DESIGN A SIMULATED MULTIMEDIA ENRICHED IMMERSIVE LEARNING ENVIRONMENT (SMILE) FOR NURSING CARE OF DEMENTIA PATIENT

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Abstract

Simulation plays an important role in education and training by using advanced technology to replicate real world context and engage students in a learning environment. In healthcare, a computer-based simulation system is particularly beneficial in reducing training risks and cost, increasing effectiveness of clinical practice, as well as improving learner's confidence and knowledge prior to delivering care to real patients.

Despite appreciation of the general value of computerized simulation in healthcare, there is only sparse literature relevant to the care of dementia patients. Also, most healthcare simulation systems or applications tend to use only one kind of media to deliver content (for example, patient avatar, narrative story, or video), which may not be sufficient to bring the system close to reality and/or provide good support for learning purposes. Furthermore, most studies lack evaluation of the use of the systems. Thus, the question of how to design a simulation system to support immersive learning for nursing care, particularly for dementia care, remains.

The goal of this research is to establish a framework to guide the development of a simulated, multimedia-enriched, immersive, learning environment, the so-called SMILE framework. This framework models essential media components used to describe a scenario applied in healthcare (in a dementia context), demonstrates interactions between the components, and enables scalability of simulation implementation. The research outcomes also include a simulation system developed in accordance with the guidance framework and a preliminary evaluation through a user study involving ten nursing students and practitioners. The results show that the proposed framework is feasible and effective for designing a simulation system in dementia healthcare training. In addition, the research demonstrates that a combination of media representations (an avatar, videos, types of questioning, and related information) help to create realism to the clinical situation. Thus, this SMILE framework can be adapted to other health domains as a guideline for future development of simulation training systems.

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List of Abbreviations

SOA	Software Oriented Architecture
UML	Unified Modelling Languages
VH	Virtual Human
EMRs	Electronic Medical Records
SUS	System Usability Scales
SMILE	Simulated-Multimedia enriches Immersive Learning Environment

Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

QUT Verified Signature

Signature:

Date: _________10/03/16_________

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Chapter 1: Introduction

This chapter outlines the background and motivation (section 1.1) and research problems (section 1.2), and the aim and objectives of this study (section 1.3). Section 1.4 describes the significance, contribution and scope of this research. Finally, section 1.5 includes an outline of the remaining chapters of the thesis.

1.1 BACKGROUND

Simulation is a technique to replicate substantial aspects of real world experiences in a fully interactive fashion, often immersive in nature (Gaba, 2004). Simulation has been utilized in multiple disciplines, ranging over education, military, industries and hospitals (Aebersold & Tschannen, 2013). In health-related education or training, simulation can be considered as using advanced technology to replicate the real world health content and context (e.g., clinical environment, health information and medical activities) and to engage students in learning.

Existing simulations in healthcare training mainly focus on intensive care, paediatrics, medicine and anaesthesia (Allan et al., 2014; Bradley, 2006; Cumin, Weller, Henderson, & Merry, 2010; McCrossin et al., 2014; Oakley et al., 2014). However, there is a lack of research on dementia patients for nurse education. The key benefits of using simulation for health education/training are safety, effectiveness and reasonable cost. Educators can use a patient simulator to help nurses practice their skills without risks to the patients (Jenson & Forsyth, 2012). A patient simulator can be treated as many times to improve or practice nurses' skills (LeFlore et al., 2012). If the patient simulator is introduced into the learning and teaching process, novice practitioners and nurses will learn how to articulate basic and advanced skills in a clinical context (Good, 2003). Using a patient simulator is also more cost-effective compared to traditional training, which consumes substantial resources including teachers, patients, time and equipment (Drews & Bakdash, 2013). Moreover, evidence increasingly supports the notion that simulation improves the clinical performance for practitioners and provides higher responsibility towards patients (Drews & Bakdash, 2013). All of these benefits are applicable in the scenario of nursing practice within dementia patients.

Media is an important component for developing a simulation system to create an immersive learning environment. There are several means of media representations, particularly, video and a virtual character (an agent). One study implemented a virtual coacher to interview people who are potentially suffering from a stress-disorder, inviting the people to share their difficulties and issues (DeVault et al., 2014). Kenny et al. (2007) also developed a virtual patient for practitioners to develop communication skills to enhance a psychopathology curriculum. Both studies received valuable information from many people, who were willing to share their thoughts via the virtual character or coacher; such information is reliable and useful for an educator. Another kind of media is video which poses significant benefits in engagement and promoting self-confidence. In term of engagement, video delivers stories which easily catch the attention of users, without being too personal or confronting, and which can motivate individual's learning (Korkiakangas et al., 2015; Moreno & Ortegano-Layne, 2008). Apart from media components, story-telling plays an important role of driving overall simulation in the so-called scenario-based simulation. The scenario-based simulation is often used for learning and training purposes (Nagle et al., 2009). Scenario-based simulation has been successfully used in clinical and nurse training. For example, one study used case scenarios from Open Labyrinth integrated with a Second life platform to train nurses via E-learning environment (Orton & Mulhausen, 2008). Telling a clinical story in text-based information does not engage individual much. However, with the help of multimedia, such as an avatar or videos, the simulated scenario can become more entertaining. To summarise, there is still not enough research attention paid to developing media simulation for education in dementia. Moreover, there has been considerable research into conceptual frameworks to guide the process of development, from gathering requirements until reaching the research evaluation stage. But, there are only limited studies on how to model conceptual simulation into practice for development purpose, using several kinds of media – such as how to structure the media components, how to structure the story technically in clinical simulation, and what programming techniques can be used to apply those media in a way that is more flexible and scalable.

In my study, the conceptual framework (SMILE Framework) was initially established based on literature, and then evaluated and improved through an implementation of a simulation system and a user study upon the system. This framework focuses on high fidelity simulation of scenarios, simplicity and flexibility of system, which can be used as an effective training or learning instrument. These are achieved by structuring scalable layers of the system, identifying the essential components of the simulation system, utilizing multimedia and evaluating the integrated effects.

Additionally, essential components are then identified for developing such a complex-simulated system to deliver clinical scenarios and enhance nurses' capabilities by the use of several multimedia solutions such as video demonstration, intelligent simulation system, and static information. An aggregate mean of a complex computer simulation can be somehow challenging due to the technical difficulties and heterogeneous educational objectives. Bringing out the most beneficial part of multimedia advancement can be seen as a worthy objective. This research evaluates the effect of each individual, dynamic media on overall performance of the simulation to deliver an objective in education or training. The research outcome will contribute to the organization of educational healthcare by modelling clinical teaching, such as patient scenarios or medical procedures, and an effective computerized artefact. The intention is to further improve the quality of nurse education. Also, users can utilise the simulation to enhance their knowledge and skills in dealing with situations within the medical domain before they enter the real-world environment.

1.2 RESEARCH PROBLEMS

Based on the gap identified in current research, the major research question is:

- What is an effective framework that can guide the design and development of a multimedia enriched simulation system characterised for immersive leaning environment?

When establishing such a conceptual and practical framework, it is essential to identify the key framework components, which may include scenarios, virtual agent, clinical data and multimedia that translate patient scenarios into a computer model for education of nurses providing care for dementia patients in a clinical situation. It is also important to design the relationship and interactions between scenarios and a virtual model to ensure an effective simulation system. Moreover, the framework should take into consideration the flexibility of the simulation system, whereby the health professionals are capable of customizing scenarios according to their specific needs, for example by updating medical documentation and patient history. Thus, the following sub-questions can be derived:

- What are the essential components of a virtual training system for supporting dementia nursing practice?
- How can the simulation be modelled to seamlessly capture nurse-patient interactions?

1.3 AIM AND OBJECTIVES

The primary outcome for this research is to design and produce a conceptual framework that provides guidance on how to transform patient-care scenarios into a computer simulation artefact which supports nursing practice, especially in dementia healthcare, while integrating with the clinical professional's inputs. This framework should be structured and validated via establishing a high or moderate fidelity system that is enriched by real human experience and given real clinical scenarios. Subsequently, the design and performance of the system is evaluated by student nurses at Queensland University of Technology (QUT) and nurse practitioners. This study involves three major objectives:

- Design an interactive and multimedia simulation framework in healthcare context and examine the proposed framework for use in the dementia context. This involves investigating key components for a virtual patient system.
- Implement a simulation system following the guidance of the proposed framework, which supports interactive communication, both verbal and nonverbal, integrated with the given patient case.
- Preliminary evaluation on usefulness, ease of use, interactivity, realism and satisfaction of the developed system.

1.4 SIGNIFICANCE, CONTRIBUTION AND SCOPE

The research significance is multi-fold:

1. It provides a novel, simulated, media-enriched, immersive learning environment, SMILE framework. This framework is modelled on essential media components needed for healthcare – particularly in dementia patients. The SMILE

framework also depicts the interaction of several media components from the end user point of view and the technical point of view. The framework employs the SOA technique to enable scalability of the system, which can further guide future research on similar research problems. Also, the framework bridges a gap by using a combination of media to support a simulated scenario applied in the dementia domain. With regard to nurse education and engagement there is not much research within this particular domain.

2. It delivers a simulation system for nursing training of dementia patient care. Although some research has been conducted in dementia for nurse training, our study implemented a combination of media such as video and virtual character for the first time in this area.

3. It provides an evaluation study to examine the framework and simulation performance quantitatively and qualitatively. The results facilitate a better understanding of different user needs and indicate further improvements for the system.

Contributing to research, the dissertation demonstrates research methodology in each stage, which can help for future research in related domains. To begin with, this will include a comprehensive review of current literature and an examination of limitations, conceptual and technical framework, and evaluation guidelines, in research initiation stage. Subsequently, the research design and development stage will employ Unified Modelling Languages (UML), such as use cases, and Software Oriented Architecture (SOA) for developing media components. In addition, our research will adopt the Agile Methodology for development, focusing on scalability, and we will collaborate with an external expert to ensure end-user satisfaction. Finally, research evaluation will use a combination of qualitative and quantitative techniques for system evaluation.

To contribute to the real-world practice, the proposed SMILE framework can be used to guide the design and development of a complicated simulation system for nursing care by adapting to various healthcare scenarios and/or other domains. The implemented simulation can be directly used by the end users. The SMILE framework guides the design of how to develop the system. The system can be utilised by the end users such as nursing students, nurse practitioners, or clinical experts. For students and nurse practitioners, they are able to use the system supported by the SMILE framework to practice their learning skills, especially skills in decision making and communication skills, before they face real circumstances. Also, it is believed that the system will be considered as an additional learning tool, which can be used as many times as required, to explore unusual or unexpected circumstances and create an opportunity to experience what the real clinic is like. From another point of view, clinical experts will be able to see how students or nurse practitioners perform in particular situation, such as how they deal with angry behaviour and how they communicate with the simulated patient. As discussed with our clinical collaboration expert, it is suggested that it is important to understand communication between nurses and patient and thereby possibly reveal individual capabilities. The study tries to capture the end-user expectation by involving opinions from nursing students or nurse practitioners and expert recommendations. With the limited resources on patient scenario, it is expected that the initial system, using a dementia patient as a sample case, will deliver a comprehensive understanding of how to model a story in a multimedia context. Later, this can be further applied in other healthcare area.

The scope of this study merely focuses on technical aspects in terms of design and validation of multimedia components needed to support a media enriched simulation within hospitalised environment. It is such a privilege to collaborate with Mr. Fred Graham who is a clinical professional in nursing. Mr Graham will assist the incorporation of a patient case into the system. The patient story is sample input of a dementia patient at the hospital. Only by doing so, will the researcher be able to gain insight into the clinical environment, where the given story (clinical scenario) will act as a basic guideline of what digitalised content requires to establish such a complex patient simulation. It should be pointed out that there is no intention to validate any clinical purpose for this study.

1.5 THESIS OUTLINE

Chapter 2 arranges and reviews literature to answer research questions, presents an overview of multimedia simulation, benefits, multimedia simulation architecture, and provides a summary literature review. This chapter begins with an investigation of the role of media simulation in healthcare and its advantages, and then explores conceptual frameworks in simulation and technical concepts for development of a simulation system. Then, the chapter investigates multimedia design guidelines to establish a solid picture of designing an engaged media simulation. Finally, chapter 2 summarises how to evaluate the performance of the proposed simulation framework, with some criteria and guidance.

Chapter 3 discusses the details of the research framework for the study. Research objectives and methodologies used to conduct the research are also discussed. Then, the chapter provides an overview of evaluation design, explaining this in conjunction with ethical clearance. The evaluation tool is then discussed in detail and research limitations outlined.

Chapter 4 gives details of the design and implementation of the media simulation. This chapter discusses the framework architecture which is then described in–depth, including details on the presentation layer, business logic layer and data storage layer. Then, the proposed framework is used in the clinical situation - dementia context.

Chapter 5 presents the results and discusses the framework from research evaluation and feedback provided by nursing students and experienced nurses. The first part summarises a preliminary evaluation with two students and then discusses quantitative and qualitative evaluation data. To conclude this chapter, both evaluation techniques are discussed.

Chapter 6 summarises all the implication of this study and discusses future research and limitations of the present research.

Chapter 2: Literature Review

In line with the research questions, the literature review is conducted from three aspects, which are critically evaluated and delineated from theoretical and/or conceptual perspectives to practical details. The literature review will begin with an overview of multimedia-enriched simulation in terms of its role and opportunities. Then, the review will explore how to design and build a simulation architecture. Lastly, a system evaluation criterion for multimedia models is discussed analytically to capture the quality of multimedia simulation experience in the healthcare domain.

To be more specific, this chapter begins with an overview of multimedia simulation in healthcare and its benefits (section 2.1) followed by the media simulation in healthcare (section 2.2). Following this, the chapter examines the types of media and resources used in healthcare simulation (section 2.3). After that, the chapter discusses multimedia simulation principles for simulation (section 2.4) and multimedia simulation architecture, which describes conceptual and technical frameworks in media simulation (section 2.5). Then, the chapter discusses implementation techniques (section 2.6), and finally deals with evaluation techniques (section 2.7). The chapter is summarized in section 2.8.

2.1 AN OVERVIEW OF MULTIMEDIA ENRICHED SIMULATION

According to Gaberson et al. (2014), simulation can be classified into three types: low fidelity, moderate fidelity, and high fidelity. Low fidelity is non-computerized simulation; it uses constant equipment to help learners practice series of steps in clinical cases. Low fidelity prolongs the benefits of psychological fidelity (Drews & Bakdash, 2013). Moderate fidelity supports more realistic clinical situations and is able to give feedback to students, albeit only one-way communication (Gaberson et al., 2014). The moderate fidelity mannequin is supported by a computer program or video (Kardong-Edgren et al., 2011). Finally, high fidelity is a reproduction of a computerized model that reacts in a realistic way for communication in real scenarios, such as involving speaking, gesturing, and movements (Gaberson et al., 2014; Kardong-Edgren et al., 2011). Compared to the others, high fidelity simulation is more immersive and more interactive; on the other hand, it is more challenging to generate. So far, no high fidelity simulation in dementia patient healthcare has been developed.

Commonly, multimedia simulation has been extensively used in multiple disciplines, ranging over education, military, industries and hospitals regardless of its capabilities (Aebersold & Tschannen, 2013). The significant reason for its being so widespread across sectors is that multimedia helps a computer-based simulation to act as close to a real life expectation (Garrett & Callear, 2001). Therefore, it minimises resource use and enhances individual learning competencies (Hennessy et al., 2006).The technological simulation enriches the clinical education system in term of teaching and learning skill, which acts as the core comprehensive strategy for delivering best practice in real life circumstances. Not only does simulation enrich individual knowledge but, in some disciplines, particularly in nursing, it is also made obligatory in assisting patient care, allowing individual to practice in preeminent procedures, which instructors find difficult to demonstrate appropriately in real-time, clinical settings (Bauman, 2012). Such a best practice approach can guide novice or more experienced nurses who wish to train valuable skills via simulation before performing actual duties with confidence and patient safety. Good (2003) also emphasized that simulation can be perceived as a valuable means to acquire both fundamental and advanced expertise for nurses, carers, and physicians. Another positive impact of multimedia simulation would be to provide insightful skills assessment for managers in the commercial healthcare sector or in the education system. One major consequence of this approach is that the educator can visualise how well students perform when making their decision in a specific context. Based on this exploration, an educator is then able to improve student capabilities based on this measurement. This assessment is often the result of simulation-based learning and training or overlaps other kinds of training (Mislevy, 2013).

A multimedia simulation can provide numerous benefits, but one of the distinct advantages is direct feedback that can be provided via a digital form of simulated arrangement based on individual performance (Good, 2003; Guise et al., 2012). Another benefit of this virtual media simulation is safety in healthcare perspectives. Educators can use a patient simulator to help nurses practice their skills without risks to patients (Jenson & Forsyth, 2012). In addition, it can prevent a fear of failure when students make mistakes and encourages them to advance to further stages (Ziv et al., 2003). A patient in virtual reality can be treated many times to improve or practice nurses' skills (LeFlore et al., 2012; Kneebone, 2003). If the patient simulator is introduced into the learning and teaching process, novice practitioners and nurses will be able to learn how to articulate basic and advanced skills in a clinical context (Good, 2003). According to the cognitive theory of multimedia learning (Mayer, 2010), multimedia demonstration can be classified as words and pictures. Those are then perceived by ears and eyes within human sense, which can then lead to a long term memory. Thus, it is critical to understand what sorts of words or pictures that being used nowadays within healthcare simulation, which discussed in the following section.

2.2 MULTIMEDIA SIMULATION IN HEALTHCARE

Upon reviewing a number of relevant literatures, this study has found four major constraints lie in healthcare sectors, and these are shown in Table 2.1.Our investigations reveal that virtual patients are increasingly used in facilitating training and education in hospitals for various purposes. However, limited research has been conducted in dementia patients and little attention has been drawn to the interaction between nurses and patient simulation where messages are exchanged mostly verbally and nonverbally. The lack of gestural behaviour may especially lead to ineffective outcomes. Another problem is that most recent studies tend to use game-based engines for improving skills. The major drawback is that non-game people may feel uncomfortable with these systems. A further problem is the lack of research on the usage of simulation in the long term. There is not enough evidence on how effective simulation is. Further study of this issue is still required.

Table 2.1 Limitation of a virtual patient in healthcare domain

Reference	Findings
Orton and Mulhausen (2008); Bamidis, Antoniou and Sidiropoulos (2014)	Little research into the development and use of virtual patients targeted at geriatric education.
Forsberg et al. (2011) ; Conradi et al.(2009); Danforth et al. (2009); Guise et al. (2012) ; Janda et al.(2004); Toro-Troconis et al.(2010)	Lack of nonverbal communication.
Toro-Rroconis et al. (2010); Quaas and Bjorklund (2012)	Takes more time to become familiar with the complex system.
Brown et al.(2012); Dickerson et al.(2005); Janda et al.(2004); Kenny et al.(2008); Raij et al.(2007)	Limited research on evaluation of the system.

