة بغية توفير التوجيه والتشجيع	70.88	352.292	.813	.744	.973
لقد فهمت بوضوح الغرض من معامل المحاكاة وأهدافها	70.63	355.645	.763	.712	.974
وفرت معامل المحاكاة لي معلومات كافية على نحو واضح لكي أتمكن من إصلاح المشكلة الناجمة عن الوضع	70.91	351.500	.827	.806	.973
تم توفير معلومات كافية لي خلال معامل المحاكاة	70.92	348.893	.856	.813	.973
الإشارات كانت مناسبة وتم تهيئتها على نحو يعزز فهمي للموضوع	70.90	350.096	.841	.800	.973
كان يتم عرض الدعم في الوقت المناسب	71.04	353.397	.796	.712	.973
كان يتم الاهتمام باحتياجي للمساعده	70.89	352.234	.833	.804	.973
كنت أشعر بأني مدعوم من الكلية خلال معامل المحاكاة	71.05	347.550	.843	.758	.973
وبوجه عام، كان أعضاء هيئة التدريس يدعمون عملية التعلم المقدم لي	70.70	353.171	.787	.734	.974
كان يتم تسهيل حل المشكلات المستقلة	70.98	356.012	.769	.660	.974
كان يتم تشجيعي على أن استكشف كافة الاحتمالات في معامل المحاكاة	70.97	349.616	.834	.752	.973
تم تصميم معامل المحاكاة على نحو يناسب المستوى الخاص بي من المعرفة والمهارات	70.96	352.817	.777	.720	.974
سمحت معامل المحاكاة لي بفرصة ترتيب أولويات المستفين من حيث تقييم الحالة وتقديم الرعاية لها	70.88	350.351	.820	.808	.973
وفرت معامل المحاكاة لي فرصة تحديد الأهداف لصالح مريضي	70.80	352.468	.840	.811	.973
الملاحظات المقدمة عن الأداء كانت بناءه	70.86	354.815	.798	.769	.973
كان يتم عرض الملاحظات على الأداء في الوقت المناسب	70.96	354.434	.802	.762	.973
أتاحت معامل المحاكاة لي فرصة تحليل سلوكي الشخصي وتصرفاتي	71.07	353.430	.766	.669	.974
تم إتاحة فرصة بعد معامل المحاكاة للحصول على الإرشاد/الملاحظات على الأداء من هيئة التدريس بغية بناء المعرفة اللازمة لمستوى آخر.	70.91	352.923	.782	.688	.974
السيناريو كان مشابها لموقف واقعي من الحياه	70.92	355.811	.709	.700	.974
تم تضمين عناصر ومواقف ومتغيرات من الحياه الواقعية في سيناريو المحاكاه	70.90	352.405	.762	.737	.974

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
حصلت على الفرصه خلال أنشطه معامل المحاكاه لمناقشه الأفكار والمفاهيم التي يتم تدريسها في الدوره مع هيئه التدريس والطلاب الآخرين	59.55	238.777	.836	.746	.970
شاركت بشكل نشط في جلسه استخلاص المعلومات بعد معامل المحاكاه	59.63	241.111	.787	.723	.971
حصلت على فرصتي لكي أفكر بشكل أكبر في تعليقاتي خلال جلسه استخلاص المعلومات	59.58	241.170	.820	.791	.970
كان هناك ما يكفي من الفرص خلال معامل المحاكاه لمعرفه ما إذا كنت قد فهمت الماده بوضوح	59.55	241.645	.806	.733	.970
لقد تعلمت من الملاحظات التي أدلى بها أعضاء هيئه التدريس قبل وخلال وبعد معامل المحاكاه	59.36	242.223	.851	.803	.970
تلقيت تلميحات خلال معامل المحاكاه في الوقت المناسب	59.45	241.984	.842	.775	.970
حصلت على الفرصه اللازمه لمناقشه أهداف معامل المحاكاه مع أساتذتي	59.54	238.662	.880	.866	.969
حصلت على الفرصه اللازمه لمناقشه الأفكار والمفاهيم التي يتولى المدربون تدريسها لي في معامل المحاكاه	59.48	238.664	.876	.823	.969
تمكن المدربون من الاستجابه للاحتياجات الفرديه للدارسين خلال معامل المحاكاه .	59.57	240.693	.814	.735	.970
سمح استخدام أنشطه معامل المحاكاه بأن يصبح وقت اكتساب المعلومات الخاص بي أكثر إنتاجيه	59.50	240.309	.836	.775	.970
كان استخدام أنشطه المحاكاه استخداما مثمرا لوقت الدارسين	59.38	240.626	.860	.782	.970
أتيحت لي فرصه العمل مع أقراني خلال معامل المحاكاه	59.18	243.794	.755	.703	.971
خلال المحاكاه، كان لزاما أن أعمل أنا وأقراني على المحاكاه السريريه معا	59.40	244.613	.674	.607	.972
أتاحت لنا معامل المحاكاه تشكيله متنوعه من الطرق يمكننا باستخدامها أن ندرس الماده	59.48	242.036	.757	.792	.971
أتاحت لنا معامل المحاكاه تشكيله متنوعه من الطرق يمكننا باستخدامها تقييم التعلم	59.51	241.243	.802	.821	.970
كانت أهداف تجربه معامل المحاكاه واضحه وسهله الفهم	59.28	245.087	.776	.719	.971
قام المدربون بإبلاغنا بالأهداف والتوقعات المطلوب تحقيقها خلال معامل المحاكاه	59.31	243.943	.773	.688	.971