Within the area of simulation in education, training, and assessment, a computer-based game simulation is commonly utilized to accommodate the need and enhance individual performance. Osman and Baker (2012) found the relationship between learner's knowledge and game-based learning that adds to the performances in Asian Classroom. This is due to the fact that the procedure of game application is close to real learning practices in terms of problem-solving approach (Begg et al., 2006). Therefore, several studies try to exploit its effectiveness and use in several areas such as military, education, marketing and advertising (Ariffin et al., 2014). One of the most well-known game learning, known as the "second life platform", is integrated into several curricula. For instance, one study uses a virtual ward in a hospital and learners participate through the ward to provide medical treatment based on their decision. Rewards are also added to encourage learner motivation and engagement to solve specific problem (Toro-Troconis et al., 2010). Another study also applied this platform in caring for the elderly in a trainee group. However, this study admitted that employing the second life as a training approach is not yet state-of-the-art in healthcare for the elderly as there is, as yet, little research in this domain and there are gaps between incorporating technology and teaching (Bamidis et al., 2014).

There are several techniques to implement a virtual simulation delivering information and assessing the ability of an individual in the clinical environment, such as multimedia, communication, decision making and health related information. In other words, different means of two and three dimensional graphics can be used to present narrative stories where users engage in the system. Table 2.2 provides a summary review of the use of multimedia simulation in healthcare from 2006-2015. Several studies rely on a combination of text-based information and only one kind of animated representation in either a virtual character or video. None of the video simulations are outstanding as a mean to increase communication experiences. The video-supported simulations often represents storytelling to learners, but provide no understanding of how leaners actually interact with them. For instance, they do not reveal the sort of questions participants want to ask or how they deal with a particular situation. A closed-scope discussion is difficult to investigate to determine how learners think, as they only have limited options to select from, and communicate with patients. In addition to this, encouraging individual thinking often uses both open- and closed- ended techniques; several studies on a virtual human tend to incorporate those techniques interchangeably. Although there is some research on video simulation, research on how to add this to the system is lacking. Apart from dynamic multimedia, static information is also required to provide more clinical practice for nurses to investigate a patient's background analytically.

Table 2.2 Summary of Components and Features of Multimedia Simulation in Healthcare

Components	Features	(McConville & Lane, 2006)	(Danforth, Procter, Chen, Johnson, & Heller, 2009)	(Yoo, Son, Kim, & Park, 2009)	(Toro-Troconis, Meeran, Higham, Mellström, & Partridge, 2010)	(Rizzo et al., 2011)	(Guise et al., 2012)	(Bamidis, Antoniou, & Sidiropoulos, 2014)	(Korkiakangas, Weldon, Bezemer, & Kneebone, 2015)
Multimedia	**Virtual Human**		✓		✓	✓		✓	
	Video	✓		✓					✓
Communication	**Interpersonal**					✓			
Decision making	**Open-ended Questions**		✓		✓	✓			
	Close – ended Questions		✓		✓	✓	✓	✓	
Health Related Information	**Clinical Record**		✓		✓			✓	

Based on the gaps and limitations in earlier discussions, our study will employ a combination of essential multimedia representations: virtual human, decision-making, videos, and related data, to deliver a completed simulation framework applied the context of the clinical environment with a sample case of a dementia situation, recognising that there is little research in this area. The following section will discuss in more detail the type of media or resources needed to develop a multimedia-enriched simulation in healthcare.

2.3 TYPES OF MEDIA AND RESOURCES USED IN MULTIMEDIA ENRICHED SIMULATION IN HEALTHCARE

2.3.1 Scenario

Apart from the technological simulation perspective, scenarios also play an important role to enrich the participant's knowledge within specific learning outcomes (Alinier, 2011). Nadolski et al. (2008) also emphasize that scenarios must be:

"modelled on real-life situations that often include a sequence of learning activities that involve complex decision making, problem-solving strategies, intelligent reasoning, and other complex cognitive skills. Students are left in charge to deal with complex problems according to professional or

scientific standards. Real-life situations display ambiguity and conflicting information and offer a large degree of freedom. Often, complex real-life problems (also referred to as "cases") are likely to involve several participants (i.e., multiuser cases). Because some actor roles could be covered by the computer, single-user cases are also possible."

Thus, building effective scenarios plays a vital part in pedagogical approaches, especially those integrating a high fidelity simulation. Simulation-based training requires flexibility over the process of learning so that designed scenarios must design to be adaptable over time. Learners' mistakes, new resources, and other updated clinical data always trigger new actions to improve the performance of the simulated system (Ziv et al., 2005). Earlier research from Seropain (2003) suggested that preparing scenarios requires several components such as objectives, personnel and equipment, computer setup, paperwork, context, teaching information, references, and notes. Dreifuerst (2009) also agreed that those essential components would assist students to think critically and theoretically, based on real clinical data. Designing each scenario consumes much time, but Dieckmann and Rall (2008b) proposed a fast prototyping model to overcome this situation. Although this theory of constructing scenarios seems well-organized and addresses various significant aspects in health care learning, there has so far been little attention in the research to how to make scenarios appropriately realistic within the simulation. One study demonstrated the need to measure the performance of cases during a pilot study (Nadolski et al., 2008). In addition, the more engaged participants are, the more knowledge can be transferred. However, it is not always true that practical learning will meet a high level of learning objectives (Dieckmann et al., 2007). Chow and Naik (2008) were of the opinion that simulation does not need to replicate all reality, as simulation is not able to, but it should provide a balance between scenarios and reality to improve the participant's experience in an efficient approach. By doing scenario design, Alinier (2011) encouraged educators to create unscripted action performed by participants unexpectedly to help them to improve their experience learning.

Prior to building an effective clinical simulation, a well-structured story must initiate the whole system by identifying essential modules: objectives, personnel and equipment, computer setup, paperwork, context, teaching information, references, and notes. Only by doing so, will scenario design have clear objectives, aims, and design. Significantly, scenario design requires a flexible structure which can be altered according to new requirements within the simulation context. The story is necessary for every media simulation, because it is a driving tool for all of the activities and interaction between users and system. Therefore, our research will define the structure of how to model the contents to be flexible and structural.

2.3.2 Virtual Human

A number of studies have developed a long term relationship of virtual agents that converse with participants verbally and non-verbally, such as MACH (My Automated Conversation Coach) and CALONIS (Hoque et al., 2013; Wilks & Jasiewicz, 2014). The development of embodied agents often follows the pattern of designing a complex game, such as Orge and Source, for physical representation (Steve, 2009; Valve, 2004). Most of the framework tools rely on what program languages are being developed and create a dependency among various components which makes it difficult to further adjust in the long run. To reduce the complexity, each engine should be developed individually. An example of this would be from the Virtual Human Toolkit (Hartholt et al., 2013). This work emphasizes each individual component loosely, which offers a solution to several aspects such as a dialogue conversation, non-verbal behaviours, and virtual characters. If one considers building a fast agent, the Virtual Human Toolkit will be the only one that demonstrates a rapport management in agent interaction. Another study from Vala et al. (2009) also proposed using the ION Framework, which decouples the simulation environment and the real engine by following a set of design guidelines: 1) coherent access to information, 2) mediation of conflicts, 3) active and passive data gathering, and 4) active configuration changes.

The examples of virtual human applications often involve crime and healthcare. In crime investigation, the JUST-Talk training applications implemented by the virtual human technology for police training to deal with mentally ill persons to ensure minimal risk of injuries; there is a need for more applications for this kind of training as the resources for this critical purpose are as yet quite inadequate (Mykoniatis et al., 2014). A significant implication of virtual human system is that it is not purely used as a substitute for training, but rather is used as an improvement to training, as it includes personal characteristics involved in communication. In healthcare, it is a relatively important matter for nursing practice to deliver the best diagnosis to patients. Kenny et al. (2007) developed a virtual patient to be used for interviewing and diagnostics for practitioners and to examine its usefulness to enhance a psychopathology curriculum. A virtual interactive patient is commonly used for increasing communication skills and decision making based on a particular case (Stevens et al., 2006). A recent study also applied virtual technology, called SimSensei Kiosk, to interview in healthcare decision support (DeVault et al., 2014). The virtual character interviews people with a stress disorder enabling them to share their information comfortably by using both verbal and non-verbal interaction. Lucas et al. (2014) highlight that the Virtual Human (VH) increases the amount of authentic information from participants and they are willing to share such information with a computer-based simulation.

In summary, the use of Virtual Human offers several benefits in various domains, particularly for training in healthcare or crime investigation. It enhances traditional training in several respects, such as participants seem to share reliable information with the virtual patient simulations. Furthermore, in military and crime investigation, participants learn negotiation skills and find suitable solutions to solve given problems effectively. As a result, our study will employ the Virtual Human Technology to develop interpersonal communication and increase a trustworthy system for users to share their thought. This strategy can help individual to be immersed into the clinical simulation due to the interaction between the virtual human and the user.

2.3.3 Video-Supported Simulation

Apart from purely text-based narratives, video technologies add a suitable option for an education system. For instance, by the use of simulation, students are encouraged to gain learning by doing (Prescott & Garside, 2009), transferring knowledge by engaging in the computer application, innovative state and motivated individual's learning (Moreno & Ortegano-Layne, 2008). There are several benefits to these technology arrangements in education and training. Korkiakangas et al. (2015) explain that video promotes attention and helps users to expand their wide-ranging sight of content without becoming too personal. With this precise advantage, Paul (2010) emphasizes that video also supports learners in critical thinking, self-reflection, self-awareness, and self-confidence. In particular, video-supported simulation helps learners to strengthen their sympathetic thinking (Korkiakangas et al., 2015). A study in a medical school demonstrated that students who gained access to online-video as another means of learning besides normal teaching exhibited positive impact of skill acquisition and satisfaction (Holland et al., 2013). Not only does this claim apply in the medical area, but also in a nursing school. Blazeck and Zewe (2013) highlighted the significant accomplishment in integrating video simulation as an opportunity for learners to become proficient in their practice under their own control. Another study from McConville and Lane (2006) also proved that the video-simulated, real life experience in nursing education, positively increased self-confidence and achievement in specific circumstances. According to Yoo et al. (2009), video-based self-assessment assisted students to develop their clinical and communication skills, as well as identifying their strengths and weaknesses in their field. Recent research similarly points out that video-assisted simulation and role-play scenario increases students' knowledge.

Even though there is much evidence on the effectiveness of video-based simulation in terms of education and engagement, there is not enough evidence to prove that such an advanced video simulation can make a difference to traditional education. Reed et al. (2013) argue that there is no proof that video learning has a greater impact on undergraduate nursing students than learning without it. This is consistent with Alinier et al. (2006), in which no relationship was found to indicate that self-confidence improved by using simulation training or compared to not using it. Additionally, this study also reported that a high-tech atmosphere made students feel pressured when using the simulation.

To conclude, and on balance, video- supported simulation seems to influence education and training in terms of acquiring user attention, improving critical thinking, engagement, and increasing self-confidence. Thus, our study will use these positive benefits to increase a trustworthy framework in combination with the Virtual Human Technology.

2.3.4 Types of Questioning in Simulation

Another important component for simulation is how to enable participants to be able to effectively communicate in a digitalized setting, such as via a virtual character. Communication skills are essential for nursing practice because insufficient communication may lead to frustration between nurses and patients (Finke et al., 2008). Fortunately, these abilities can be improved and taught (Maguire and Pitceathly, 2002). Deveugele et al. (2005) emphasize that effective communication in healthcare include listening to patients, dealing with some emotional behaviours, giving some information or feedback, and dealing with psychosocial issues. Doyle et al. (2011) and Wong et al. (2011) found that the causes of this miscommunication are nurse ability, nurse behaviour or patient related.

Consequently, in order to improve communication skills, it is a must to focus on appropriate methods to cope with clinical complexity and delivering the best practice to patient care and satisfaction (Gausvik et al., 2015). In addition to delivery of high quality care towards patients, nurses must know how to report situations precisely back to other clinical staff in a standard manner (Velji et al., 2008).

Communication in reality often includes both open-ended and closed-ended questions. The open-ended question aims to ask users to express their opinions based on their knowledge without any hints or clues. On the other hand, the closed-ended questions, or cueing questions, provide more clues by giving a multiple choice option. Both arrangements have positive and negative impacts.

The benefits of using both open- and closed-ended questions include: encourage participants to think before expressing their opinions (Iyengar, 1996; Roberts et al., 2014); help participants to release their stress and smooth the path along the way to learning (Wickers, 2010); assist students to recognize the connection of various perspectives such as patient symptoms, pathophysiology, and nurse intervention; help educators to understand their students' perception of how they communicate with patients so that educators can rethink a better way to improve related issues that most students have (Chan, 2014). Thus, it is believed that both styles of questions contribute helpful outcomes to simulation training and education.

The negative impacts of both strategies are that it can be difficult to express a short response to an on open-ended question; information provided by items for multiple choice selection can be misunderstood producing false knowledge (Butler & Roediger, 2008; Roediger & Marsh, 2005); multiple-choice questions can lack vision of individual thought(Roediger & Marsh, 2005).Although there are some drawbacks in both types of questioning, it is believed that the positive impacts of including both outweigh drawbacks.

Therefore, a combination of open- and close-ended questions will boost learner ablities, create more critical thinking based on specific circumstances, reduce student stress and frustrations, and help the educator to better understand what needs to be improved by investigating learner decisions.

2.3.5 Health Information Resources

There is a need for technological development in the way health information is integrated into nursing practice and education. It is essential to provide appropriate patient information to supporting decision making which nurses can provide good and safe care to patients (Sanford, 2010). A pilot study in the explanation of health documents indicates that paper explanations might be a vital field for developing a virtual character (Bickmore et al., 2007). However, incorporating healthcare information in nursing education is challenging and difficult due to the complexity of information management and interactive technology (Jensen et al., 2009). According to a study of health management through organizational simulation, information literacy stimulates people's views and helps them to deliver consequent outcomes; however, this study does not indicate whether accessing information will result in better performance in the clinical setting (Basole et al., 2013). Despite technological challenges, incorporating health information poses benefits such as increasing clinician proficiency, assisting clinical persons when making their decision and fostering quality of care (Dayhoff et al., 2001). AlFalah et al. (2013) state that medical data are significant for patient care during practical sessions and also for research purposes. A study from the United Kingdom focused on information handover between doctors and junior doctors using traditional method versus electronic information software. This study proved that using web-based delivery of information has a potential benefit, such as improving the accuracy of information transferred from doctor to doctor compared with traditional methods using pen and paper during handover sessions (Patel et al., 2009). However, Vuk et al., (2015) identified several issues related to electronic medical information, such as not being patient-centred (Shachak et al., 2009), variation in communication skills (Shachak et al., 2009), and staff apprehension of the approach (Ludwick & Doucette, 2009). Electronic Health Record (EHR) can enhance decision-making such as in emergency department. This technological advancement enables medical professionals to access information related to patient history or records, which are crucial when one needs to make decisions. Ben-Assuli et al. (2015) support the fact that if medical information is easy to access, the staff will make a good judgement.

It is not surprising that health information is essential for the clinical sector due to advances in digital delivery and the need for nurses to increase information literacy when delivering care to patients. Moreover, electronic medical information helps to eliminate practice mistakes and delivers a cost-effective system (Thurston, 2014).

To summarize, health information in the form of digitalised patient histories or records is an important element for clinical simulation as it supports learners to deliver good care to patients, and increases clinical proficiency. Medical information is usually provided to learners while they are studying in the classroom. Likewise, in the simulation context, it would be perceived as a valuable resource for learning and practicing their knowledge.

2.4 MULTIMEDIA PRINCIPLES FOR SIMULATION

The combination of several media can be changed by addition or subtraction within the simulation, and there is no limit to the number of demonstrations. Ziden and Rahman (2013) suggest that adding several media, such as graphics, audio, video, and text, stimulates learning outcomes. However, drawbacks of multiple media can arise if unnecessary images or audios are excessive, which then affects learning capabilities (Mayer et al., 2001). Consequently, when designing simulation that is appropriate for healthcare education, Chiniara et al. (2013) propose a two-dimensional matrix with "Opportunity" and "Acuity" as the x and y axis respectively, shown in Figure 2.1. "Acuity" relates to the classification of prospective events and their impact on patients; "Opportunity" is the amount of time that particular people are involved in dealing with the event. The available literature rarely discusses how to choose the most applicable simulation for education. Moreover, Chiniara et al. (2013) describe the "zone of simulation" based on Acuity and Opportunity depending on the healthcare need. Simulation is likely to be most beneficial and cost effective, when dealing with activities that fall within the zone of simulation. As a result, effective cost of implementation is a must to design appropriate multimedia content displayed in a computer-based model to prevent information overload to individual.

Figure 2.1 The Zone of Simulation Matrix. Adapted from "Simulation in healthcare: A taxonomy and a conceptual framework for instructional design and media selection," by G. Chiniara et al., 2013, Medical Teacher, 35(8) p. e1382

Although integrating multimedia components in education and training is not a new trend, the technique to represent media has gradually changed over time according to new technological advancements. Several studies have proposed guidelines when developing multimedia in applications. Such a standard guideline is provided to build effective systems which allow engagement and learning simultaneously. Reed (2006) proposed a guideline for multimedia instruction categorised into (1) Multimedia Principle; (2) Spatial contiguity Principle; (3) Temporal Contiguity Principle; (4) Coherence Principle; (5) Modality Principle; (6) Redundancy Principle; and (7) Individual Difference Principle. Many of these principles resemble Gilakjani's guidelines (2012). However, Gilakjani's design adds one more design category of encouraging learners to apply new knowledge and providing feedback to keep learners informed. Feedback is a vital element of learning for beginners to get an idea of doing complex tasks such as in games, simulations, and interactive tutoring systems (Johnson & Priest, 2014; Ayres, 2015).

The most challenging of multimedia principle is how one can design multimedia contents to be immersive and natural in the way that closely resembles reality. The term "dynamic visualizations" encompasses how to design media contents intuitively; its objectives are to use a broad scale of graphic depiction to represent information (Plass et al., 2009). Dynamic visualizations are mainly focused on visual design principles and interactive principles to deliver media content such as simulation and animation. For the visual design principle, Plass et al. (2009) expand on information design from various perspectives such as the cueing principle, the information principle, colour coding principles and integrating multi-visualization principle. Plass et al. (2009) concluded that the challenge for integrating media contents is how to incorporate and animatedly associate all the materials.

Another feature of dynamic visualization is the so-called "interaction design principle" in simulation. This principle determines how to handle contents and how to represent information. Plass et al. (2009) also state that the more the learner is able to manipulate related content, the more improvement on virtualization they can gain. While previous studies concentrate on learner perspectives when visualizing media materials, Weiss et al., (2002) introduced their guidelines for designing interactive content through animation for designers to deliver the right purposes of animation, which normally come in terms of structures and fidelity. This guidelines of Weiss et al. (2002) are classified into five groups: cosmetic function, attention gain function, motivation function, presentation function and clarification function.

Apart from media and animation design, a manikin is also one of the multimedia components. This area is more complicated as it requires a well-integrated three dimensional design. Within nursing care, the virtual human can be used to mimic the role of patient, namely virtual patient. The virtual patient mostly uses in the clinical settings and tends to enhance nurse performance in the long term. One study conducted research based on student suggestions in focus groups (Huwendiek et al., 2009) which conformed to Cook and his colleagues' suggestion (2012) to include medical staff and related people into the planning stage.

Huwendiek et al. (2009) proposed ten principles for designing a virtual patient from the perspective of promoting students' clinical thinking.

1) *Relevance:* The problems and consequences need to be applicable in reality.
2) *Appropriate level of complication:* Should use suitable cases for students and provide guidance throughout the process.
3) *Interactivity:* Simulation is preferred to be more highly interactive in several aspects such as a mix of type of questions (a short answer question or a multiple choice question). This will help the educator to see students' knowledge and capabilities.

4) *Explicit Feedback:* Every decision that students experience in the system needs a suitable response to show the student what they do well or what mistakes they made and what decision experts would make.

5) *Suitable use of media:* Deferent types of media should cooperate in the system so that it closes to reality. It is recommended that pictures or videos are used for the beginning of the case and patient history to develop authenticity.

6) *Concentration on related learning theme:* Use precise words without ambiguity to prevent misunderstanding on the longer-text and use different styles, such as bolds or colours to highlight the important matters.

7) *Summary what the key of learning points*: At the end of training, students prefer to have summaries of significant points so that they can review afterwards.

8) *Authenticity of web-based interface:* The simulation interface will need to be as close to reality as possible so that students are motivated and engaged during the training sessions.

9) *Authenticity of student activity:* All possible decisions will need to be more actively related to the clinical context to allow students to make decisions and retrieve important documents such as patient examination, outpatient, management and treatment.

10) *Using questions and explanations to encourage students to think clinically:* Asking students to boost up their critically based thinking on short answer question and provide appropriate feedback. By integrating design principles 3, 4, and 9, students have a positive perception towards being well-prepared for treating patient in a real environment.

All these discussed design guidelines acts as a foundation for developing a successful simulation framework and this study will integrate those guidelines in our proposed SMILE Framework to deliver applicable contents and artefacts to the end-users and at the same time engage end-users through media.

2.5 MULTIMEDIA ENHANCED SIMULATION ARCHITECTURE

The development of multimedia simulation comprises two main concepts: conceptual simulation framework, and technical simulation framework.

2.5.1 Conceptual Simulation Framework

Bauman (2012) provides a broad simulation framework to practice pathway in clinical healthcare, emphasizing that manikin-based simulation is the "man in the middle" who connects knowledge acquisition and clinical practices. This study shows an overview of how educators can adapt fidelity simulation in curriculum to add value in learning activities. In addition, this is not only a suitable view for higher managerial level in the education system, but is also a tool for lower-level understanding on overall concepts. However, there is a need to be critical in terms of the technological point of view as well. Thomas and Milligan (2004) provide two models of simulation: computerize and experimental model.

Firstly, the computerize model controls how the system behaves. The simulated model can be developed using a two-dimensional technique or a three-dimensional technique which include more learner engagement (Jimoyiannis, 2011). In order to determine what type of models is suitable for simulation, it is necessary to define how much fidelity to real situations is required in the education system (Gaberson et al., 2014; Marten, 2011). Aebersold and Tschannen (2012) emphasize that most educators use integrated technology and simulated frameworks to construct simulators. Secondly, the users will interact with the computerized model. Predominantly, the model focuses on people-based interaction. By providing inputs, the system then generates responses to users. In conducting participant experiments, it is important to understand their need through understanding the scope of the training, the likely psychological operations, the performance required and the overall goals of the training (Drews & Bakdash , 2013). Although Thomas and Milligan's model of simulation is self-explanatory, these two concepts do not discuss how to develop a real-life, complex system technically.

In conjunction with a computerized model, a scenario also plays an important role in leading overall simulation. According to Niel (2009), the scenario is categorized into three forms: "on-the-fly", "ad hoc", and automated approach. The on-the-fly and ad hoc scenarios are scalable and no presumption is needed, which reduces development time. The automated approach is an automatic scenario, which requires prewritten code. Nile (2009) emphasizes that every scenario needs a design template, such as patient records, psychomotor and cognitive skills, set-up environment and the type of simulator. Thus, Aebersold and Tschannen (2012) propose five steps to develop a scenario-based simulation aiming to optimise fidelity, as shown in Figure 2.2. Another successful framework to develop stories is from Drews and Bakdash (2013), who visualize five processes: (1) procedure/task analysis, (2) identification of training goals and performance measures, (3) definition of the type of training, (4) development of the simulation tool/technology and (5) development of the feedback model. These two scenario frameworks are analogous in terms of their process-focused method which initializes the scope until producing the actual simulation. However, there is insufficient research on how to formulate and model an effective scenario within simulation that can be used in multiple contexts.

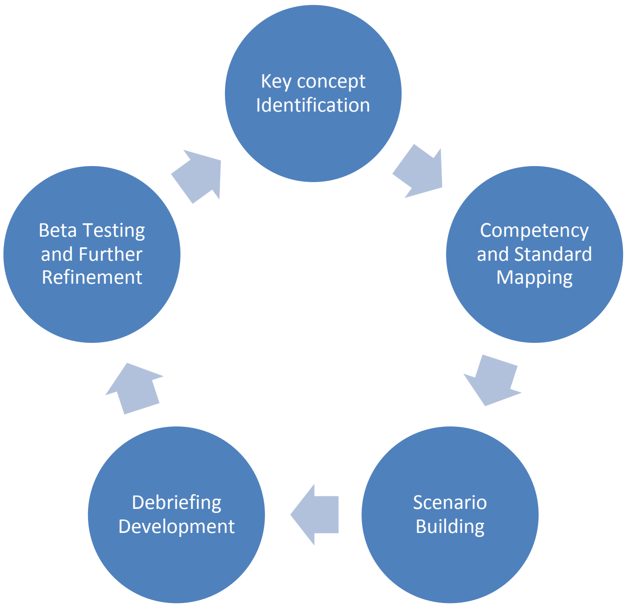


Figure 2.2. Scenario Development Process (Adapted From Aebersold and Tschannen(2012))

One interesting study from Huang (2005) proposed an evidence-based framework for successful development in a patient simulation. This framework was characterized by five phases, shown in Figure 2.3. Particular attention is paid to the whole process of development. Huang (2005) recommended developing multimedia design into five tasks: (1) understand the education difficulty and what users need; (2) design the content linked to technologies; (3) build multimedia with standard matter and incorporating human factors; (4) user testing; and (5) evaluate and improve design.

To start with initial development, it is suggested that the overall system should be outlined, which is called storyboarding, before continuing in the development phases (Huang, 2005). At the start, content must be initialized with concise words and meaningful ways to demonstrate clear objectives, such as by using bullet points to list all related aims and objectives. Then, multimedia design will need to make a connection with content in order to demonstrate the rough information into a visualised representation, such as images and animations. After that, we will need to design how a user experiences the system by identifying all associated interface layouts and how to present different styles of information uniformly throughout the whole system. It is essential for us to code each module iteratively with related content, media, and interface layout.

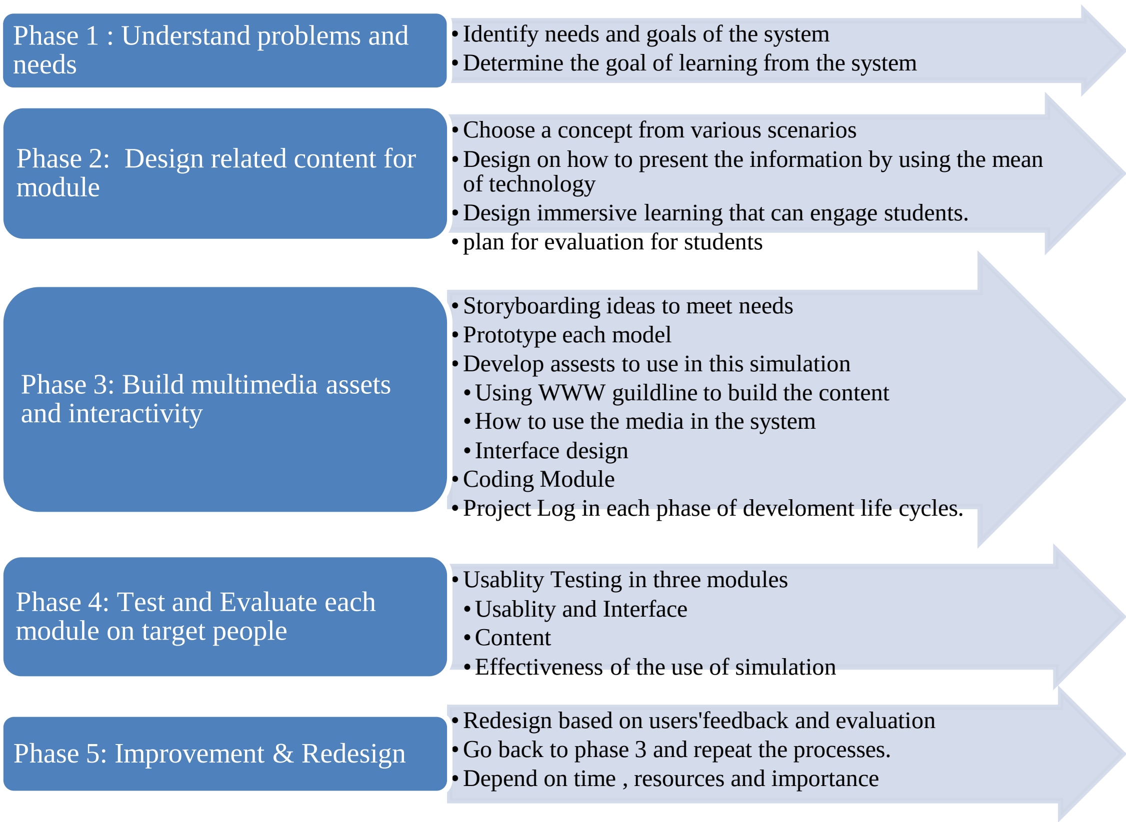


Figure 2.3 The life cycle of multimedia design (Adapted from Huang (2005))

However, the most significant phase is building such a complex simulation by using adequate, multimedia resources. Huang emphasizes an interconnection between each asset and tool required to design the necessary graphics. His view captures every person involved in the system, such as project managers, experts, designers and programmers. Nevertheless, most of the previous studies do not take into account identifying multimedia and stakeholders. This designed framework provides an insight view to establish concrete knowledge when obtaining feedback from many experts in related fields. As a result, this study will seek advice from related health professionals to understand the need and opportunity to deliver a best practice framework within a clinical context.

2.5.2 Technical Simulation Framework

Previous conceptual frameworks are well defined on how to construct a mannequin at an earlier stage. However, they place more emphasis on process-oriented simulation which does not capture how to develop a real system. Significantly, McCallum et al., 2011, p. 703) state that “Learning and teaching strategies are required that are interactive, immersive, real and which link theory and practice”. Thus, technological development has a great impact on simulation.

Hellyby (2013) emphasizes that a large number of emergency services are beginning to use virtual reality to develop and practice skills, because real situations are complex and involve high cost. For instance, Brown et al. (2012) developed an ICU handover application for nurses to develop their caring skills with patients and the method of communication among nurses themselves, especially when transferring documents between shifts. In this application, nurses can key in patient admission details and the records may be updated or removed any time during the handover session.

Ellaway et al. (2008, p.172) suggested that “Virtual Patients are no different in this respect. Because they typically employ narrative and/or aspects of lived experience, the teacher or learner’s need to align the virtual patient with their own experience and understanding is much greater than for more formal and abstract informational styles (such as that of textbooks)”. Ellaway et al. (2008) propose a standardized patient framework which consists of a five-component system linking user and virtual patient. The interaction between the user and virtual human is handled by an activity model which initiates the direction from user’s commands. The activity model mainly links the virtual patient and resources such as images, audio or patient records. Based on this model, health professional education will be able to standardize virtual patients in several aspects, such as in a surgical training program (Filichia et al., 2010) and pharmaceutical care simulation programs (Benedict & Schonder, 2011). Furthermore, current research proposes a new model and simulation framework to address problems in healthcare organization (Augusto & Xie, 2014). It proposes three different views based on a meta-model: process view, resource view and organization view. These three views are not mainly based on theoretical considerations but rather as constructs in a technological perception by using Unified Modelling Languages (UML) or Use case to drive the process from patients to the clinical environment. As a result, our study will employ the similar terminology of a meta-model to capture user and developer points of view so that it reduces the level of complexity and ambiguity in simulation development. Our research aims to divide into three levels: presentation level, business logic level, and data storage level. More details are provided in Chapter 4 on Design and Implementation of a Media Simulation for Clinical Learning Environment.

2.6 IMPLEMENTATION OF SIMULATION FRAMEWORK

2.6.1 Service-Oriented Architecture

The Service-Oriented Architecture (SOA) is a structural model implemented by the service paradigm. The service concept is composed of several components, which act as a software component that works independently and collaboratively within the application (Papazoglou & Georgakopoulos, 2003; Teixeira et al., 2015). The major advantage of SOA is that it is loosely coupled so that, the service component can be further modified and customised based on the application requirements. The decoupling concept is flexible and adaptable over a period of time. The SOA concept normally applies in the software development lifecycle, so the application is more durable over time.

Ameller et al. (2015) state that the SOA reference model demonstrates the overall structure of services which can then be applied in various states within a stipulated domain, such as health care and logistics. The services normally communicate to other components via messages (García Valls & Basanta Val, 2013). As a result, the SOA reference model is applied in a number of SOA applications.

Also, industries and organizations strongly support the SOA paradigm in software development (Keum et al., 2013). The main principles used in SOA application in various disciplines are as follows (Erl, 2005):

• **Reusability**: Generalisation is the key to building SOA applications. Thus, some fundamental services from one application should be adaptable to another context.

• **Flexibility**: The major advantage of SOA is loose coupling so that, the service component can be further modified and customised based on the application requirements. The decoupling concept is flexible and adaptable over a period of time. Thus, the services need to be easy to customize when requirements change. In addition to the flexible services, they need integrate easily within the application itself or into another domain.

To summarise, SOA provides a useful guideline for software development. The characteristics of this technical terminology can be applied to our study for building multimedia-enriched simulation. Each media will be implemented based on the generalised services that then can be communicated to each other via messages. With the flexible characteristic of SOA, a SMILE framework adopts the former's positive features to facilitate and model the story context into the real environment, for learning and practicing in medical situation.

2.6.2 Implementation Criteria of Simulation Framework

The study of Herrington and Oliver (2000) indicate nine principles for developing a simulated system in the learning environment, as shown in Table 2.3. The majority of these components are similar to Huang (2005). However, the focus of these criteria also emphasizes stimulating learners to coordinate their knowledge with experts and other peers to be able to deal with such complex scenarios. Another important area is that they put effort into building an open-ended environment and complex activities, which aim to perform closely to the real situation. Beaubien and Baker (2004) recommended one way to mimic reality by using a gaming platform to design simulation. Moreover, it is recommended that another party such as, in the healthcare domain, clinical members needs to be involved in the game development to ensure accurate production (Cook et al., 2012). The advantages of an open-ended environment and the gaming platform enhance individual ability in terms of building learner knowledge and producing a more reliable artefact. Thus, this study will use a combination of these strategies to deliver a trustworthy, media simulation within a given clinical setting.

Table 2.3 Criteria for Implementation (Adapted from Herrington and Oliver (2000))

Component of situated learning	Guideline for implementation
1. **Authentic Context to reflect real experience.**	▪ The environment will need to affect the real use in general with no attempt to shorten the physical context. ▪ Incorporating a variety of resources with non-linear design.
2. **Authentic Activities**	▪ Allowing relevant activities to be as close as possible to real-world tasks. ▪ Provide a single complex task with adequate time for investigation and allow users to discover new information with self-direct navigation. ▪ Allowing for collaboration and integration of various subject domains.
3. **Access to expert presentations and the modelling of processes**	▪ Allowing users to access to expert thinking and modelling manners. ▪ Providing multiple level of proficiency.
4. **Multiple roles and perspectives**	▪ Allowing multiple dimensions on the topics and also allowing users to express their various perspectives. ▪ Providing an overlap learning environment
5. **Support collaborative knowledge.**	▪ Tasks and Activities are targeted at a team-based practice rather than individual.
6. **Promote reflection**	▪ Providing an opportunity for learners to associate their knowledge with experts or other peers within the setting.
7. **Allow articulation**	▪ Allowing users to integrate their knowledge into a complex task. ▪ Enable defence learning
8. **Provide guidance and scaffolding**	▪ Provide a complex activity and open-ended environment with non-linear design. ▪ Provide a guideline in variety of contexts such as a recommendation from experts or collaborative learning.
9. **Provide reliable assessment within the learning tasks.**	▪ Allow time for collaboration ▪ Complex and challenging tasks for users to develop their skills. ▪ Validity and reliability

2.7 EVALUATION CRITERIA FOR MULTIMEDIA SIMULATIONS

Current research is developing integrated frameworks for building a successful virtual patient across multiple disciplines. However, it is still lacking in the evaluation of simulation. Bland et al. (2011) propose models for a learning strategy in education which gather data to evaluate the performance of simulation techniques. This makes it possible for data analysis to take place by using thematic analysis (Braun & Clarke, 2006) emphasizing identification, examination and recording of data patterns. Clarke and Braun (2013) describe thematic analysis as "a method for identifying and analysing patterns in qualitative data". This is a clear approach to broaden our knowledge of what we need for each step and how these steps are related. Therefore, this could be the initial process for evaluating virtual patients in a learning context. Another key area of focus is introduced by Kneebone (2005). He concentrates on four major stages. These are:

1. Developing nurse skills and ability to perform tasks through repetition.
2. Advice available as required by students.
3. Conducting learning within professional context.
4. Simulation training provides effective component for learning

The four stages, outlined above, are guidance to measure the simulator and nurse education. However, it is also necessary to design a pre-test and post-test to measure the effectiveness of the use of simulation training (Alinier et al., 2006).

2.7.1 Approach to simulator evaluation

In healthcare education, several means of simulation are being integrated into curricula, from low level fidelity to high level fidelity. It is not always the case that a high level manikin will deliver a better outcome compared to low fidelity due to tasks and student capabilities (Munshi et al., 2015). According to Norman and his team (1985), there are five dimensions to evaluate simulated training in a healthcare sector. The first dimension, *fidelity* is the degree of resemblance between reality and simulator. This measurement is similar to the authenticity that Lamont and Brunero (2014) proposed to evaluate mental health for generalist nurses which consider e-simulation as a realistic and believable system. In addition to this, participants also claim that seeing this realistic case helped them to remember past experiences. According to Barrows and Feltovich (1987), there are three elements that must be included in a realistic, clinical simulation: 1) relatively little information should be available in the beginning; 2) students have freedom to navigate through, employing questions in any sequence; and 3) students should be given information over time during the simulation session. The second dimension is *reliability* which is the way to define how consistency is achieved in various circumstances using different types of simulation (Kardong-Edgren et al., 2010). The third dimension is *validity,* which identifies what measurement tools are used to measure the outcome. Kardong-Edgren et al. (2010) suggest minimum instruments that need to be evaluated: 1) content validity which refers to appropriate information and completeness of the measurement and 2) construct validity which focus on the process of action representing the idea that is being evaluated. The fourth dimension is *learning, which* is the extent of the knowledge that the student receives after the training or learning. One study pointed out that different levels of simulated representation made learning difficult for students (Van der Meij & de Jong, 2011). Lastly, *feasibility* is the way to evaluate whether the simulation is affordable and capable of implementation considering cost and value. Such a comprehensive evaluation is recommended in a healthcare situation to measure the effectiveness of simulation (Munshi et al., 2015).