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
طرائق التدريس المستخدمة في هذه المحاكاة كانت مفيدة وفعالة	46.61	147.288	.864	.823	.968
وفرت المحاكاة لي تشكيلة متنوعة من المواد والأنشطة التعليمية هدفها تعزيز قدرتي على تعلم المنهج الطبي	46.69	146.821	.851	.765	.969
لقد استمتعت بطريقة تدريس معلمي للمحاكاة	46.53	148.701	.837	.780	.969
مواد التدريس المستخدمة في هذه المحاكاة كانت تحفيزية وساعدتني في أن أتعلم	46.67	147.245	.854	.780	.969
كانت الطريقة التي استخدمها المعلم (المعلمين) في تدريس المحاكاة مناسبة للطريقة التي أتعلم بها	46.65	147.514	.854	.782	.969
أنا واثق أنني مستمر في إتقان محتوى نشاط المحاكاة الذي يقدمه لي معلمي	46.51	148.177	.858	.782	.969
أنا واثق من أن هذه المحاكاة نجحت في تغطية الجوانب الحرجة من المحتوى والتي تنطوي على أهمية فيما يخص إتقان المنهج الطبي	46.65	146.309	.877	.803	.968
. أنا واثق من أنني أكتسب ما يلزم من المهارات والمعرفة من هذه المحاكاة لكي أتمكن من تأدية المهام الضرورية في النشاطات السريرية	46.61	146.706	.881	.795	.968
استخدم معلمي موارداً مفيدة في تدريس المحاكاة	46.62	146.662	.878	.801	.968
أنا مسؤول بصفتي طالب أن أتعلم كل ما أحتاج إلى معرفته من نشاط المحاكاة هذا	46.44	151.297	.786	.702	.970
أنا أعرف كيف أحصل على المساعدة عندما أعجز عن استيعاب المفاهيم التي تغطيها هذه المحاكاة	46.54	147.495	.848	.786	.969
أنا أعرف كيف أستخدم أنشطة المحاكاة في تعلم الجوانب الحرجة من هذه المهارات	46.64	148.167	.830	.762	.969
إن المعلم هو المسؤول عن إخباري بما أحتاج إليه لكي أتعلم من محتوى نشاط المحاكاة خلال أوقات الدرس	46.51	153.743	.658	.549	.973

Appendix 41: Exploratory factor analysis for the SDS, EPQ and SSCL scales (study 3)

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.960
Bartlett's Test of Sphericity	Approx. Chi-Square	5214.646
	df	190
	Sig.	.000

Communalities

	Initial	Extraction
قدمت الكلية معلومات كافية في بداية معامل المحاكاه بغية توفير التوجيه والتشجيع	1.000	.803
لقد فهمت بوضوح الغرض من معامل المحاكاه وأهدافها	1.000	.822
وفرت معامل المحاكاه لي معلومات كافية على نحو واضح لكي أتمكن من إصلاح المشكلة الناجمة عن الوضع	1.000	.833
تم توفير معلومات كافية لي خلال معامل المحاكاه	1.000	.826
الإشارات كانت مناسبة وتم تهيئتها على نحو يعزز فهمي للموضوع	1.000	.834
كان يتم عرض الدعم في الوقت المناسب	1.000	.740
كان يتم الاهتمام باحتياجي للمساعدة	1.000	.808
كنت أشعر بأني مدعوم من الكلية خلال معامل المحاكاه	1.000	.768
وبوجه عام، كان أعضاء هيئة التدريس يدعمون عملية التعلم المقدم لي	1.000	.705
كان يتم تسهيل حل المشكلات المستقلة	1.000	.688
كان يتم تشجيعي على أن استكشف كافة الاحتمالات في معامل المحاكاه	1.000	.769
تم تصميم معامل المحاكاه على نحو يناسب المستوى الخاص بي من المعرفة والمهارات	1.000	.845
سمحت معامل المحاكاه لي بفرصة ترتيب أولويات المسعفين من حيث تقييم الحالة وتقديم الرعاية لها	1.000	.859
وفرت معامل المحاكاه لي فرصة تحديد الأهداف لصالح مريضي	1.000	.825
الملاحظات المقدمة عن الأداء كانت بناءة	1.000	.765
كان يتم عرض الملاحظات على الأداء في الوقت المناسب	1.000	.792
أتاحت معامل المحاكاه لي فرصة تحليل سلوكي الشخصي وتصرفاتي	1.000	.652
تم إتاحة فرصة بعد معامل المحاكاه للحصول على الإرشاد/الملاحظات على الأداء من هيئة التدريس بغية بناء المعرفة اللازمة لمستوى آخر.	1.000	.706
السيناريو كان مشابها لموقف واقعي من الحياة	1.000	.875
تم تضمين عناصر ومواقف ومتغيرات من الحياة الواقعية في سيناريو المحاكاه	1.000	.883