Because of the limited time available in this study, a method of evaluation of this product is optimised to address the efficiency of software development lifecycle. As a result, the System Usability Scale (SUS), developed by Brook (1996), is adopted to measure the usability of the system which is evaluated by nurse students. This empirical evaluation is well known as a “quick and dirty” survey which emphasizes a single score of the scale that can be understood by a large number of people such as students, researchers, nursing educators, and managers (Bangor et al., 2008). Thus, researchers and practitioners will have the same idea towards the system’s performance. Each question will be generated in several aspects such as learnability, efficiency, memorability, errors and satisfaction. Those components are prescribed by Daniels et al. (2007). With regard to the reliability of the SUS evaluation approach, several products use this to assess their system performance, for example, mobile applications, web applications, speech systems, etc. (Bangor et al., 2008). Having stated that, the SUS is a stand-out method and an efficient tool for broader interfaces that assist researchers and people involved in the product lifecycle.

2.8 SUMMARY AND IMPLICATIONS

The aim of this literature review has been to guide research directions and aid essential components needed to collaborate in a simulation platform for clinical purposes. Prior to going into depth regarding details of multimedia simulation, several roles of multimedia simulation in healthcare have been presented to acquire an overall understanding of simulation. Then, more literature which drives the architecture of multimedia simulation frameworks conceptually and technically has been examined. This demonstrates what simulation frameworks exist and are currently employed and how they are constructed. After that, the review has explored the important guidelines from multimedia design principles in terms of user perspectives (introduced by Huwendiek's principles) and developer perspectives (introduced by Huang's guidelines and Herrington and Oliver's implementation guidelines). The proposed guidelines lead us to grasp an understanding of how to design multimedia assets and build them to deliver a comprehensive strategy in a hospital environment and focusing on both user and developer viewpoints.

The design and implementation guidelines for multimedia simulation are derived by considering the cycle from conceptual design to technological implementation, as shown in section 2.5. As a result, this literature review chapter has provided a basis for constructing the media simulation framework, as follows:

1) *Users and Developers Focus*

User-centric and implementation design guidelines are added to guide development for interactive multimedia simulation, so we understand in-depth of user and developer perceptions within the learning environment.

2) *Media Needs*

Each multimedia component (virtual human, video-supported simulation, decision, and health-related information) is discussed separately to reveal their benefits and drawbacks. Then, examination of multimedia simulation development in the health care environment reveals implications for incorporating static and dynamic information. Virtual human studies tend to enhance engagement compared with video-supported simulation, at least in principle. However, an advantage of video is also that it is perceived as improving both clinical thinking and knowledge overall. Moreover, according to Table 2.2 which summarises existing use of multimedia simulation, several projects have developed videos, an avatar-based simulation, and clinical information together to increase engagement and progress towards clinical best practice, as well as allowing nurses to develop at their own pace.

3) *Technical complexity for multimedia component interaction*

By defining what media components are required, the study will apply the SOA technique to handle each element to deal with transferring and receiving messages, which often involves complicated communication. UML modelling will also be applied to obtain the overall structure of framework clearly.

4) *Limited research on geriatric education:*

Through the literature review, several gaps have been identified in terms of technological complexity and the need for multimedia simulation in virtual patients targeted at geriatric education (Table 2.1).

Chapter 3: Research Design

The intent of the research has been modelled important media components applied the clinical domain, where little research has taken place in the dementia environment, and to deliver a completed system in a computer-based simulation. The simulation will create realistic situations and provide an alternative learning tool in nursing practice to promote good care of patients. This chapter discusses the research framework and methodologies used to achieve the research goal.

3.1 RESEARCH FRAMEWORK

This research involved four stages: research initiation, research design, research development and research evaluation (Figure 3.1). Research initiation was conducted following user-centric, design guidelines from Huwendiek et al. (2009), as shown in Chapter 2, section 2.4. The user-centric, design guidelines help researchers to understand requirements more from a user's perspective, for example, taking into account appropriate media use and achieving a suitable level of complexity in the stipulated simulation. Understanding user requirements is of considerable significance for developing an artefact that meets the user's expectations. From this starting point, the research design aimed to structure the whole system architecture from the user's perspective to developer's perspective. Also, the user study in this project was designed to structure the subsequent procedure, equipment, and prepare the project proposal for ethical clearance. The research development stage employed the implementation guidelines from Herrington and Oliver (2000), as shown in section 2.6.2, to ensure consistency in the simulated situation, which was guided by clinical experts and students. In the end, research evaluation was conducted to validate the system using quantitative and qualitative methods. The research is discussed in detail below.

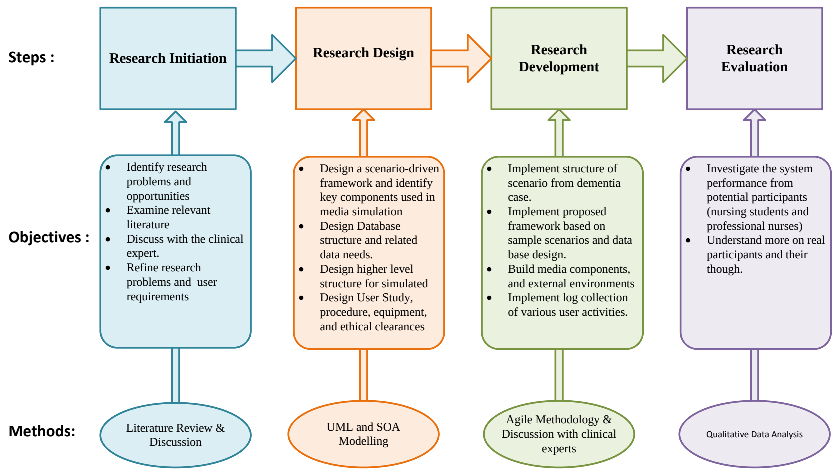


Figure 3.1 Research Framework

3.1.1 Research Initiation

Research initiation included reviewing and examining relevant literature to capture gaps and opportunities in dementia domains. It also involved collaborating with clinical experts to ensure rigorous understanding of research problems and shape desired research outcomes more precisely. The primary stage of this research was to develop a research plan, which itself involved three steps: identifying research problems, examining related literature, and refining research problems within the scope of the research. To achieve outlined objectives, an extensive literature search has been employed to:

- Survey existing technologies used to develop a virtual patient in healthcare and other, related media relevant to simulation.
- Identify theories or frameworks which have already been developed to address similar research problems.
- Identify gaps or limitations in the literature to further improve research areas, draw a clear project concept and establish a conceptual framework.

After critical exploration of existing research, our proposed research was discussed with clinical experts in the dementia domain to obtain advice and suggestions, especially in terms of the needs of nurses need and guidelines for data collection. The findings, which are existing technologies and frameworks, and an understanding of the limitations of research thus far, were significant in shaping our research outcomes in following manners: i) they captured user needs and opportunities to deliver alternative tools for practicing and learning by nursing students and nurse practitioners (section 2.4); ii) they captured essential media components of simulation, frameworks, and how to model these using suitable techniques (section 2.3 and 2.6, respectively); iii) they explored opportunities in the (currently limited) areas of study in the geriatric discipline (section 2.2).

3.1.2 Research Design

This stage involved activities to demonstrate the overall system architecture by employing UML and SOA techniques. It delivered two main outcomes: i) a conceptual framework using a combination of media components and an extended virtual, human toolkit for the dementia context; and ii) a user study procedure for evaluating the proposed framework.

To accomplish the conceptual framework, this stage generated the following designs: a scenario structured for the dementia context; database structure and data required for clinical purpose; and a high-level architecture for essential components. Details will be described in Chapter 4.

3.1.3 Research Development

Research development aimed to develop a media-enriched simulation framework for nursing care of patients with dementia using Virtual Human Toolkit (VHToolkit) and a Database system (SQLite). This proposed framework combined and extended the VHToolkit functionalities, such as characters, verbal and nonverbal behaviour, video demonstration and clinical information, to fulfil a fast prototyping in a virtual agent targeted at mental deterioration. It is difficult to develop each function without good planning. Thus, our study employed "Agile Methodology" to build the system due to its efficient development technique and its flexibility where improvement is required. Our study collaborated with clinical experts to gather some requirements and feedback which were then prioritized according to needs.

Development was iteratively updated according to adjustable feedbacks from a clinical expert and categorized into a smaller chunk of programming phases: i) building a structure of the patient case, ii) implementing scenario and media components, iii) building media components (the virtual patient, videos, and types of questioning for decision making and related resources) according to the sample dementia case, iv) building database structure to record user activities. To ensure quality assurance, each phase employed functional testing to confirm what the system essentially was doing and to reduce unexpected errors at the end of the development lifecycle. At the final stage of development, system testing for overall functionality was conducted before delivering this artefact to end users. The proposed architecture will be presented in Chapter 4, where we simplify interactions among human, virtual patient, videos and health-related information. It was a privilege to gain access to a real patient case as a sample case for building such a complex simulation in the healthcare domain. As an outcome, nurses will be able to communicate with and care for patients with psychological symptoms of dementia. The system can be modified or updated in the future based on new clinical situations and improvements in approaches to patient care.

3.1.4 Research Evaluation

The framework was evaluated by potential (simulation) users using a combination of quantitative and qualitative approaches. Having obtained empirical data from the evaluation sessions, observations, discussions, and questionnaires, the system can be utilised by other researchers who are interested in dementia simulation to enhance nursing practice and to further improve the performance of the system.

Our research recruited a group of students and experienced nurses from the Nursing School, Faculty of Health in QUT (10 participants), and collected data through questionnaires. For the quantitative analysis, each participants provided ratings using a 5-point scale (from 1–strongly disagree to 5–strongly agree) to evaluate the system performance in terms of: i) usefulness, ii) ease of use, iii) interactivity, iv) realism and vi) satisfaction. In addition, each participant's log data in the system was recorded to examine the time spent. A qualitative technique was employed to obtain insight into user behaviours: data were obtained from written feedback, researcher's observations, and discussions with the participants. Our research also obtained participant's background information to determine whether demographic or work experience factors influenced user perception of the simulation.

The last stage of the evaluation was to evaluate the proposed framework and to discuss the issues relevant to design of such a simulation system. This was done by collecting data from simulation users and using a combination of quantitative and qualitative approaches.

Overall, the evaluation provided an insight into user behaviours and expectations and a deep understanding of how the system performed and how it could be improved. Also, the user's logging data while using the system is also helpful to reflect the system performance and the user's behaviours.

The details of the evaluation design are shown in the next section 3.2, and results will be presented in Chapter 5.

3.2 EVALUATION DESIGN

The purpose of evaluation has been to identify essential components for use in a media enriched simulation within a hospitalised environment. The outcome has provided guidance on how to design each module to capture nurse-patient interaction based on a given scenario from dementia patient.

3.2.1 Evaluation Scenario

The scenario is a role-playing simulation where users act as a new nurse who is trained to look after patients in the ward. One patient, whose name is John, diagnoses as mixed dementia and injury to his right foot. During his stay at the ward, his behaviour changes completely from his normal behaviour. He starts to talk about things that are not quite relevant to current circumstance, for instance, asking about his dog and his neighbours. The new nurse and her peer become confused which lead to difficulty in diagnosis. If he is not given appropriate treatment, he will start shouting and probably attack his neighbouring patient. On the other hand, if the nurse can diagnose his pain and give suitable medicine, his behaviour will be settled and calm.

3.2.2 Evaluation Procedure

The study recruited participants who are nursing students and experienced nurses. The demographic is classified based on gender, age, experience in dementia and experience in the clinical environment. A total number of 10 participants was recruited to participate in this study due to the limitation of Master's degree research. Also, it is recommended that 10 to 12 participants can produce significant outcomes for usability testing (Spyridakis & Fisher,1992). Having obtained all empirical data from participants, this study has been able to deliver a standard framework which can be used in a real environment.

The procedure of this study comprised three main sessions, it took approximately 60 minutes to complete. Firstly, participants answered demographic questions regarding their personal experience in healthcare and computer-based learning. Then, the researcher demonstrated how to use the system to make participants familiar with the system and also help avoid tension that might otherwise occur during the real study. After the demonstration session, participants started using the actual system without further assistance from the researcher. Clinical information and multimedia content were displayed based on the scenario. The participants were asked to answer questions in order to move to the next stage of the procedure. In the end, participants answered questionnaires based on their system usage in terms of usability, ease of use, realism, interactivity, and satisfaction. The procedure is outlined in Table 3.1. Participants were allowed to stop this study at any time if they were not comfortable for any reason; under this circumstance recorded data were discarded.

Table 3.1 User Study Procedure

Step	Procedure	Time (mins)
1	Overview of the study	5
2	Fill in Background Pre-Questionnaire	5
3	Demonstration	10
4	Using the system	20-30
5	Fill in Post-Questionnaire on the system performance	10

3.2.3 Ethical Clearance

The evaluation of the system involves humans in the entire process of system testing. The study applied for approval from the Ethics Committee (See Appendix A, B, C, D, E and F) to perform the experiment.

3.3 DATA ANALYSIS

The data was processed and analysed using Microsoft Excel 2010 due to the limited number of participants (10). The analysis focused on average scores of satisfaction and standard error. Our study used Microsoft Excel to conduct the analysis due to the small number of participants undertaken in this pilot study (eight students from the nursing faculty and two experienced nurses). As a result, the statistical inference assumption associated with using the SPSS program is not suitable for this study. The study conducts two sets of evaluation: quantitative and qualitative feedback.

The quantitative data in background information was codified prior using the system. Evaluation scores, in the user study ranged from 1 to 5 (strongly disagree to strongly agree). The system also recorded how much time participants spent and other communication in SQLite; this was extracted to the format of a csv file for calculate time spent.

Another approach of our analysis made use of qualitative data. The responses of the participants were classified into two themes: role of media components and system satisfaction. Codes were used to record each user's assessment of system performance, such as ease of use, and satisfaction. This qualitative feedback was obtained via observation and discussion after the participants had finished their performance evaluation. The feedback from participants helped us to understand in-depth the perception from the participant's point of view.

3.4 STUDY AND LIMITATIONS

Due to the time limitation, our research can only include ten participants for evaluation of our system. However, the small number has been adequate to deliver an evaluated system that can be utilized in a real environment. A further evaluation may be required to provide a more depth understanding of the multifaceted system. The empirical evaluation has been used to/will be used to refine the theoretical framework to address any outstanding issues, especially to enhance participant satisfaction. However, the refined framework could not be re-evaluated due to the time limits. After finishing the user study, all recorded data are stored in QUT H Drive, and a backup copy stored in a hard-drive kept in a cabinet at the researcher's workstation. This certified data integrity and secured-storage.

Another limitation of the study concerns actual system performance when it is first rendering an avatar character on the screen. This issue may vary depending on how fast each computer performs. However, the delay is approximately 20-40 seconds. This only occurs once through the whole process. The scenario structure that was used in our system is only one case story and this had to be used to derive the overall interaction of several media resources, due to limits on time and available resource. Nevertheless, it is believed that even one story is sufficient to develop the essential concept on how to model media content interactively and engagingly. The reason behind this belief is that every story consists of beginning, middle and an end event, which connected the whole events together (Aristotle, 1996). Thus, one story is sufficient for this study and within the time frame of Master's degree. In terms of system performance, our study additionally stored non-identified user information on activities they performed during the session. This information, such as time spent at a particular decision point, could be perceived as a useful tool for senior management assessment of an individual's ability, but there has been insufficient time for our system to compile useful data for this, including reporting in a more graphical format

Chapter 4: Design and Implementation of a Media Simulation for Clinical Learning Environment

This chapter proposes the system architecture of Simulated Multimedia enrich Immersive Learning Environment Framework (SMILE Framework) for the simulation and focuses on the media components which are required to deliver best practice media simulation based on Chapter 2. The SMILE Framework adopts Service-Oriented Architecture technique (SOA) to model media components due to its mobility and flexibility. As a result, the system architecture is generalizable and aim to apply in future context.

This chapter begins with the overall system framework (section 4.1) which describes a high-level framework architecture, describes the support libraries (section 4.2) , and then focuses on the three tiers of development, presentation, business logic, and data storage layers (section 4.3, section 4.4, and section 4.5, respectively). The low-level architecture is discussed on actual modules in media components and their interaction. Then, the SMILE Framework is applied in the clinical environment (Section 4.6). The technical practice is then summarised in the last section (Section 4.7).

4.1 THE SYSTEM FRAMEWORK ARCHITECTURE

The SMILE System Architecture outlines the SOA techniques and its key components used in developing the integrated media simulation as shown in Figure 4.1. The system is divided into three main layers, the presentation layer, the business logic layer , and the data storage layer. The presentation layer can communicate directly to the business logic layer via the communication bus, but it cannot communicate directly though the data storage layer. However, the presentation layer can communicate indirectly via the business logic layer ,which act as a joint channel, through the data storage layer.

Each layer has its own module to operate its tasks and every module is loosely coupled and operated according to the object-oriented programming and SOA techniques, which are designed to be flexible and scalable. The system development includes the following objectives:

- To model required components needed from user's perspective through developer's perspective.
- To develop required components used for nursing care of dementia patients which acts as a sample story.

More details of the SMILE Framework will be discussed in the following section.

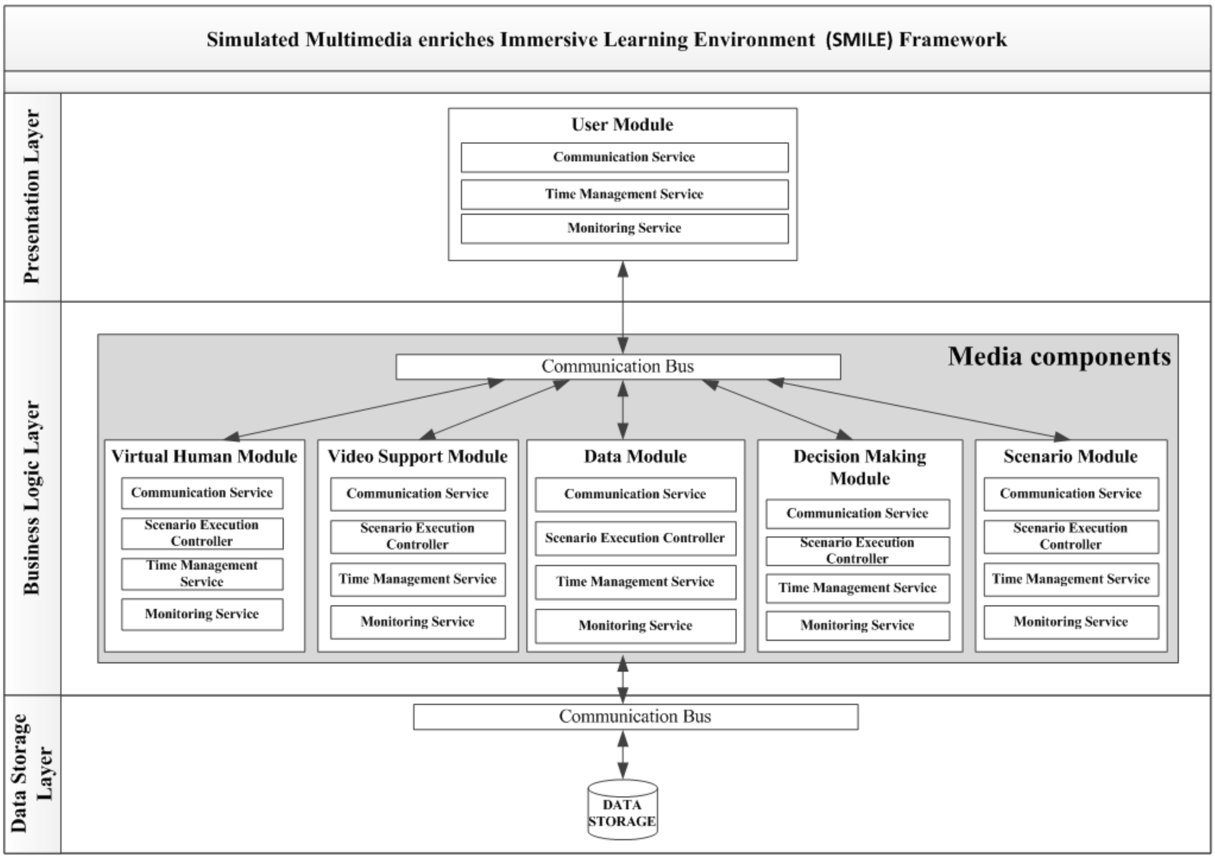


Figure 4.1 Overview of SMILE Framework

4.2 SUPPORT LIBRARIES

There are three libraries to support the development of the system: Virtual Human Toolkits, videos, and SQLite database libraries. The platforms is initiated, customised and extended to deliver a clinical simulation with learning and practice in the simulated environment.

Firstly, the Virtual Human Toolkit, created by the University of Southern California's Institute for Creative Technologies, contains a set of modules, tools, libraries and 3rd party software (Hartholt et al., 2013). Those tools are capable of creating life-like virtual characters to communicate with users via typing text and talking voice, but our system emphasizes more on textual-based information. Moreover, it can generate non-verbal behavioural responses with pre-recorded or text-to-speech manually and automatically. The primary modules used in this study are:

- *AcquireSpeech*: This is a communication interface of the Virtual Human Toolkit. *Acquire* Speech integrates speech recognition to use it as an input via a microphone and via text input from users.
- *NPCEditor*: This module allows a user and the system to communicate virtually via preconfigured questions and answers. The *NPCeditor* uses a text classifier to provide an appropriate response to the user by training their data beforehand.
- *NonVerbal Behaviour Generator*: Apart from speech, this component generates a non-behavioural response, such as gestures, facial expression and gazes. It is an XML configured file that can be modified to suit the need.
- *Smartbody*: This offers a virtual character library to synchronize locomotion, lip syncing and non-behaviour. It can cooperate with another game engines such as a Unity 3D Program to build a character and customise several features.
- *Text to Speech*: This is a voice generator that helps translate words to spoken languages when responding to answers from users. This study will use the default text-to-speech from Virtual Human Toolkit, Festival and MS SAPI, to handle the communication.

Secondly, video-simulated role-playing is integrated into our system separate from the Virtual Human Character. It is quite complicated to build a virtual agent platform for a clinical scene, especially in dementia patient care. Therefore, the use of videos is a suitable approach to reduce the complexity. In addition, the video delivers content without being too subjective and increases the attentiveness of users (Korkiakangas, Weldon, Bezemer, & Kneebone, 2015).

Thirdly, the light and portable SQLite is embedded in our system as it can operate across multiple platforms, such as in Windows and Mobile applications. Also, the setup has few requirements from an administration point of view compared to other database management systems such as MySQL and SQL server. Based on these reasons, SQLite is appropriate and useful to embody in our system to support user management. The system keep records of users' activities in the SQLite database file format. The support libraries are then used to assist the development of the SMILE Framework in the presentation, business logic and database layers.

4.3 PRESENTATION LAYER

The presentation layer is responsible for delivering information, through the SMILE Framework, to the end user. The end user is also able to input data via the user interface. The interface was designed based on user-centric guidelines (Chapter 2, section 2.4) where simplicity and interactivity are the critical features of interface representation. Only relevant information is displayed and self-described without ambiguity. This strategy can reduce overload with information where the information or other external environments are not required. It is believed that the three-dimensional interfaces regularly involve the level of complexity using a game-based environment which might not appropriate for inexperience users. In addition, the literature suggested that three-dimensional game environments produce negative feedback in terms of system familiarity, because users find it difficult to become familiar with the game-based environment (Toro-Rroconis et al., 2010; Quaas and Bjorklund, 2012).

The presentation layer receives all responses from the user such as data input and user activities. The system uses a unique code number to differentiate amongst users. However, the purpose of the non-identified user, the system does not deal with any personal identity but rather groups users anonymously. The monitoring module keeps track of an individual's activities via the monitoring service where all information logs into the database storage layer. The time management service records the amount of time taken when the user responds to questions. Also, the communication service interacts with the business logic layer to execute the actual tasks and logs in the data storage layer.

4.4 BUSINESS LOGIC LAYER

This layer contains all essential components for developing a multimedia simulation. The simulation is developed using the Unity 3D program. The media components are chosen based on positive feedback on perceiving ease of use and reducing the level of complexity when using the application, based on literature. The design of the SMILE framework is based on a loosely coupled technique, which each module communicates via messages and performs its operation to assist another module.

The following content describes the general services commonly used in each module and explains each module in more details based on its role and functionality.

4.4.1 Generalised Services

The SMILE Framework implements five modules, the virtual human module, the video support module, the data module, the decision making module, and the scenario module, to initiate the role-playing simulation. Each module performs using a generalized concept and object-oriented programming and is self-contained and flexible, as shown in Figure 4.1. At the runtime of the framework, within the module, there are four necessary services, which support and monitor messages between user and the system via the communication bus, as follows:

I. Communication Service

The communication service receives messages from and sends messages into other modules, and this is the top service to enable user interaction, from the communication bus, and other services. In the current implementation, the primary role of this service is to filter unnecessary information such as removing stop words when the user inputs some common words in English through the system before this service sends messages to the scenario execution controller service.

II. Scenario Execution Controller Service

The operations of the scenario execution service include generating and updating events to control when and what event occurs, within its own module and between modules. The execution will acquire scenario information from the scenario module via the communication bus. Then, the communication service triggers tasks to the targeted module, based on a given event from the scenario module, and the target module will perform its operation such as displaying related data on the screen or displaying related video to demonstrate the external environment. The event is generated by the scenario execution controller deliver message to another module using an asynchronous procedure.

III. Time Management Service

The time management service is responsible for managing time constraint at various decision points within the simulation. The reason we implemented the time management service is that, in reality, time is often an important factor for nurses making their decisions based on a patient's condition. Also, our first evaluation with two students suggested having timer on the screen, so that the user knows how much time they have left to respond to questions. As a result, in the SMILE Framework, we set the time remaining on the screen so that users could be aware of it.

IV. Monitoring Service

Several activities are undertaken by the user. The monitoring service keeps track of everything the user does to complete tasks, such as the words typed or the decision made. Also, the monitoring service records the starting time, how much time the user spends at decision making points, and when the user finished their tasks, all of which can be helpful for future use. Especially, the records can be used to gain insight into each user in terms of individual performance and individual capabilities.

4.4.2 Scenario Module

The scenario module plays an important role in generating an event for media components that initiate and drive the story within a given situation. The first step in developing is to set up the scope of the story and events. In our system, we constructed a particular patient case where the end user will act as a role of nurse. The overview of scenario module is shown in Figure 4.2. It consists of two main sections, *header and content*. The *header* is an indicator which determines the current story and next story; in our research we only apply one story related to dementia care. It is believed that one story is sufficient for this study due to the fact that it contains several situations happening in one particular topic of dementia patient. The story is a real clinical story, which belongs to the clinical expert and this is such a privilege to gain access to this valuable resources. The *content* consists of several tasks to link the whole scenario together in a consistent manner, based on clinical practice and suggestions by experts.

The link between each task is determined by the clinical expert in the dementia field and our study apply contents to model them in a programming structure.

To begin with, the scenario will need to determine whether it should be used as a video demonstration, a virtual agent, a decision making point, or related information. The video is selected based on how complicated the scene is, such as determining if the scene involves many external factors such as humans, or complicated emotions. The virtual agent is also selected based on the scenario that often involves communication between the nurse and patient. The decision making point determine what types of questioning can be used, such as open-ended or close-ended questions. The health-related information regarding a patient's history or health-related information is shown. After choosing an appropriate media component, we need to define what will be the outcome from this particular scenario, which leads to the next scenario defined as a task sequence. Within the task sequences, there are five primary attributes to keep track and to do some operations within the task sequence and to next task sequence as follows:

- *Scene*: identify what type of scenes will display, for instances, multimedia scenes or information scenes. This will further assist as pre-requisite information for the scenario module.
- *Update Scene*: There will probably be some changes, e.g. updated records based on medication given, occurrences during the scene, which causes several updates, e.g. the medication document changed, in the system. All changes are recorded for future use and can be viewed by a high-level healthcare professional within a data storage module, mainly looking at user performance.
- *Current Decision and Next Decision*: These are the points where users need to make their decision based on their knowledge and a given circumstance.*Current decision* stores a present decision point of view in a given scenario and the *next decision* will lead to a further decision point based on the consequence. For instance, in the current decision, if there is a situation where the patient acts aggressively towards nurses and other patients, what the consequences will be if the user ignores his attitude

and walks away. The next decision will determine the outcome and directs the user to that particular task.

- *Next Task*: This is the link directed to the next task that is performed based on a next decision outcome.

To demonstrate the use of scenario module, the sample scenario is discussed as follows. Given the scenario that the patient is quite aggressive on the ward, and he tries to attack other patients (defined as a *Task Sequence*). This particular scenario involves many external factors such as other patients, nurses, and often involves complicated behaviour by the patient. Thus, the video demonstration is selected to display the aggressive behaviour as a *Scene,* which can be updated via *Update Scene*. The Current Decision is based on a particular scenario, in this example, the patient is hostile. Also, the outcome of this particular scenario is either calmness or aggressiveness (*Next Decision*). Therefore, this decision will lead to other task sequence (*Next Task*). In the second task sequence, the scenario directs the nurses to talk with the patient by demonstrating the virtual agent scene. The nurse can ask patient questions based on text-based responses and we precede the same things as video demonstration scene. The concrete example of the content section is shown in Figure 4.2 (Right).

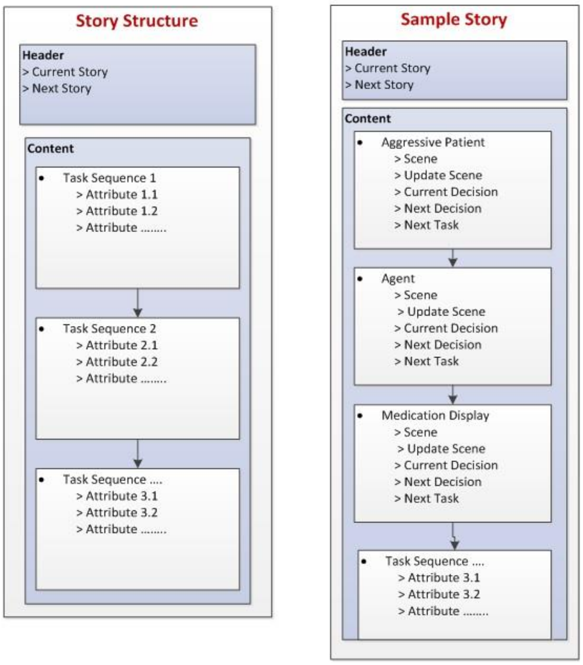


Figure 4.2 The overall scenario structure (left) and the details scenario (right)

4.4.3 Decision Making Module

The decision-making module is designed for users' competencies, by providing a combination of open- and closed-ended questions. The open-ended questions intend to examine user's knowledge by allowing them to express their thought to solve a particular task provided that the user answers in a short description. However, the system has a list of pre-defined answers to offer the user if they have difficulty trying to answer many times without success. Then, the cueing options can assist the user in making their decision. Based on Section 2.3.4 in Chapter 2, the combination of cueing and open decision draw positive feedback in terms of reducing learner stress and understanding what the user thinks.

4.4.4 Data Module

The goal of this data module is to depict real information to users so that they are more familiar and understand the content, and know what the clinical information looks like. Related information is necessary for supporting the decision-making module. Therefore, the data module is preferred as a mean of acquiring related resources for the participant when it is needed. The information display in this module will use the scan pictures or information which then imported to the system. The data module can help the user to make their decision based on relevant information to come up with the final answers. As a result, the data module is constructed to provide essential information to simulate role-playing for nurses, especially in the clinical environment.

4.4.5 Video Support Module

Based on section 2.3.3 in Chapter 2, the video-supported simulation provides benefits for users in terms of increasing self-confidence and attention. Thus, our SMILE framework adopts its positive effects to demonstrate scenarios within a simulated circumstance. As a consequence, the videos are used in the system to guide the user and create the environmental glimpse within the simulation situation. Importantly, the video cannot be paused or played back because the system is designed for the simulated reality in which it is unacceptable to replay the situation again in the real circumstances, especially in the hospital. This statement is also supported by clinical experts when designing simulation in the hospitalised environment. The video demonstration enhances the internal and external environment which reduces the level of complexity comparing with the three-dimension avatar.

As previously stated on the generalised module, section 4.4.1, the video support module may recieve requested messages to be active and produced relevant contents via the communication service. Within the video module, the requested messages proceed to the scenario execution controller where it retrieves related information from the data module, such as the actual file and related information.

4.4.6 Virtual Human Module

The animated avatar module is a complex system that involves various parts ranging from user inputs to the processed system delivering messages back to the user. The SMILE framework customises the functionality of the Virtual Human Toolkit from the University of Southern California to model the virtual human, which acts as a virtual patient, to interact with the user within the clinical situation.

At this stage of the development, the SMILE System was developed mainly in a text-based conversation rather than focusing on voice recognition. This is due to the limited time of the Master research degree and the fact that voice recognition technology is still not entirely sufficient within the hospital context. However, the system employs the use of the text-to-speech for a viable option to deliver messages to the user in conjunction with text-based communication. Importantly, some translation of text to speech may be slow.

Furthermore, the proposed system uses non-verbal communication for social interaction with the user to increase the level of engagement. When the virtual human is talking to the user, upper body movement occurs, such as the hands point towards his body when the virtual human says something relate to himself.

The communication between the virtual patient and users uses NPCEditor Program to convey responses to user questions. The agent responds based on the pre-defined set of answers. However, it might be difficult for users to think what to ask. The system has implemented guidelines questions, which they can ask by using the upper arrow on the keyboard to generate sample answers.

4.5 DATA STORAGE LAYER

The main purpose of data storage layer is to retrieve related information and save user's activity in the whole system lifecycle. SQLite is chosen because of its flexibility and adaptability to integrate into the Unity 3D Development.

To start with, all conversations between the user and the virtual human will be logged in the system, based on time, questions, responses and user's information. The user's information links to code number, which does not relate to any personal identity, to differentiate among users.

The scenario is stored in the data storage layer to initiate events and trigger modules. Then, the scenario is designed as the pre-defined story based on the scenario-driven component in Section 4.4.2. The scenario execution module in Section 4.4.1 is the central pool for retrieving information through the communication channel (via user input) and sending an appropriate response back to the scenario execution module to update data or trigger another module.

There are various activities during the decision-making component when users need to make their judgement in combination with open-ended and close- ended questions. As a result, the log data recording the user's input can provide insight into personal thinking, which will benefit the individual for learning improvement in the future.

4.6 APPLYING SMILE FRAMEWORK IN CLINICAL SITUATION

4.6.1 Overview Architecture of SMILE Framework in Dementia Situation

The proposed system framework extends the Virtual Human Toolkit, provided by the University of Southern California, for implementing the virtual character and other media components. Based on Chapter 2, different means of media representation (e.g. an animated avatar, videos, decision choices and related information) provide positive feedbacks in terms of authenticity, engagement and improvement on information literacy.

As a result, The SMILE system framework is a mix-and-match multimedia approach to deliver an effective simulation. The framework development is described based on the data and operation perspectives, shown in Figure 4.3. The SMILE Framework is implemented by using the three layer guidelines from the presentation, business logic, and data storage layer (sections 4.3, 4.4, and 4.5, respectively). The presentation layer consists of the user module, which is responsible for receiving information from and delivering information to the end user for displaying and for the business logic layer for processing outputs. The main purpose of the business logic layer is to manage the communication between the presentation layer and the data storage layer. It consists of several procedures, operations, tasks, data, and activities. In our research, the business logic layer comprises the main multimedia modules: the virtual patient, the video, the data, the decision, and the scenario. The data storage layer is responsible for storing, updating and accessing data using the database tables. The following section will discuss more details of the development strategy and the structure of SMILE Framework applied the nursing care situation.

4.6.2 The Development Strategy of SMILE Framework

The SMILE Framework is implemented using the Unity program together with Virtual Human Toolkit. Every module from the presentation, business logic and data storage layer is implemented using the concept of abstracted objects which conform to the prefab term in the Unity development. The prefab comprises various objects related to the scenario, decision, videos, and virtual patient. Implementing various scenes in Unity causes some delays to transit from one scene to another scene if there are many rendering objects. The delay happens when the scene is triggered by the virtual human scene, which takes some time to render the actual avatar. As a result, prefab is chosen as a convenient mean to switch between individual modules. However, it is important to have at least one scene to handle all the modules, so we implemented the main scene to act as a controller to delegate tasks to other media components according to the user's input.

The main scene displays all related story supported by the scenario module (Figure 4.2) and transmits messages to other modules based on how the story is organised. The SMILE system uses a prefab module to display related information. To activate each module, the main scene broadcasts messages to the corresponding module based on retrieving messages from scenario module; the subscribed modules registered to receive messages will perform their operations such as displaying videos, activating the virtual patient, or displaying related information, from the receiving buffer. The other modules will also receive broadcast messages but if the module is not registered it will not proceed any further. The main scene displays one assigned task at a time to reduce the level of complexity which may occur during the execution time, as shown in Figure 4.4.