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	13.541	67.704	67.704	13.541	67.704	67.704	5.765	28.827	28.827
2	.834	4.170	71.875	.834	4.170	71.875	4.194	20.972	49.799
3	.768	3.838	75.712	.768	3.838	75.712	3.176	15.882	65.680
4	.654	3.272	78.984	.654	3.272	78.984	2.661	13.304	78.984
5	.531	2.655	81.639						
6	.496	2.481	84.120						
7	.430	2.148	86.268						
8	.372	1.861	88.129						
9	.344	1.718	89.847						
10	.304	1.520	91.367						
11	.261	1.306	92.673						
12	.243	1.213	93.886						
13	.211	1.054	94.940						
14	.193	.963	95.902						
15	.179	.897	96.799						
16	.151	.754	97.553						
17	.138	.688	98.241						
18	.126	.629	98.870						
19	.117	.583	99.453						
20	.109	.547	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component				
	1	2	3	4	5
كان يتم الاهتمام باحتياجي للمساعده	.720	.293	.305	.316	.192
وبوجه عام، كان أعضاء هيئة التدريس يدعمون عملية التعلم المقدم لي	.704	.367	.262	.189	.196
كان يتم عرض الدعم في الوقت المناسب	.675	.280	.219	.345	.252
كنت أشعر بأني مدعوم من الكلية خلال معامل المحاكاه	.667	.375	.286	.264	.268
كان يتم تسهيل حل المشكلات المستقله	.622	.246	.275	.346	.237
كان يتم تشجيعي على أن استكشف كافه الاحتمالات في معامل المحاكاه	.537	.352	.466	.332	.171
لقد فهمت بوضوح الغرض من معامل المحاكاه وأهدافها	.248	.781	.210	.249	.209
قدمت الكلية معلومات كافية في بداية معامل المحاكاه بغية توفير التوجيه والتشجيع	.281	.697	.280	.326	.238
الإشارات كانت مناسبة وتم تهيئتها على نحو يعزز فهمي للموضوع	.358	.696	.283	.301	.224
وفرت معامل المحاكاه لي معلومات كافية على نحو واضح لكي أتمكن من إصلاح المشكله الناجمة عن الوضع	.334	.690	.404	.183	.228
تم توفير معلومات كافية لي خلال معامل المحاكاه	.463	.648	.301	.256	.207
تم تصميم معامل المحاكاه على نحو يناسب المستوى الخاص بي من المعرفه والمهارات	.326	.336	.731	.144	.267
سمحت معامل المحاكاه لي بفرصه ترتيب أولويات المسعفين من حيث تقييم الحاله وتقديم الرعاية لها	.329	.316	.719	.277	.260
وفرت معامل المحاكاه لي فرصه تحديد الأهداف لصالح مريضي	.334	.368	.664	.390	.158
أتاحت معامل المحاكاه لي فرصه تحليل سلوكي الشخصي وتصرفاتي	.287	.289	.349	.688	.164
كان يتم عرض الملاحظات على الأداء في الوقت المناسب	.345	.312	.171	.669	.381
الملاحظات المقدمة عن الأداء كانت بناءه	.376	.382	.140	.628	.309
تم إتاحة فرصه بعد معامل المحاكاه للحصول على الإرشاد/الملاحظات على الأداء من هيئة التدريس بغية بناء المعرفه اللازمه لمستوى آخر.	.458	.239	.330	.574	.185
السيناريو كان مشابها لموقف واقعي من الحياه	.295	.246	.166	.243	.828
تم تضمين عناصر ومواقف ومتغيرات من الحياه الواقعية في سيناريو المحاكاه	.227	.297	.353	.263	.746

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 7 iterations.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.947
Bartlett's Test of Sphericity	Approx. Chi-Square	4436.105
	df	136
	Sig.	.000

Communalities

	Initial	Extraction
حصلت على الفرصه خلال أنشطه معامل المحاكاه لمناقشه الأفكار والمفاهيم التي يتم تدريسها في الدوره مع هيئه التدريس والطلاب الآخرين	1.000	.769
شاركت بشكل نشط في جلسه استخلاص المعلومات بعد معامل المحاكاه	1.000	.731
حصلت على فرصتي لكي أفكر بشكل أكبر في تعليقاتي خلال جلسه استخلاص المعلومات	1.000	.811
كان هناك ما يكفي من الفرص خلال معامل المحاكاه لمعرفه ما إذا كنت قد فهمت الماده بوضوح	1.000	.727
لقد تعلمت من الملاحظات التي أدلى بها أعضاء هيئه التدريس قبل وخلال وبعد معامل المحاكاه	1.000	.821
تلقيت تلميحات خلال معامل المحاكاه في الوقت المناسب	1.000	.793
حصلت على الفرصه اللازمه لمناقشه أهداف معامل المحاكاه مع أساتذتي	1.000	.832
حصلت على الفرصه اللازمه لمناقشه الأفكار والمفاهيم التي يتولى المدربون تدريسها لي في معامل المحاكاه	1.000	.831
. تمكن المدربون من الاستجابه للاحتياجات الفرديه للدارسين خلال معامل المحاكاه	1.000	.706
سمح استخدام أنشطه معامل المحاكاه بأن يصبح وقت اكتساب المعلومات الخاص بي أكثر إنتاجيه	1.000	.759
كان استخدام أنشطه المحاكاه استخداما مثمرا لوقت الدارسين	1.000	.789
أتيحت لي فرصه العمل مع أقراني خلال معامل المحاكاه	1.000	.850
خلال المحاكاه، كان لزاما أن أعمل أنا وأقراني على المحاكاه السريريه معا	1.000	.887
أتاحت لنا معامل المحاكاه تشكيله متنوعه من الطرق يمكننا باستخدامها أن ندرس الماده	1.000	.927
أتاحت لنا معامل المحاكاه تشكيله متنوعه من الطرق يمكننا باستخدامها تقييم التعلم	1.000	.912
كانت أهداف تجربه معامل المحاكاه واضحه وسهله الفهم	1.000	.876
قام المدربون بإبلاغنا بالأهداف والتوقعات المطلوب تحقيقها خلال معامل المحاكاه	1.000	.844