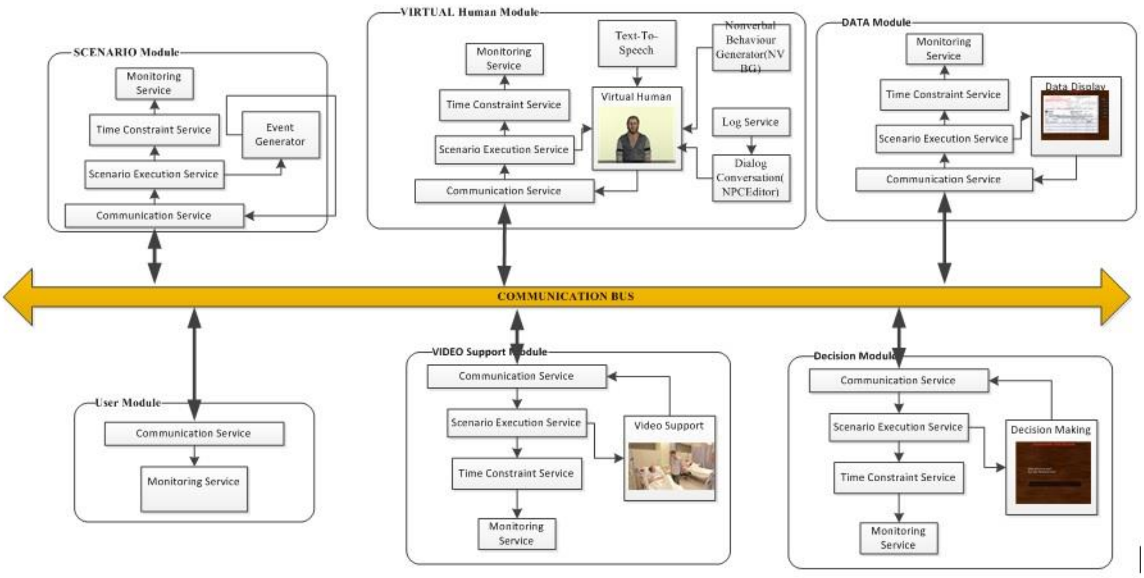


Figure 4.3 The SMILE Architecture applied Clinical Situation

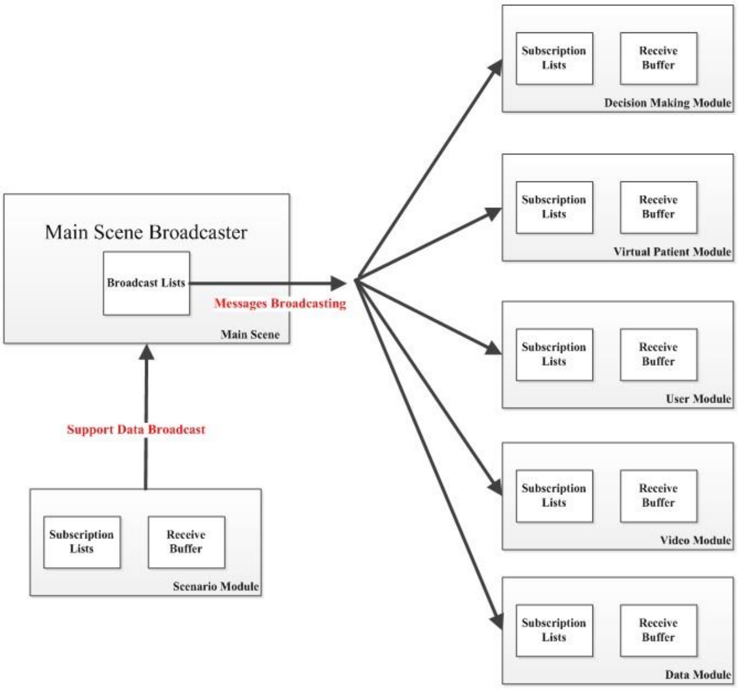


Figure 4.4 The Broadcast and subscribe Structure of SMILE Framework

4.6.3 SMILE Use Cases and Implementation

The goal of this system is to integrate all related media and data story into practice within the clinical environment, due to the needs of clinical experts and little research conduct in dementia context. Based on the literature review, the study identifies underlying modules required to develop collaborative, multimedia simulation: a virtual-like human character, videos, decision-making and health related information. The use case diagram displayed in Figure 4.5 shows a high level system design applied the clinical environment and follows the scenario module discussed previously in Section 4.4.2 on how to classify each narrative story. The use case diagram consists of one main actor and four use cases. The actor is the end user who is currently studying in the nursing faculty or is a nurse practitioner. The end user enters the system using a unique identification which can be generated by the system (given by the researcher in our evaluation study). The end user initiates four main use cases: talk to virtual human, view medial data, watch short clips, make decisions, and login.

The end user will need to log in to the system by a given id (received from researcher) which can be used to classify each user. Then, the video debriefing story of the clinical situation can be displayed to demonstrate the current situation. After the video ends, a decision-making case will be activated to question the user on what he or she will do after watching this situation. The types of questioning consist of an open-ended question and a close-end question. The open-ended question aims to ask the users to express their opinions in a short answer in a text format. However, it is often difficult for users to express their knowledge on a particular situation without having any experience. Thus, the system also provides the close-ended questions, which is a multiple choice option, to guide the user. At some point, the user can request to talk with the virtual patient, to ask about their needs or provide some help. Alternately, the user can also request to view some health related information, such as medical records, or patient history.

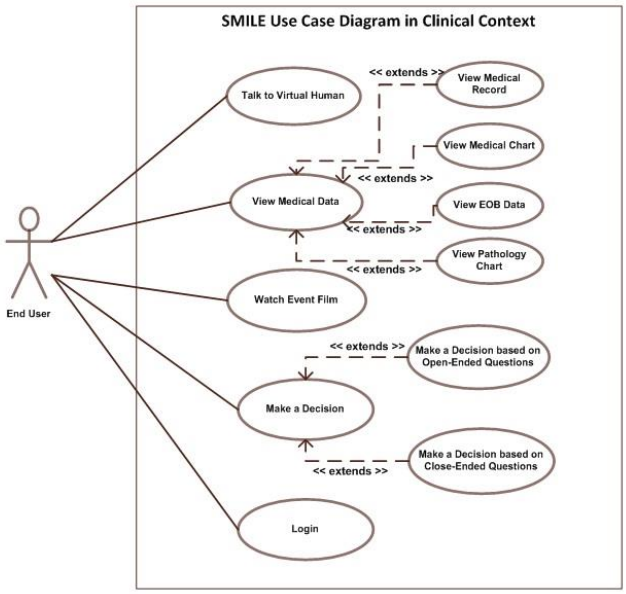


Figure 4.5 The System Use Case Diagram of Interactive Multimedia Simulation in Clinical Environment

Based on the SMILE Architecture applied the clinical situation, shown in Figure 4.3, the following will discuss in more detail the main responsibility and operations of each module which can communicate with the communication channel, namely the communication bus.

User Module

The information of participants is labelled by a code number so that individual identity is not revealed. The log-in screen uses a unique number for each user to gain entry to the system. The communication service is responsible for receiving user input and displaying corresponding outputs back to the user. The monitoring service will record the starting time and the finishing time during the user session.

Scenario Module

The main scenario module acts a story pool from which other modules can retrieve a story, based on the user's input. The story is stored in SQLite database, which is organised the same way as the proposed scenario structure, shown in section 4.4.2. This module consists of five main services; communication, scenario execution controller, event generator, time management, and monitoring module.

To begin with, the requested messages can receive from the user or other modules via the communication service. Within the communication service, the messages will be normalised and sent to the scenario execution controller. Then, the controller will perform its task by acquiring related data from the event generator. The event generator is responsible for generating scenarios from the database and updating any changes to it. All activities are logged into the system by the monitoring service. Time management may be used within the scenario as a constraint. At the end, the output from the event generator is delivered to other modules via the communication bus.

Virtual Human Module

The agent acts as a primary communicator with nurses who deliver care and observe the patients. Gulz (2004) suggested that an animated social character, using features such as body movement, smiles, and gazes, increases the natural communication between people in a normal manner. He also believed that the more the virtual character can mimic those behaviours, the better humans will gain information. As a result, the Virtual Human Toolkit has been used and its functionality expanded to deal with a dementia context. To create a human-like simulator, our system used a smartbody renderer incorporated with Unity 3D program (http://unity3d.com/unity) to build the patient's character. Our research chooses a pre-defined model based on his appearance which matches the scenario requirement, in section 3.2.1 , suggested by the clinical expert. There are also several characters that are available off the shelf, but in this case our system selected an appropriate character for a dementia clinical situation. Also, the system chooses a plain background for this prototype designed to minimise the risks of a complicated environment. This approach helps users to become familiar with the system easily without distracting external factors such as unnecessary objects within a scene.

The main objective of the virtual human module is to depict the patient in the virtual form for the user to communicate with and the module is reffered to as the virtual patient. The virtual patient module is implemented based on the SMILE Architecture (Figure 4.3). This module is also implemented based on the four primary services, communication, scenario execution, time management, and monitoring services, discussed earlier in section 4.4.1 . However, the virtual patient also employs several services including text-to-speech, non-verbal behaviour generator (NVBG), and dialog conversation (NPCEditor), discussed in section 4.4.6.

To discuss more details on how the virtual patient and end user interact, Figure 4.6 shows a work flow activity which involves the user's input and the system's response. The end user requests to communicate with the virtual patient module by typing questions. However, there is a time constraint for the end user to ask questions (within one minute) which can prevent the idle stage if the end user ignores the communication. A pop up can come up to ask whether the user still wants to talk or move to another stage. If the user sends some text input, the system will generate the response. The response comprises of IN-Topic and OFF-Topic discussion. The In-Topic discussion is the predefined questions and answers generated by the NPCEditor. However, the pre-defined set of Q&A may not capture all the possible questions from the user, which we consider as the OFF-Topic. The movement of the virtual patient is important based on the Chapter 2, so that the NVBG is customised to model eye movement and body movement.

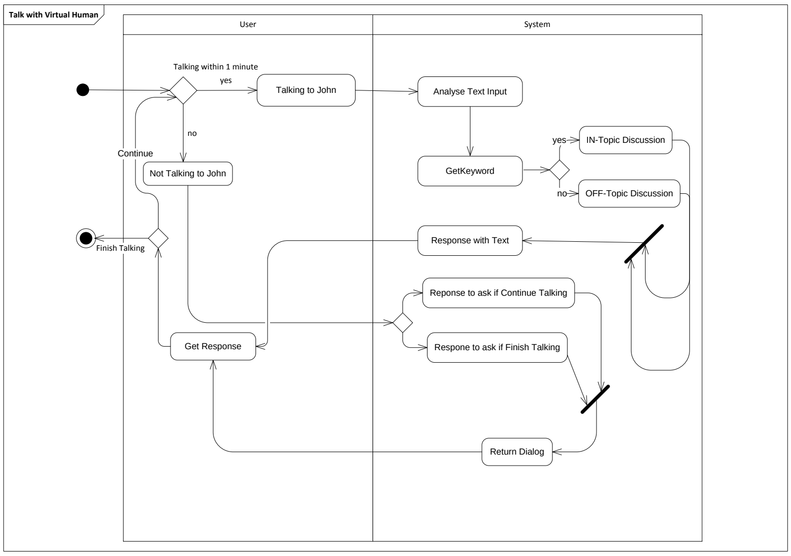


Figure 4.6 The Virtual Human Activity Diagram

Video Module

There are supplementary digital means to support an interactive patient simulation. This study uses multiple video resources as additional tools for the simulated patient to develop an environment and external involvement, which then enhance a connection between nurses and external people within hospitalised context. Due to the nature of simulated real content, videos seem to be the best source for demonstrating an external factor within the hospital. Thus, the video module is designed and developed to demonstrate related contents to users. This module is built based on the proposed scenario structure in Figure 4.2. The scene attribute is demonstrated as video component displaying the content and identifies any changes or updates via an update scene attribute. In addition to this update, next task attribute will identify the next stage of the scenario as well as the decision which being made by users.

Decision-Making Module

Each decision point where the user considers what to do is a valuable resource for higher-level management and the education system, as it is a view of nurses' capabilities in patient treatment. Based on Chapter 2 on the open- and close- ended section, open-ended questions and close-ended questions pose several benefits, especially in terms of exploring individual thinking and reducing stress during the scenario assessment. Thus, our system designs both open-ended questions and multiple choices for users to make their decision and increases individual thinking before giving cues. The use case activity diagram in Figure 4.7 depicts the overall flow from receiving input until producing output to the users.

To extract an open-ended answer from users, our system eliminates stop words and detects only possible keywords to map with our clinical dictionary via the SQLite database. The list of the pre-defined dictionary is recorded based on the clinical domain. Then, each keyword within the particular domain will try to match user input and offer alternative choices as a given clue. Given responses will be recorded and stored in the user log; an unexpected response can be added later to suit pre-set keywords in particular domains.

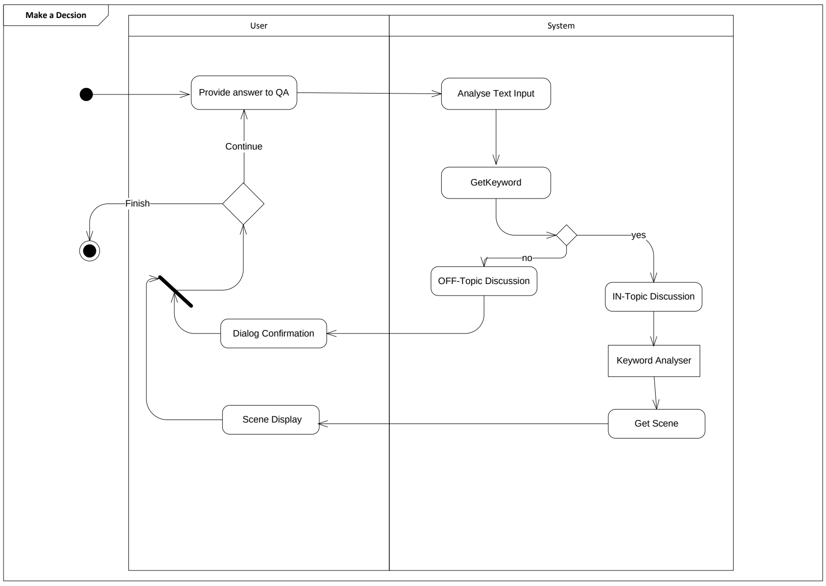


Figure 4.7 The Activity Diagram of Keyword Extraction

Information Flow and Health Information

In order to communicate with a virtual patient, NPCEditor, called a dialog conversation, is a flawless instrument to initiate conversation between nurses and patients. Several questions can be asked based on the nurse's knowledge and patient conditions. At the prototype design, a text-based conversation is implemented to deal with questions and answers only, due to time limitation. Significantly, it is probable that nurses would ask several unexpected questions. The NPCEditor can be programmed to handle these issues via several options such as off-topic responses and unknown questions where the system asks users to retype again. However, it is expected that nurses may be in the idle state and do not ask any further information. The time remaining service is implemented and shown to users, whether to go to the next stage or to persist talking to the animated patient. Every conversation will be logged to the system via SQLite database engine to further incorporate new questions into NPCEditor.

Supporting users with related data is perceived as a fruitful approach to clinical simulation. Several forms of health-related information are displayed based on clinical design. This component is constructed to conform to the proposed scenario for development purpose (Figure 4.2). This data module is also built by a Unity 3D program and aim to be flexible when attaching it to the main agent. Health information is shown based on user input to let users navigate through several options. In addition to this, all navigation to each menu in health information is monitored in the system via the database interface and the data display also retrieves information via the SQLite Database System.

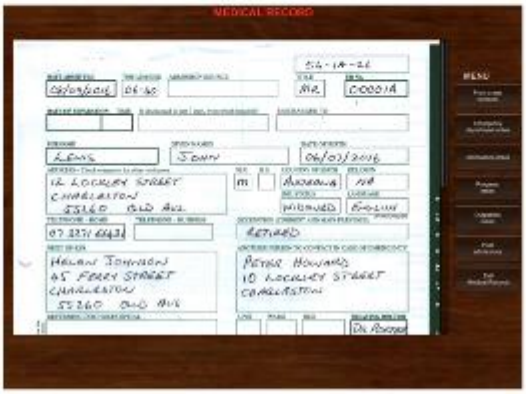
4.6.4 A case study of SMILE Framework for nursing care of patient with dementia

The SMILE Framework was applied in a clinical situation – a dementia patient. Our research collaborates with Mr. Fred Graham who is a clinical expert on dementia scenarios. The application is a case study using SMILE framework to model media contents in a role-playing situation for nursing care purpose. Some screen shots of the system are shown in Figure 4.8. The whole simulation is driven by the scenario module which generates scenario tasks to activate allocated modules. To gain access into the application, the user needs to log in to the system using the unique numbers given by the researcher. The system uses this number to differentiate among users. The system will log individual's session until the scenario ends. The scenario is the main driver for the whole process in the system such as activating the virtual patient, video, and related information. The scenario is stored in the SQLite database from which any changes are retrieved and updated according to the user's input. Once, the user logs in to the system, the video is shown to demonstrate the start-up situation, which gives the overall situation for the user to understand the whole concept of this particular dementia case. Then the virtual patient is activated so that the user can ask him questions, such as "how are you?" and "what are you looking at?". The virtual patient will respond based on pre-configured questions from NPCEditor. The counter time placed in the top right corner of the screen show the user how much time they have left to ask him questions. The time remaining helps users to know that they need to make their decision as quickly as possible due to the time restriction, and time always play an important role in the clinical situation. The user has a choice between two options whether to continue the conversation with the virtual patient or to move to the next stage.

If the user decides to move to the next stage, the system will display the video situation that demonstrates the current situation in the ward. After finishing the video session, the system activates the decision making screen to ask the user to make their decision, based on open-ended questions and closed –ended questions, based on what the user sees, as shown in Figure 4.8 (c) and (d).The system can activate the appropriate response based on stored scenarios. For instance, the system can display related information that user decides to look at, such as medical records and medication chart, shown in Figure 4.8 (e) and (f).The system logs all records from starting point to the end of the scenario. The record includes a list of conversations between the nurse and the virtual patient, and the total time the nurse spent.

(a) (b)

(c) (d)



(e) (f)

Figure 4.8 Screen shots of SMILE Framework in Clinical Situation. (a) User Login ; (b) Virtual Patient ; (c) Open-ended questions ; (d) Multiple choices ; (e) Medication chart ; (f) Medical record

4.7 SUMMARY

This chapter describes the SMILE Framework and its overall architecture applied the clinical environment. The system comprises five media modules for use in the media simulation: virtual human, video, data, decision making and scenario module. The SMILE Framework adopts positive feedback on each media and applies this within the clinical case to deliver the best practice to the users. This is done by employing SOA paradigm which improves the reusability and flexibility. Each module delegates messages to others so that they can perform their own operations. The data storage layer saves all activities performing by users; this data can be used in the future for clinical supervision or higher level management, to assess participant performance and capabilities

Chapter 5: Results and Discussion

This chapter provides the results and discussions of the SMILE Framework applied in a clinical context by a pilot user study evaluation. The first section discusses the SMILE framework evaluation (section 5.1).The user study design is presented section 5.2. The evaluations include a preliminary section (Phase one evaluation) and a more complete section (Phase two evaluation), after updating based on the preliminary evaluation, using quantitative and qualitative measurements. The quantitative evaluation focuses on perceived ease of use, usefulness, realism, interactivity and satisfaction (section 5.3.1). The qualitative evaluation assesses the interface appearance, its usefulness and recommendations (section 5.3.2). Finally, implications based on results are discussed (section 5.4).