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.810	69.468	69.468	11.810	69.468	69.468	6.756	39.742	39.742
2	.900	5.292	74.760	.900	5.292	74.760	2.391	14.067	53.809
3	.634	3.731	78.491	.634	3.731	78.491	2.361	13.890	67.699
4	.521	3.066	81.556	.521	3.066	81.556	2.356	13.858	81.556
5	.485	2.851	84.407						
6	.399	2.346	86.753						
7	.352	2.072	88.825						
8	.328	1.928	90.753						
9	.253	1.489	92.242						
10	.230	1.355	93.597						
11	.222	1.304	94.901						
12	.199	1.171	96.072						
13	.187	1.100	97.172						
14	.173	1.020	98.192						
15	.132	.778	98.970						
16	.094	.552	99.522						
17	.081	.478	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component			
	1	2	3	4
حصلت على فرصتي لكي أفكر بشكل أكبر في تعليقاتي خلال جلسة استخلاص المعلومات	.825	.233	.145	.233
حصلت على الفرصة اللازمة لمناقشة الأفكار والمفاهيم التي يتولى المدربون تدريسها لي في معامل المحاكاة	.767	.329	.286	.230
حصلت على الفرصة اللازمة لمناقشة أهداف معامل المحاكاة مع أساتذتي	.760	.332	.280	.257
لقد تعلمت من الملاحظات التي أدلى بها أعضاء هيئة التدريس قبل وخلال وبعد معامل المحاكاة	.758	.209	.193	.406
شاركت بشكل نشط في جلسة استخلاص المعلومات بعد معامل المحاكاة	.752	.288	.264	.115
تلقيت تلميحات خلال معامل المحاكاة في الوقت المناسب	.749	.164	.332	.308
حصلت على الفرصة خلال أنشطة معامل المحاكاة لمناقشة الأفكار والمفاهيم التي يتم تدريسها في الدورة مع هيئة التدريس والطلاب الآخرين	.738	.333	.247	.229
كان هناك ما يكفي من الفرص خلال معامل المحاكاة لمعرفة ما إذا كنت قد فهمت المادة بوضوح	.714	.177	.336	.270
سمح استخدام أنشطة معامل المحاكاة بأن يصبح وقت اكتساب المعلومات الخاص بي أكثر إنتاجية	.706	.296	.352	.219
كان استخدام أنشطة المحاكاة استخداما مثمرا لوقت الدارسين	.666	.274	.434	.287
تمكن المدربون من الاستجابة . للاحتياجات الفردية للدارسين خلال معامل المحاكاة	.627	.366	.286	.312
أتاحت لنا معامل المحاكاة تشكيلة متنوعة من الطرق يمكننا باستخدامها أن ندرس المادة	.343	.816	.275	.259
أتاحت لنا معامل المحاكاة تشكيلة متنوعة من الطرق يمكننا باستخدامها تقييم التعلم	.429	.767	.250	.277
كانت أهداف تجربة معامل المحاكاة واضحة وسهلة الفهم	.377	.285	.756	.286
قام المدربون بإبلاغنا بالأهداف والتوقعات المطلوب تحقيقها خلال معامل المحاكاة	.398	.270	.730	.281
خلال المحاكاة، كان لزاما أن أعمل أنا وأقراني على المحاكاة السريرية معا	.270	.268	.199	.838
أتيحت لي فرصة العمل مع أقراني خلال معامل المحاكاة	.379	.211	.336	.740

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 6 iterations.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.958
Bartlett's Test of Sphericity	Approx. Chi-Square	3587.438
	df	78
	Sig.	.000

Communalities

	Initial	Extraction
طرائق التدريس المستخدمه في هذه المحاكاه كانت مفيده وفعاله	1.000	.833
وفرت المحاكاه لي تشكيله متنوعه من المواد والأنشطه التعليميه هدفها تعزيز قدرتي على تعلم المنهج الطبي	1.000	.798
لقد استمتعت بطريقه تدريس معلمي للمحاكاه	1.000	.783
مواد التدريس المستخدمه في هذه المحاكاه كانت تحفيزيه وساعدتني في أن أتعلم	1.000	.817
كانت الطريقه التي استخدمها المعلم (المعلمين) في تدريس المحاكاه مناسبه للطريقه التي أتعلم بها	1.000	.814
أنا واثق أنني مستمر في إتقان محتوى نشاط المحاكاه الذي يقدمه لي معلمي	1.000	.777
أنا واثق من أن هذه المحاكاه نجحت في تغطيه الجوانب الحرجه من المحتوى والتي تنطوي على أهميه فيما يخص إتقان المنهج الطبي	1.000	.821
. أنا واثق من أنني أكتسب ما يلزم من المهارات والمعرفه من هذه المحاكاه لكي أتمكن من تأديه المهام الضروريه في النشاطات السريريه	1.000	.812
استخدم معلمي موارد ا مفيده في تدريس المحاكاه	1.000	.808
أنا مسؤول بصفتي طالب أن أتعلم كل ما أحتاج إلى معرفته من نشاط المحاكاه هذا	1.000	.804
أنا أعرف كيف أحصل على المساعده عندما أعجز عن استيعاب المفاهيم التي تغطيها هذه المحاكاه	1.000	.782
أنا أعرف كيف أستخدم أنشطه المحاكاه في تعلم الجوانب الحرجه من هذه المهارات	1.000	.766
إن المعلم هو المسؤول عن إخباري بما أحتاج إليه لكي أتعلم من محتوى نشاط المحاكاه خلال أوقات الدرس	1.000	.825

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.691	74.548	74.548	9.691	74.548	74.548	6.696	51.505	51.505
2	.748	5.752	80.300	.748	5.752	80.300	3.743	28.795	80.300
3	.473	3.639	83.939						
4	.347	2.671	86.610						
5	.290	2.232	88.842						
6	.248	1.909	90.751						
7	.236	1.818	92.569						
8	.210	1.619	94.188						
9	.192	1.480	95.667						
10	.166	1.278	96.945						
11	.156	1.201	98.146						
12	.141	1.086	99.233						
13	.100	.767	100.000						

Extraction Method: Principal Component Analysis.

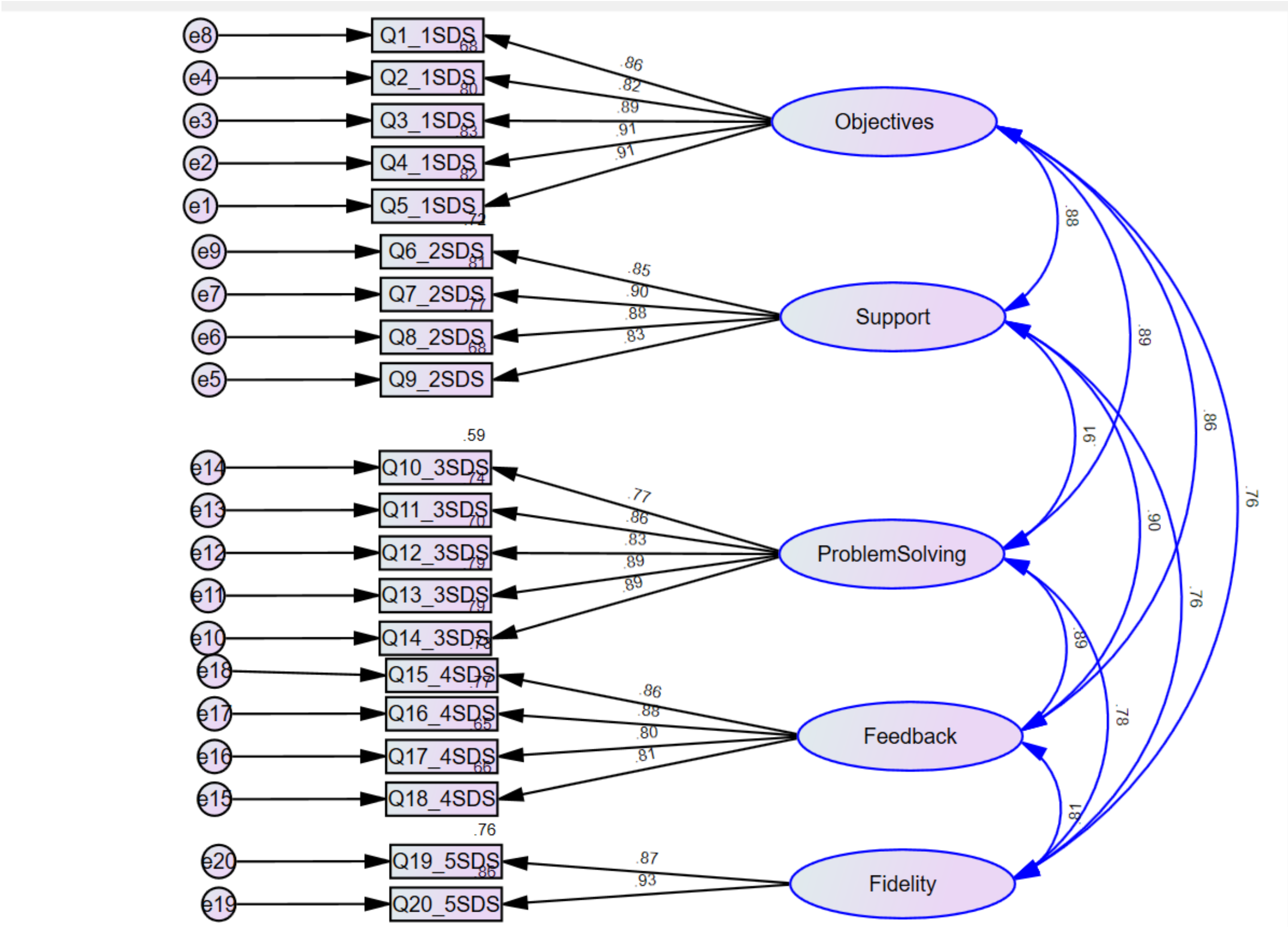
Rotated Component Matrix[a]