5.1 SMILE FRAMEWORK EVALUATION

In line with the structure of this SMILE Framework, the evaluation study considers validations for its three layers: presentation layer, business logic layer, and database layer. The presentation layer is evaluated based on the interface representation; this involves feedback/suggestions from users (nursing students and nurse practitioners). In the business logic layer, we are dealing with the complexity of the overall simulation, where we proposed five essential components (virtual human, videos, related information, decision-making technique and story-telling) to simulate a clinical environment which aims to engage individuals and improve the learning environment. The evaluation of the business logic layer is via questionnaires, researcher's observations, and discussion in which each component may be consider as an essential component for clinical simulation – in this instance for a dementia case – or not. The database layer is not evaluated through the questionnaires; however, all activities during the evaluation session were logged as support evidence (system logs) for qualitative and quantitative analysis.

To validate the three aspects of the SMILE framework, the following summarizes three specific questions that are examined by the user study and examines relevant results based on data analysis. More details regarding the evaluation design, procedure, and data analysis will be presented in the coming sections.

- Question 1: Overall, how satisfactory is the SMILE Framework used by the participants?

The most suitable indicator for system's satisfactoriness is the participants' experience in which they express their feelings towards the ease of use and usefulness. Overall, the majority of participant (90%) responses agreed that the system is satisfactory for their need.

- Question 2: Is the interaction with the system interface good?

To evaluate the interactivity between the user and the system, the questionnaire asked how much engagement the user felt when he or she used the system. Also, the study evaluated how the system performed through interaction of the various media components. More details of interactivity will discuss at a later stage.

- Question 3: Are the components essential? If they are essential, why?

The media components are based on investigation of positive impacts in terms of learning, practice, engagement, and realism (see Chapter 2). Overall, media components are explored through four different means: (1) Virtual Human, (2) Video, (3) Decision Making Techniques, and (4) Related Information Resources. Table 5.1 provides the summary of learning and immersion impacts on the four major modules. Significantly, video plays a very crucial role in both learning and engagement, based on questionnaires and discussions. The virtual human also poses potential benefits on learning, interactivity, and realism. Both health-related information and decision-making techniques are helpful for learning as well.

Table 5.1 Summary of SMILE Evaluation

Components	**Learning**	**Immersion**		
	Help for learning	**Engagement**	**Interactivity**	**Realism**
Virtual Human	✓		✓	✓
Video	✓	✓	✓	✓
Health Related Information	✓			✓
Decision Making Technique	✓			

5.2 EVALUATION USER STUDY DESIGN

The preliminary evaluation was aimed to obtain initial feedback and suggestions about the use of the system and to examine the user study procedure from a user's point of view. The participants were either nursing students or experienced nurses. For our initial study, two participants who were nursing students were recruited. The procedure of the user study is as follow:

1) Researcher provides user with overview of the objectives of the study and describes the scenario of the clinical situation, shown in 3.2.1.

2) The participants fill in the background information survey which asks questions to obtain demographic data and information on clinical experiences, as shown in Appendix E.

3) The researcher demonstrates how to use the system to guide the participants.

4) After the demonstration time, the participants use the system.

5) At the end, the participants are asked to evaluate the system's performance, in terms of the ease of use, usefulness, interactivity, realism, and satisfaction through a post questionnaire.

The data obtained from the user study are from three main sources: (1) system log, (2) questionnaires, and (3) discussion and observation. The following section will discuss details of our initial evaluation with two participants and our complete evaluation with other eight participants.

5.2.1 Phase One Evaluation

The preliminary evaluation captures the ease of use and interface representation of the presentation layer in the SMILE Framework. The discussion and observations with the two participants in this phase determined that the major issues were mainly with the amount of time, the decision choices (i.e. types of questioning) and that the system lacked sample questions to communicate with the virtual patient. Participants mentioned that there was not enough time for making a decision due to their limited knowledge and thinking processes. The initial design only allowed up to one minute based on clinical suggestions. In addition to the decision-making points, both of the users preferred to have multiple choices rather than open-ended questions. Regarding the virtual patient, the prototype was designed for participants to express their thoughts via typing their answers. As the researcher observed and discussed, mostly the users spent more than one minute thinking about what to type.They also mentioned that the system should provide some basic questions to guide them so that they would have the general idea of how to procede further.

As a result of this preliminary evaluation, the system was modified to increase the lengh of time for decisions by up to 3 minutes and to display the remaining time on the screen so that the users know how much time they have left in order to answer the questions. The display of remaining time was placed on the decision screen and the virtual character screen. Sample questions were integrated into the system; participants can use the upper arrow on the keyboard to browse some fundamental questions. Also, the sample questions were explained during the demonstration session so that the participants obtained general ideas on what to ask. The modified prototype was used in the next round of study evaluation to increase the ease of use and increase the user's awareness of time limitations.

5.2.2 Second Phase Evaluation

The complete evaluation for our study recruited eight participants, in addition to the two participants from preliminary evaluation (a second phase of evaluation). The second phase of evaluation used suggestions from the preliminary study to deliver better simulation experiences. The participants comprised eight students and two nurses. The biographical data were obtained from participants before they evaluated the system performance. There was no gender difference, all participants being females. Ages were divided into two groups; less than and over 25 years old. All had previously experienced a computer-based learning approach and normally use it in their study and work. Only two participants, who were professional nurses, had experience in the clinical environment and in dementia. Other participants did not have any clinical experiences. The next section discusses the evaluation details to reflect the SMILE Framework.

5.3 RESULTS

5.3.1 Quantitative Data

The quantitative data are mainly from two sources: system log and paper-based questionnaires. The system log captured the amount of time that users spent communicating with the system. Other data are from participant responses to the entered on a Likert scale from 1 to 5, ranging from strongly disagree to strongly agree.

System Log

Our system recorded the total time participants spent using the application as shown in Figure 5.1. The average time participants spent in the system was approximately 11 minutes. The graph is classified into two groups of participants: students and nurses. The two nurses spent less time to complete the task than the students.

On average, the total time for decision making points was approximately 6 minutes. Again, experienced nurses spent less time than the nursing students. For each individual participant, the time for decision making varied from four to eight minutes, as shown in Figure 5.2

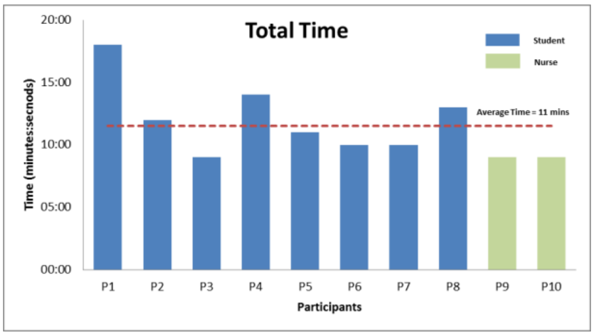


Figure 5.1 Total Time Participant using the SMILE System

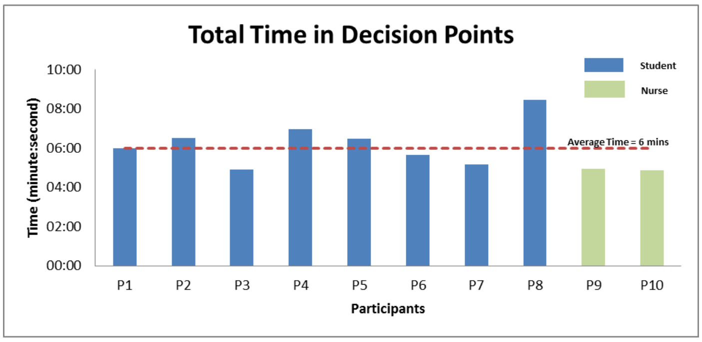


Figure 5.2 Total time in decision making points

Questionnaires

The study measured the system performance in terms of usefulness, ease of use, interactivity, realism, and satisfaction. The outcomes are summarised in Figure 5.3 – 5.8. Because of the small number of participants, our study does not allow extensive inferences to be drawn from this data. However, our primary data deliver basic understanding of participant opinions and suggestions.

Figure 5.3 indicates that the participants' consideration of the factors of usefulness (***Use to improve skill***) and ease of use (***Ease of use***) were above the neutral ranking (3points) with the mean score of 3.75 (95% chance), which can be considered as positive feedback. The graph shows strong agreement in terms of feeling confident to use the system (***Confidence to use***), where the study shows a mean score of 4.

In terms of interactivity, shown in Figure 5.4, participants agreed that the system was interesting (***Interesting***), engaged them in the clinical situation (***Engagement***), and was challenging (***Challenging***), all of which received a mean rating of at least 3.5. There is an interesting point in dealing with decision techniques. The majority of the students expressed the score of 4.6 points in favour of the multiple choice questions (***Preferred Multiple choices***). However, the open-ended questions (***Preferred Open-Ended QA***) seem not to suit the participants; this receives a mean of only 2.7 points. The reasons for this situation may include the limited knowledge of clinical situations and experiences.

With respect to the realism in the simulation, Figure 5.5 demonstrates the difference between realism and potential learning. Participants expressed their feeling that the video was helpful for making a real story with the highest mean score of 4 points (***Helpful for realism)***. This also conforms to the fact that they wanted the video to be included in the learning environment with the mean score of 4 (***Helpful for learning***). There is not much difference between the virtual patient and clinical data where the helpfulness of media and learning approach are concerned, receiving a score 3.4 and above. This can be considered as a good indication of using both the virtual patient and medical information.

Overall, shown in Figure 5.6, almost all participants agreed (9 out of 10) that they were satisfied with the multimedia components used in the simulation (***Overall satisfaction***). 70% of participants felt that clinical documents used in the system were clearly presented (***Inf. Clearly presented***). The majority of participants stated that they felt comfortable to use the system (80% in ***Comfortable to use*** bar). Interestingly, 40% of participants claimed that the system did not have enough information; however, they expressed positive feedback on representing the medical documents in the system. The results show positive feedback towards the system satisfaction. The negative feedback on lack of information may depend on the knowledge of participants.

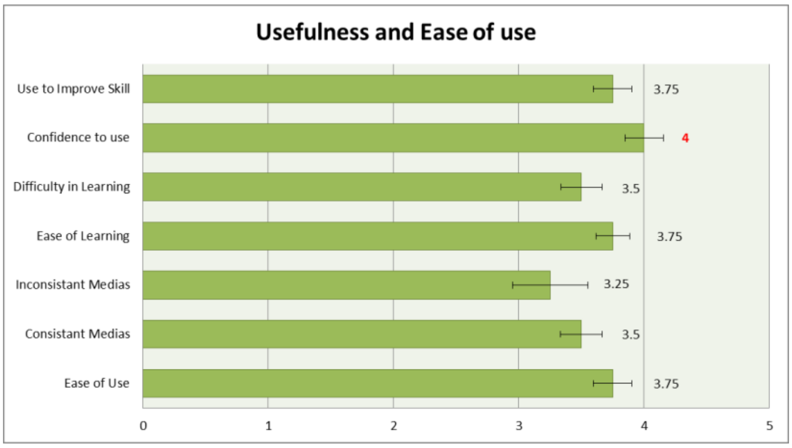


Figure 5.3 Usefulness and Ease of Use: results of Part Usability Questions (mean value and standard error)

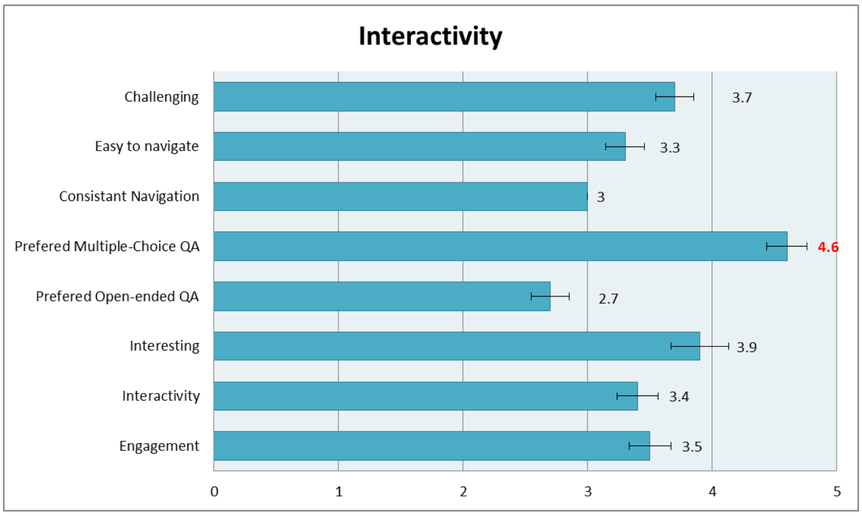


Figure 5.4 Interactivity Questionnaire: results of Part Interactivity Questions (mean value and standard error)

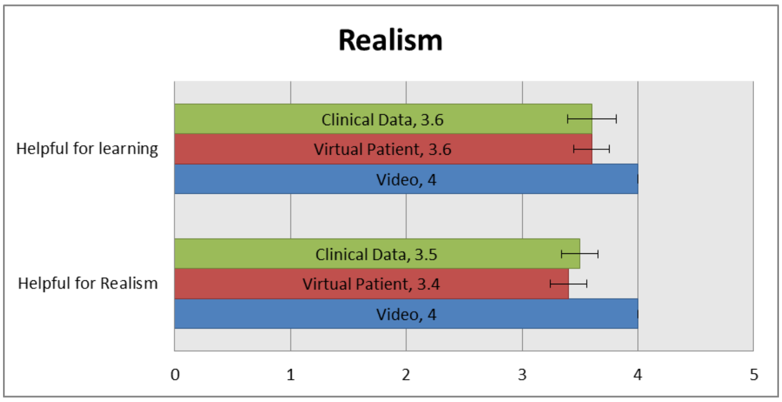


Figure 5.5 Realism Questionnaire: results of Part Realism Questions (mean value and standard error)

Figure 5.6 User Satisfaction Questionnaire: results of Part Satisfaction

5.3.2 Qualitative Data

The qualitative data were obtained from conversations, discussions, observation, and open-ended questions from surveys. The extracted feedback follows a qualitative data analysis method which categorises participants' quotation into categories (such as role of media and system satisfaction) which involved different aspects, and presents their comments, shown in Table 5.2.

Table 5.2 provides the evidence of participant's comments on using the SMILE Framework within the clinical situation which the researcher observed and discussed with the participants. The theme of this qualitative evaluation is classified into two categories: Role of Multimedia Components (from business logic layer) and System Satisfaction (from presentation layer). The role of multimedia is selected based on the positive feedback from Chapter 2. In addition to this, the researcher also discussed with participants how they felt towards the four major modules. No one mentioned any other type of Media in this study. Therefore, no bias can be found to derive the media role into four main aspects. The role of multimedia consists of the virtual patient, video support, decision making, and health-related information. The system satisfaction will be described in terms of ease of use and usefulness.

Qualitative data indicated that the conversation between the virtual patient and the participants mainly emphasized providing more choices and suggestions to initiate the discussion. As stated by one participant: “I do not know what to discuss with John, probably give me some clues”. Providing a set of selections or general questions to guide participants seems to stimulate them to convey their queries. The participants expressed their feeling of the virtual patient being a good performer when participating in conversations. Another participant supported the previous statement: “I like his performance.” However, there were some concerns regarding his eyeballs and a participant mentioned that “ I cannot see his eyeballs.” This statement can mean that the appearance of the virtual patient affects the participant’s attention.

The supported videos engage participants into the clinical environment and provide some clues for participant’s symptoms. One participant mentioned that “ I like the videos, they engage me in the context..” and another one envisioned that “this guy is dementia.” straight after one saw the video. The participant also mentioned that somehow “I want to pause the video..”

The participants expressed their first feeling when they saw the first decision point, that “it should have some clues to guide like options, otherwise, the scope is too broad”. Immediately after the responding answers, the system provides the list of options based on what participants typed and they actually agree with the suggested clues saying that “this make sense when I typed let him finish what he is doing, it should provide an option and go further stage.” One major challenge of responding to questions is time. At the earlier evaluation, participants only had one minute to answer questions. They suggested to have more time and to provide the counter time on the screen. As a result of receiving this feedback, our system increased the decision-making time up to three minutes and placed the time indicator to demostrate how much time was remaining. As the rusult of this, the simulation now has no major issues regarding the time participant need to make their judgments.

The health-related data drew positive feedback from participants. Participants mentioned that the data looked real and supportive for clinical decisions.

The study focused on how participants felt about system performance in terms of ease of use and usefulness. The combination of virtual agent, videos, decision-making technique and related data provided a positive impression on media simulations, with one participant very supportive: “I like the concept of video, virtual patient.” Interactive media is initiative and controllable as mentioned by one person saying that “if it is interactive, I would love to be able to control everything like video pausing or go forward”. This comment reflects a conflict in understanding between simulation and a game. A simulation is not a kind of game in which everything can be controlled and managed by the users. A simulation rather tries to simulate or mimic the real situation within a virtual situation. Participants also expressed that they thought that the system was easy to learn and useful.

Table 5.2 Qualitative Data

Core	Aspects	Comments
Role of Media Components	Virtual Patient (3D)	▪ “The scope to talk with John is too broad; it should have a list of choices to select from.” (P1) ▪ “I do not know what to discuss with John, probably give me some clue?” (P8) ▪ “I like his performance” (P2) ▪ “it don’t think virtual patient engage me much, I think video engage me a lot” (P9) ▪ “I can’t see his eye balls” (P4)
	Supported-Video	▪ “I want to pause the video sometime…” (P5) ▪ “I like the videos, they engage me in the context...” (P3) ▪ “This guy is dementia when I see the video….” (P6)
	Decision Making Techniques	▪ “…in what will you do now? It should have some clues to guide like options. Otherwise, the scope is too broad.” (P8) ▪ “This make sense when I type let him finish what he is doing, it should provide an option and go further stage.” (P2) ▪ “I want to have more time to think.” (P1)
	Health related Information	▪ “This chart looks real” (P7) ▪ “It is always a good idea to support clinical information such as patient information.” (P9)
System Satisfactory	Ease of Use	▪ “I like the concept of video, virtual patients………” (P4)

Core	Aspects	Comments
		▪ "If it is interactive, I would love to be able to control everything like video pausing or go forward." (P2) ▪ "I would like to have a counting time whenever the system wants me to make a decision, so that I know how much time left for my decision." (P1)
	Usefulness	▪ "I really do like this sytem. It is very useful and easy to learn" (P9) ▪ "Probably I can use this for my practical skill in communication" (P3)

5.4 DISCUSSION

According to the SMILE Framework for evaluation, section 5.1, the discussion will focus on three layers: presentation layer, business logic layer, and database management layer, and in particular on how well they perform towards user satisfaction.