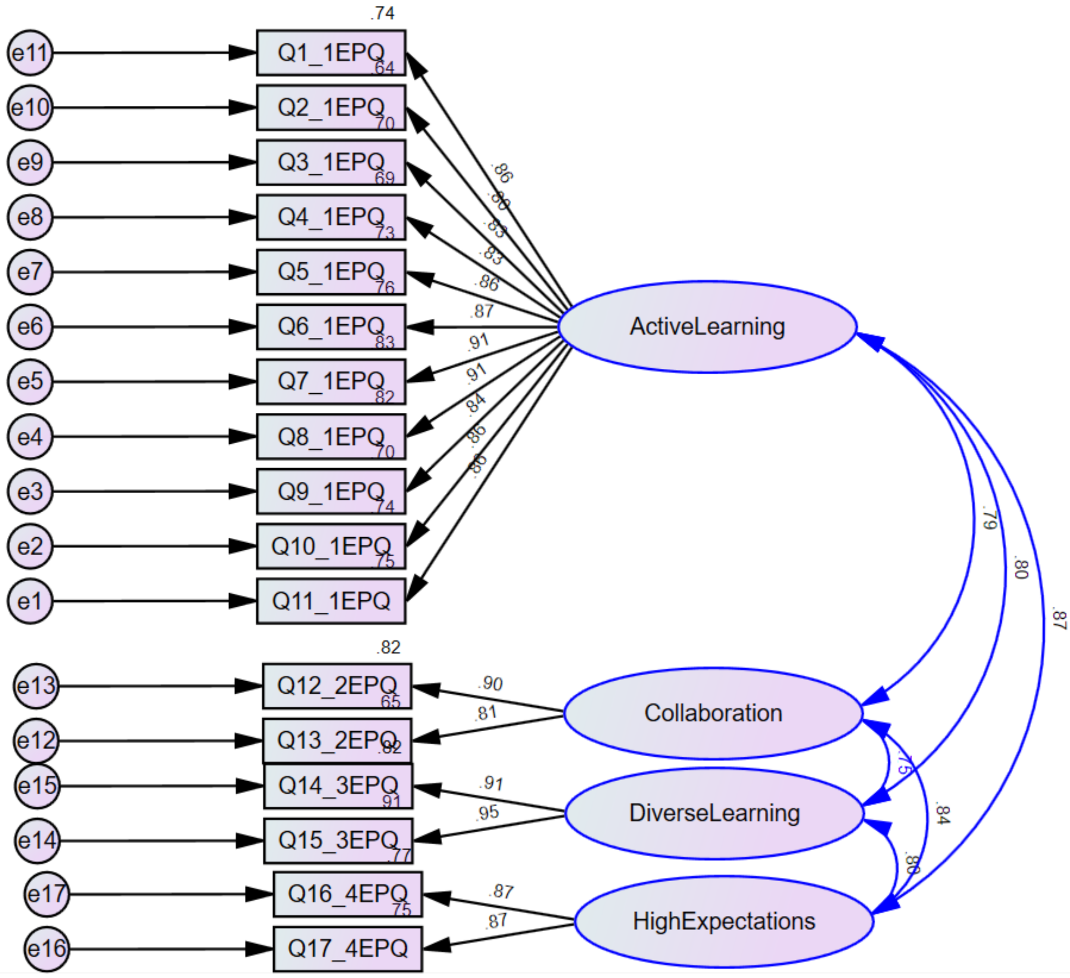
	Component	
	1	2
طرائق التدريس المستخدمة في هذه المحاكاة كانت مفيدة وفعالة	.847	.339
مواد التدريس المستخدمة في هذه المحاكاة كانت تحفيزية وساعدتني في أن أتعلم	.839	.336
كانت الطريقة التي استخدمها المعلم (المعلمين) في تدريس المحاكاة مناسبة للطريقة التي أتعلم بها	.835	.341
وفرت المحاكاة لي تشكيلة متنوعة من المواد والأنشطة التعليمية هدفها تعزيز قدرتي على تعلم المنهج الطبي	.817	.362
لقد استمتعت بطريقة تدريس معلمي للمحاكاة	.816	.341
أنا واثق من أن هذه المحاكاة نجحت في تغطية الجوانب الحرجة من المحتوى والتي تنطوي على أهمية فيما يخص إتقان المنهج الطبي	.800	.425
استخدم معلمي موارداً مفيدة في تدريس المحاكاة	.740	.510
. أنا واثق من أنني أكتسب ما يلزم من المهارات والمعرفة من هذه المحاكاة لكي أتمكن من تأدية المهام الضرورية في النشاطات السريرية	.734	.523
أنا واثق أنني مستمر في إتقان محتوى نشاط المحاكاة الذي يقدمه لي معلمي	.721	.508
إن المعلم هو المسؤول عن إخباري بما أحتاج إليه لكي أتعلم من محتوى نشاط المحاكاة خلال أوقات الدرس	.233	.878
أنا مسؤول بصفتي طالب أن أتعلم كل ما أحتاج إلى معرفته من نشاط المحاكاة هذا	.449	.776
أنا أعرف كيف أستخدم أنشطة المحاكاة في تعلم الجوانب الحرجة من هذه المهارات	.592	.644
أنا أعرف كيف أحصل على المساعدة عندما أعجز عن استيعاب المفاهيم التي تغطيها هذه المحاكاة	.624	.626

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 3 iterations.

Appendix 42: Confirmatory factor analysis for the SDS, EPQ and SSCL scales (study 3)





e11
e10
e9
e8
e7
e6
e5
e4
e3
e2
e1
e13
e12
e15
e14
e17
e16
Q1_1EPQ
Q2_1EPQ
Q3_1EPQ
Q4_1EPQ
Q5_1EPQ
Q6_1EPQ
Q7_1EPQ
Q8_1EPQ
Q9_1EPQ
Q10_1EPQ
Q11_1EPQ
Q12_2EPQ
Q13_2EPQ
Q14_3EPQ
Q15_3EPQ
Q16_4EPQ
Q17_4EPQ
ActiveLearning
Collaboration
DiverseLearning
HighExpectations
.74
.64
.70
.69
.73
.76
.83
.82
.70
.74
.75
.82
.65
.82
.91
.77
.75
.86
.87
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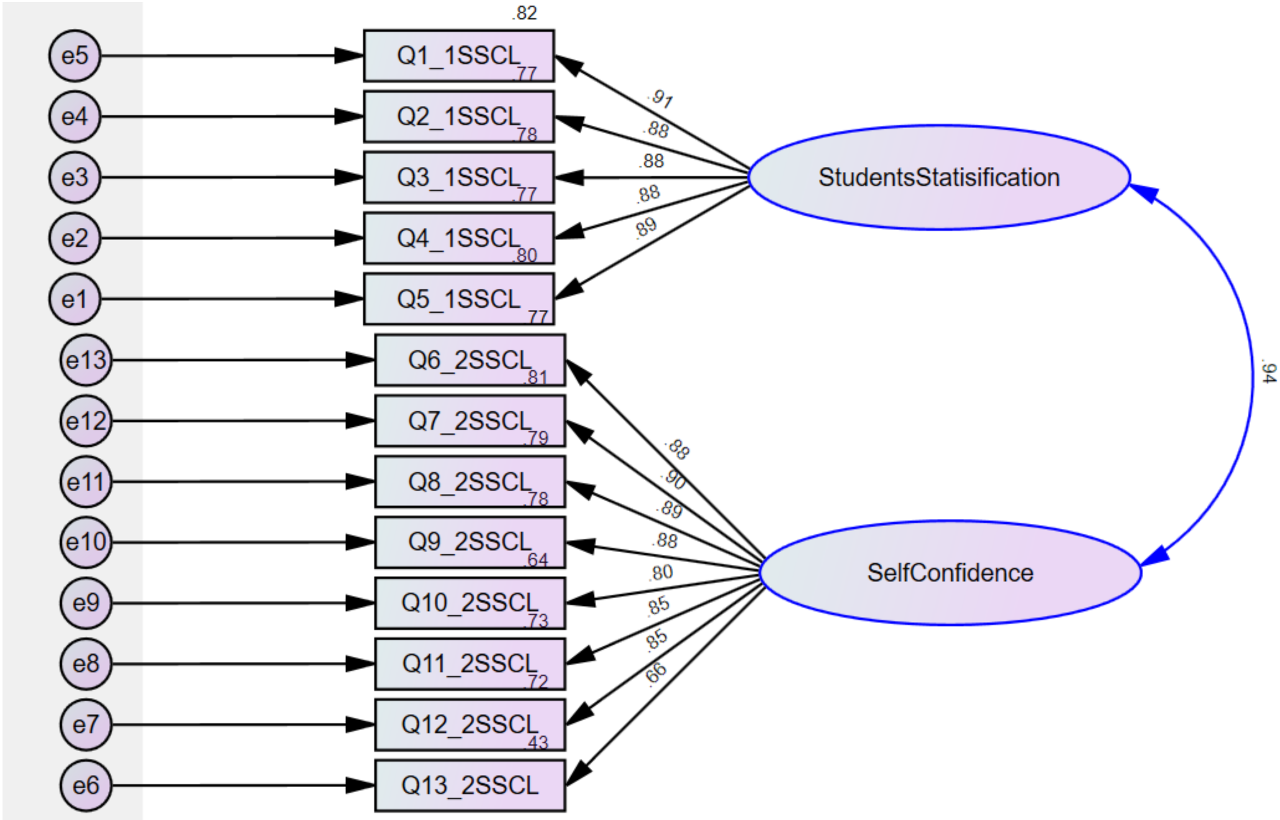
.80
.87
.75
.84



.82
e5
e4
e3
e2
e1
e13
e12
e11
e10
e9
e8
e7
e6
Q1_1SSCL
.77
Q2_1SSCL
.78
Q3_1SSCL
.77
Q4_1SSCL
.80
Q5_1SSCL
.77
Q6_2SSCL
.81
Q7_2SSCL
.79
Q8_2SSCL
.78
Q9_2SSCL
.64
Q10_2SSCL
.73
Q11_2SSCL
.72
Q12_2SSCL
.43
Q13_2SSCL
.91
.88
.88
.88
.89
StudentsStatisification
.94
.88
.90
.89
.88
.80
.85
.85
.66
SelfConfidence

Appendix 43: Model fit for the SDS, EPQ and SSCL scales (study 3)

Model fit for the SDS scale

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	70	470.920	160	.000	2.943
Saturated model	230	.000	0		
Independence model	20	5547.294	210	.000	26.416

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.915	.889	.942	.924	.942
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.762	.697	.718
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	310.920	249.653	379.820
Saturated model	.000	.000	.000
Independence model	5337.294	5097.798	5583.151

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	1.832	1.210	.971	1.478
Saturated model	.000	.000	.000	.000
Independence model	21.585	20.768	19.836	21.724

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.087	.078	.096	.000
Independence model	.314	.307	.322	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	610.920	623.378		
Saturated model	460.000	500.932		
Independence model	5587.294	5590.854		

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	2.377	2.139	2.645	2.426
Saturated model	1.790	1.790	1.790	1.949
Independence model	21.740	20.809	22.697	21.754

Model fit for the EPQ scale

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	57	379.986	113	.000	3.363
Saturated model	170	.000	0		
Independence model	17	4768.204	153	.000	31.165

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.920	.892	.943	.922	.942
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.739	.680	.696
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	266.986	211.576	329.999
Saturated model	.000	.000	.000

Model fit for the SSCL scale

Navigation tree

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	40	217.505	64	.000	3.399
Saturated model	104	.000	0		
Independence model	13	3674.021	91	.000	40.374

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.941	.916	.957	.939	.957
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.703	.662	.673
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	153.505	112.444	202.167

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.097	.083	.111	.000
Independence model	.391	.381	.402	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	297.505	302.114		
Saturated model	208.000	219.984		
Independence model	3700.021	3701.519		

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	1.158	.998	1.347	1.176
Saturated model	.809	.809	.809	.856
Independence model	14.397	13.640	15.182	14.403

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	99	111
Independence model	8	9

Model	NCP	LO 90	HI 90
Default model	266.986	211.576	329.999
Saturated model	.000	.000	.000
Independence model	4615.204	4393.398	4844.251

Navigation tree

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	1.479	1.039	.823	1.284
Saturated model	.000	.000	.000	.000
Independence model	18.553	17.958	17.095	18.849

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.096	.085	.107	.000
Independence model	.343	.334	.351	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	493.986	502.572		
Saturated model	340.000	365.607		
Independence model	4802.204	4804.765		

ECVI

Appendix 44: Correlation analysis of SDS, EPQ and SSCL scales (study 3)

Correlations

		SDS	EPQ	SSCL
SDS	Pearson Correlation	1	.870**	.853**
	Sig. (2-tailed)		<.001	<.001
	N	258	258	258
EPQ	Pearson Correlation	.870**	1	.858**
	Sig. (2-tailed)	<.001		<.001
	N	258	258	258
SSCL	Pearson Correlation	.853**	.858**	1
	Sig. (2-tailed)	<.001	<.001	
	N	258	258	258

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

Appendix 45: Correlation analysis of SDS subscale, EPQ subscales and SSCL subscales scales (study 3)

Correlations

		Objectives	Satisification
Objectives	Pearson Correlation	1	.776**
	Sig. (2-tailed)		<.001
	N	258	258
Satisification	Pearson Correlation	.776**	1
	Sig. (2-tailed)	<.001	
	N	258	258

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

Correlations

		Objectives	Confidence
Objectives	Pearson Correlation	1	.724**
	Sig. (2-tailed)		<.001
	N	258	257
Confidence	Pearson Correlation	.724**	1
	Sig. (2-tailed)	<.001	
	N	257	257

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

Correlations

		Satisification	Support
Satisification	Pearson Correlation	1	.783**
	Sig. (2-tailed)		<.001
	N	258	258
Support	Pearson Correlation	.783**	1
	Sig. (2-tailed)	<.001	
	N	258	258

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

Correlations

		Support	Confidence
Support	Pearson Correlation	1	.715**
	Sig. (2-tailed)		<.001
	N	258	257
Confidence	Pearson Correlation	.715**	1
	Sig. (2-tailed)	<.001	
	N	257	257

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

Correlations

		Confidence	Problemsolving
Confidence	Pearson Correlation	1	.753**
	Sig. (2-tailed)		<.001
	N	257	257
Problemsolving	Pearson Correlation	.753**	1
	Sig. (2-tailed)	<.001	
	N	257	258

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

Correlations

		Problemsolving	Satisification
Problemsolving	Pearson Correlation	1	.799**
	Sig. (2-tailed)		<.001
	N	258	258
Satisification	Pearson Correlation	.799**	1
	Sig. (2-tailed)	<.001	
	N	258	258

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

Correlations

		Satisification	Feedback
Satisification	Pearson Correlation	1	.779**
	Sig. (2-tailed)		<.001
	N	258	258
Feedback	Pearson Correlation	.779**	1
	Sig. (2-tailed)	<.001	
	N	258	258

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

Correlations

		Feedback	Confidence
Feedback	Pearson Correlation	1	.742**
	Sig. (2-tailed)		<.001
	N	258	257
Confidence	Pearson Correlation	.742**	1
	Sig. (2-tailed)	<.001	
	N	257	257

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

Correlations

		Satisification	Fidelity
Satisification	Pearson Correlation	1	.728**
	Sig. (2-tailed)		<.001
	N	258	258
Fidelity	Pearson Correlation	.728**	1
	Sig. (2-tailed)	<.001	
	N	258	258

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

Correlations

		Fidelity	Confidence
Fidelity	Pearson Correlation	1	.674**
	Sig. (2-tailed)		<.001
	N	258	257
Confidence	Pearson Correlation	.674**	1
	Sig. (2-tailed)	<.001	
	N	257	257

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

Correlations

		Confidence	Activelearning
Confidence	Pearson Correlation	1	.758**
	Sig. (2-tailed)		<.001
	N	257	257
Activelearning	Pearson Correlation	.758**	1
	Sig. (2-tailed)	<.001	
	N	257	258

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

Correlations

		Activelearning	Satisification
Activelearning	Pearson Correlation	1	.810**
	Sig. (2-tailed)		<.001
	N	258	258
Satisification	Pearson Correlation	.810**	1
	Sig. (2-tailed)	<.001	
	N	258	258

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

Correlations

		Satisification	Collaboration
Satisification	Pearson Correlation	1	.693**
	Sig. (2-tailed)		<.001
	N	258	258
Collaboration	Pearson Correlation	.693**	1
	Sig. (2-tailed)	<.001	
	N	258	258

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

Correlations

		Collaboration	Confidence
Collaboration	Pearson Correlation	1	.659**
	Sig. (2-tailed)		<.001
	N	258	257
Confidence	Pearson Correlation	.659**	1
	Sig. (2-tailed)	<.001	
	N	257	257

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

Correlations

		Satisification	Diversewayso flearning
Satisification	Pearson Correlation	1	.782**
	Sig. (2-tailed)		<.001
	N	258	258
Diversewaysoflearning	Pearson Correlation	.782**	1
	Sig. (2-tailed)	<.001	
	N	258	258

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

Correlations

		Satisification	Highexpectaion
Satisification	Pearson Correlation	1	.798**
	Sig. (2-tailed)		<.001
	N	258	258
Highexpectaion	Pearson Correlation	.798**	1
	Sig. (2-tailed)	<.001	
	N	258	258

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

Correlations

		Confidence	Highexpectaion
Confidence	Pearson Correlation	1	.749**
	Sig. (2-tailed)		<.001
	N	257	257
Highexpectaion	Pearson Correlation	.749**	1
	Sig. (2-tailed)	<.001	
	N	257	258

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

Appendix 46: Descriptive of students (study 3)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Satisification	258	1.00	5.00	3.8401	1.05090
Confidence	257	1.00	5.00	3.9163	.99007
Objectives	258	1.00	5.00	3.7969	1.08803
Support	258	1.00	5.00	3.7274	1.08928
Problemsolving	258	1.00	5.00	3.7306	1.05067
Feedback	258	1.00	5.00	3.7080	1.02922
Fidelity	258	1.00	5.00	3.7519	1.17302
Activelearning	258	1.00	5.00	3.6562	1.02626
Collaboration	258	1.00	5.00	3.8837	1.12023
Diversewaysoflearning	258	1.00	5.00	3.6705	1.16448
Highexpectaion	258	1.00	5.00	3.8740	1.03754
SDS	258	1.00	5.00	3.7443	.98679
EPQ	258	1.00	5.00	3.7099	.97844
SSCL	258	1.00	5.00	3.8671	.99939
Valid N (listwise)	257				