The presentation layer was evaluated initially during the Phase One Evaluation and, again, as part of the Second Phase of system evaluation to ensure the ease of use and the overall integration of media. The preliminary evaluation provided initial feedback from real participants and our system was modified to suit needs, such as offering a time counter, shown in Figure 4.8 (B), (C) and (D), providing sample questions, and increasing time available to participants for typing their responses. The evidence from the quantitative data provided positive feedback on usefulness, ease of use, interactivity, realism and satisfaction. Significantly, the participants expressed their confidence in using the system, which is a positive indicator of a user friendly application.

The next layer is the business logic layer where complexity occurs in dealing with several forms of media. The first form of media is the virtual human and the most important consideration is how the virtual human affects the participant's feelings. The result from researcher's observation and discussion indicated (Table 5.2) that the virtual human is easy to use and participants have no difficulty in dealing with the 3D virtual patient. However, one participant mentioned that "probably we do not need a virtual patient, the videos are already enough for telling us the story". Another participant also mentioned that the virtual patient did not influence them much. However, the rating scale for the virtual patient still received an acceptable mean of

3.4 (Figure 5.5), which seems to indicate that participants have a positive attitude towards the virtual patient and that it is a promising form of media.

Another component of the business layer is video which is always well regarded by participants because, presumably because of the quality and quantity of data which it provides. The mean rating of video was 4 points and one participant also mentioned that "I like the videos, they engage me in the context". Evidence from our observation and discussions, during the user's study session, suggested that participants can recognise a dementia person. One participant stated that "this guy is dementia" straight after they had seen the video. Significantly, videos definitely are one of the most preferable choices for telling stories.

The next element of the business logic layer is the set of types of questioning. The majority of participants expressed their preference for multiple choices questions rather than open-ended questions (mean = 2.7) which conformed to rating scales for this form of question (mean = 4.6). One participant said that "sometimes, it is hard for me to think on what to type, why the system doesn't provide options". However, straight after their typing-based response, the system shows options for them to select from and this caught the attention of participants. From the clinical point of view, it is good to understand what nurses are thinking. Significantly, showing multiple choices seems to relieve their stress. As a result, a combination of types of questioning, including alternative choices, may be best decision making, especially for promoting a good learning environment based on simulation of a medical situation.

The final component of the business logic layer is the related medical information. Undoubtedly, participants also paid attention to the representation of the information provided, such as medical charts. One participant mentioned with regard to the displayed medical information that "this chart looks real". However, our research recorded that 40% of participants said that the information provided was not enough. Based on the researcher's observation, the reason behind this might be that some participants did not even access the medical charts or related information. The main issue is that they have limited knowledge or nursing experience. However, from the rating scale in Figure 5.5, the related information receives a good rating for realism and learning.

The last layer is the database layer, which our study used to support the evidence of participants' satisfaction, apart from questionaries, observation, and discussion. The results of total, system log on time (i.e. the time which each participant used), appear to be fall into two groups. Experienced nurses spent less time to complete the whole task and also spent less time when making their decisions. This conforms to our observation that when the students were typing they had tried multiple times until they reached the points that they could select multiple choices to respond to the questions. Based on background information, it is certain that nursing students still have limited knowledge and experience in clinical situations which match with our survey. Nurses and students gave the same opinion about the decision making technique. All of them would prefer to have multiple choices instead of open-ended questions. There is evidence of this from both qualitative and qualitative data.

In summary, the evaluation by ten participants provides positive feedbacks on ease of use, usefulness, interactivity and realism for the multimedia representation. After consideration of all results, it is clear that the essential component required to build a multimedia simulation is definitely the video, which tend to increase engagement between the participants and system compared with the virtual human. Although the virtual human gained an acceptable score for realism and learning, it can be considered as only an alternative means of media simulation which can enhance engagement in the learning environment. The rating scale of the related information components and decision-making techniques obtained acceptable scores and receive good qualitative feedback (Table 5.2). This result provides a sound foundation for modelling a multimedia simulation in the dementia context and perhaps also in other health care context.

Chapter 6: Conclusion

This chapter illustrates research contributions, summarises key findings, identifies limitations and indicates some future research direction.

Our research delivers three things of significance: the novel SMILE framework, the multimedia-enriched simulation based on the SMILE Framework in dementia patients for nurse training and learning, and the evaluation study of the system. More details of these are provided in section 6.1. The last section (section 6.2) discusses limitations and future research.

6.1 CONTRIBUTIONS OF THIS RESEARCH

The media simulation has involved conceptual design and technical development for a multimedia-enriched simulation in a dementia context. This thesis has presented several existing simulation applications in the healthcare situation. The existing framework, from the Virtual Human Toolkit, for developing the virtual patient is customised and expanded its functionality to answer research questions in concert with videos, decision-making, and related medical information. The essential components have been selected based on benefits of communication and engagement and applied in the SMILE Framework.

The development of the system has involved several tools or resources and it has been time consuming to build such a complicated system. The design of the SMILE Framework is able to explore crucial media structure needed in developing such a complex agent conversation applied a hospital context. The SMILE framework offers a bridge between conceptual and technical development for enhancing nurse practice supported by several means of media representation. With the main emphasis on media simulation, the system designs each media separately and components communicate with each other via messages, which applied the concept of SOA in our system. The SOA concept supports the flexibility of the system by implementing the framework into a system with sample cases from clinical perspective.

For the pilot user evaluation study, our system was evaluated with eight nursing students and two nurses. The quantitative and qualitative feedback provided promising indicators in terms of usefulness, ease of use, interactivity, realism and satisfaction. All components in the media simulation (virtual patient, videos, decision-making techniques and related data) are perceived as a potential element for practicing and learning in the future.

6.2 LIMITATIONS AND FUTURE RESEARCH

This research has designed and evaluated a SMILE framework in various media technologies: an animated virtual character, supported videos, a decision-making component using a combination type of open-ended and close-ended questions, and related information. However, there are some limitations for the research including:

6.2.1 Limited Resources for the sample scenario in clinical situation

Due to the lack of real scenarios from other parts in the hospitalised environment, this study involved only one valid scenario provided by the clinical expert as a sample input into the system. Different storytelling may require different content to feed into the system. However, it is believed that a foundation framework in this study contributes a potential benefit to initiate a flexible module in other domains.

In order to create a strong flow in multimedia simulation, storytelling plays a vital part for the whole process from the beginning to the end. Multiple resources of a case story may be required in a prospective study to make a more generalizable concept and understand commonalities within the medical environment.

6.2.2 Windows-based Program for SMILE Framework

Another point to consider is that when a program starts for the first time in rendering a 3D character, a delay of approximately 30-40 seconds is to be expected to initiate an avatar agent. The time may vary from one machine to another machine, depending on the computer's capabilities. Thus, the avatar only displays the upper half of the body to reduce the complexity of rendering. It also minimises depiction of other objects within the three-dimension environment.

A standalone Windows application for developing the virtual patient is the only suitable choice at this stage. A web application is under development but not yet available as a toolkit. In addition, voice communication is managed in only one way, by text-to-speech from a virtual character. The participant is not able to use voice to communicate to the avatar at this stage, due to the complexity of voice recognition systems and the limited timeline for the present project. Nevertheless, communication by text-based typing will be used to develop conversation between the two parties.

It is expected that further research is required to customise the system's own character to minimise redundant components or minimise the time required to render a three-dimensional avatar. There is an ongoing-study at the USC Institute for Creative Technologies (ICT) on capturing a real person and then mimicking it as a 3D model using Microsoft Kinect, which talks and acts like human. In order to maximise research accessibility, it is worth delivering content as a web application platform. Such an arrangement will greatly assist accessibility. It would also enable evaluation during development by a larger number of users. In addition to this, a more interactive communication will need to be developed using a voice command instead of only typing between users and the system. Speech recognition will be an interesting area to investigate and will increase the positive benefits to several circumstances.

6.2.3 Evaluation time limitation and research

To validate the proposed framework, preliminary evaluation was undertaken to investigate the system capabilities in term of usefulness, ease of use, interactivity, realism and satisfaction. Because of the limited timeframe of Master research and funding, only a minimal number of participants (10 participants) were used as a primary contribution to ensure research validity and understand the foundation of participant perspectives. In addition to this, one study stated that 10-12 participants produce significant findings for usability studies (Spyridakis & Fisher, 1992).

A large number of participants are required in the future research to ensure a more valid result by using our evaluation framework. It is supposed that the more participants are involved in our research evaluation, the more we can benefit from user insight and adapt to user needs. In addition, all communication in the system is logged to facilitate future research and improvement.

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Appendices

Appendix A: Application for Low Risk Research Involving Human Participants

University Human Research Ethics Committee (UHREC)
APPLICATION FOR REVIEW OF NEGLIGIBLE / LOW RISK RESEARCH INVOLVING HUMAN PARTICIPANTS

QUT Queensland University of Technology Brisbane Australia

February 2015

NOTE • *All answers should be written __in simple and non-technical language__ that can be __easily understood by the lay reader__.*
• *You must provide an answer to each questions – __N/A is not acceptable__.*

SECTION A: RESEARCH PROPOSAL OVERVIEW

A1 Summary Information

A1.1 Project title (200 character limit including spaces)

SCENARIO-DRIVEN SIMULATION FRAMEWORK FOR NURSE TRAINING IN DEMENTIA PATIENT HEALTHCARE

A1.2 Brief project summary in LAY LANGUAGE (i.e. plain English)

The purpose of this research is to examine a simulated, clinical case platform depicting a person with dementia in hospital. The simulated, clinical case design aims to provide a virtual, clinical setting representing the resources and context in which nurses make clinical decisions in hospitals. The design has been achieved through the use of multimedia components such as a computerised patient model, videos and clinical data. The study will collect data on participant experience of the virtual, simulated platform via paper-based questionnaires. Data from these questionnaires will be transferred to Microsoft Excel format for analysis. The analysis will assess how well the system approximates the clinical situation.

A1.3 Provide an overview of your __research participants and their involvement__ (max 250 words)
The purpose of this question is to gain a sense of who the participants will be, and what you expect them to do within the research

The participants will be nursing students/QUT staff or experienced nurses who are members of the professional, nursing community listed on the Dementia Training Studies Centre (DTSC) mailing list. Participants will be recruited through email and advertisement at DTSC events. This study involves one recruited participant at a time, with each needed for approximately 60 minutes. Participants will be required to complete paper-based questionnaires prior to and after using the system. Initially, each participant will complete a pre-session questionnaire with the researcher (10 minutes). The researcher will label each questionnaire with a code number which will not be linked to the participant's identity. No personal identity information is required for the study. After this, the researcher will spend 5 minutes demonstrating to the participant how to interact with the system. Then, the participant will use the system for a 35 – 40 minute session. Finally, the participant will complete a post-session questionnaire to assist with system evaluation (approx. 10 –15 minutes). Again, participants will not be identified through their responses to the questions. All paper-based records will be transferred to Microsoft Excel format for analysis of system performance.

A1.4 Provide a summary of the __merits of this proposed research__ (in LAY LANGUAGE) including the aims / hypotheses / research questions (refer to Section 1 of the National Statement, NS1.1, when preparing your response).

- Include potential contributions to the body of knowledge and methodological rigor (max **250** words).Briefly provide evidence that the proposed research is based on knowledge of the relevant literature, and provide a list of key references.You may also attach a research plan / methodology which __does not substitute for the summary above__ – this attachment should be no longer than 6 pages.**NOTE:** Unless proposed research has merit (and the researchers who are to carry out the research have integrity) the involvement of human participants in the research cannot be ethically justified.

Scenario-based simulation is a new, state-of-the-art, educational tool using a computerized program to facilitate teaching and learning (Nagle et al., 2009). For example, one recent study used case scenarios from the Open Labyrinth integrated with a Second Life platform to train nurses in an E-learning environment (Orton & Mulhausen, 2008). Kneebone et al. (2005) explained that this approach to learning helps to smooth the traditionally sharp, educational borderline between theoretical/laboratory learning on one hand and the clinical setting on the other hand. This is achieved especially by magnifying clinical procedures and making them more realistic in the teaching environment. It is anticipated that this will be is a successful approach for Nurse Training in Dementia Patient Healthcare. However, it is challenging to establish an effective simulation system that can flexibly convert various scenarios into computer actions, and properly capture and respond to user behaviour.

The aim of this proposed research is to develop a theoretical framework. Therefore, it is essential to identify the key framework components, which may include scenarios, virtual agents, clinical data and multimedia that translate patient scenarios into a computer model. It will then be possible to apply the model to the training of nurses in the care of dementia patients in a clinical context or, alternatively, to other observational studies which use a virtual patient scenario.

From the above discussion, a research question remains:
-What are the essential components required to support a virtual simulator in specific, clinical case scenarios and how do these components interact to incorporate scenarios and agents within the simulation?
-How to model the simulation to seamlessly capture scenario-driven, nurse-patient interactions, which can be generalized for future cases?

The research outcome will contribute to providing a theoretical framework for the building of future, virtual clinical case

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platforms that educational healthcare organizations may use for their clinical teaching (such as teaching relating to patient scenarios or medical procedures). It is hoped that an effective, computerized artefact, will improve the quality of nurse education. Additionally, such a framework may inform future observational studies which seek to replicate clinical settings in a virtual world.

Nagle, B. M., McHale, J. M., Alexander, G. A., & French, B. M. (2009). Incorporating scenario-based simulation into a hospital nursing education program. *Journal of Continuing Education in Nursing*, *40*(1), 18–25; quiz 26–7, 48.

Orton, E., & Mulhausen, P. (2008). E-learning virtual patients for geriatric education. *Gerontology & geriatrics education*,*28*(3), 73-88. doi:10.1300/J021v28n03_06

Kneebone, R. (2005). Evaluating clinical simulations for learning procedural skills: a theory-based approach. *Academic Medicine*, *80*(6), 549-553

A1.5 Why should this be considered a negligible OR low risk application?

Refer to Chapter 2.1 of the National Statement when preparing your response and note that:

- 'Negligible risk research' describes research in which there is no foreseeable risk of harm or discomfort; and any foreseeable risk is no more than inconvenience (e.g. filling in a form, participating in a street survey, or giving up time to participate in research).
- 'Low risk research' describes research in which the only foreseeable risk is one of discomfort (e.g. minor side-effects of medication, the discomforts related to measuring blood pressure, and anxiety induced by an interview).
- Research in which the risk for participants is more serious than discomfort (e.g. where a person's reactions include pain or becoming distressed) the research cannot be considered low risk.

This research meets the criteria of Negligible /Low Risk of QUT Human Ethics. This study does not involve any tasks which may cause physical, psychological, social, economic or legal harm. The participant will be using the system for evaluation of performance of a digital system. The evaluation requires participants to fill in a pre- and post- session questionnaire anonymously and navigate within a virtual program. The participant is free to withdraw from the research at any point without penalty or harm. There will be some questions related to demographics such as age and gender. This information will be non-identifiable and will only be used to develop generic, participant qualities associated with the system evaluation.

A2 Potential Risks and Benefits (refer to Chapter 2.1 of the National Statement when preparing your response)

A2.1 Describe ALL the identified potential risks and who may be affected by these risks e.g. researchers, participants, participant community and / or the wider community. Ensure all risks mentioned at A2.1 are discussed here, and that the risks and their management are consistent throughout the application and are discussed where applicable in the Participant Information Sheet and Consent Form.

When gauging the level of risk ensure you take into account:

- The kinds of harm, discomfort or inconvenience that may occur.
- The likelihood of these occurring.
- The severity of any harm that may occur.
- The choices, experience, perceptions, values and vulnerabilities of different populations of participants will also be relevant.

This research contains no potential risks for researchers, participants, participant community, and/or the wider community.

A2.2 How are the risks to be minimised? And how will they be managed if they were to occur during the study or arise after the completion of the study?

NOTE: The greater the risk to participants in any research for which ethical approval is given, the more certain it must be both that the risks will be managed as well as possible, and that the participants clearly understand the risks they are taking on. Ensure all risks mentioned at A2.1 are discussed here, that the risks and their management are consistent throughout the application and relevant information is included in the Participant Information Sheets and Consent Forms.

The risk is minimised because the participant can choose to withdraw from the survey at any time if he or she feels any discomfort.

A2.3 What are the potential benefits of the research and who would benefit from these?

- Benefits of research may include, e.g. gains in knowledge, insight and understanding, improved social welfare and individual wellbeing, and gains in skill or expertise for individual researchers, teams or institutions.
- Some research may offer direct benefits to the research participants, their families, or particular group/s with whom they identify. Where this is the case, participants may be ready to assume a higher risk than otherwise.

Organisations which provide health care training may benefit from this research as it aims to provide a theoretical framework that can be used for other virtual simulations, especially of clinical case scenarios, for observational research or for developing skills of healthcare professionals through computerised training. This project may also benefit individual participants who, after being exposed to the specific clinical scenario of caring for a person with dementia in hospital, may gain new insights into their practice through self-reflection. This study will provide important evidence on user satisfaction in computerized learning, an essential component for simulated training. This will benefit research in related fields of computer-based learning.

A2.4 How do the benefits justify the risks?

- Research is ethically acceptable only when its potential benefits justify any risks involved in the research.

The benefits outweigh the risk in this research as the risk is considered negligible and the potential benefits improving processes and training in healthcare are significant as it may be used to. Such improvements have the potential to improve the quality of care provided within the healthcare system.

A3 Other General Information

A3.1 Where will the data be collected? (e.g. on site at QUT or other location)

NOTE: If you would like to conduct your study at the premises of an external organisation/association please ensure you provide a copy of your intended approach letter which requests their support/permission for this, or provide evidence of this if already gained.

X	QUT		Other – details:	

A3.2 Is the QUT Human Research Ethics Committee (UHREC) the primary or only ethics committee reviewing this proposal?

If **NO**, provide details of any other institutional HREC involved and the role of each institution (including QUT) in the project. If the project involves more than one institution that also has a HREC, please provide details on the role of QUT UHREC; whether arrangements can be put in place for to minimise multiple review; arrangements for communication of the roles/responsibilities between the institutions HRECs, e.g. who will monitor etc.

QUT is the primary and only HREC reviewing this proposal

A3.3 What are the estimated timeframes for the project? (dd / mm / yyyy)

NOTE: Data collection cannot commence until you have received formal written UHREC approval.

Start of project	01/08/2015	**Start of data collection**	05/08/2015
End of project	31/10/2015	**End of data collection**	31/10/2015

SECTION B: PARTICIPANT OVERVIEW (refer to Chapter 2.2 of the National Statement when preparing your response)

B1.1 Who will be approached to participate? Clearly outline each participant group.

Provide details of the potential participant pool. If you are accessing secondary data please provide full details, including whether permission has been sought. If you are accessing Queensland Health data, you should determine (http://www.health.qld.gov.au/ohmr/) if it is necessary for you to submit a QH application (under the Public Health Act).

The participants will be nursing students/staff at QUT or experienced nurses who are members of the professional nursing community listed on the Dementia Training Studies Centre (DTSC) mailing list (and therefore have registered an interest in improving their professional care for people with dementia).

B1.2 How many participants do you need for your study and approximately how many will you need to approach?

Approximately 10 +

B1.3 How will potential participants be identified and approached?

NOTE: If you would like to recruit participants via an external organisation/association please ensure you provide a copy of your intended approach letter which requests their support/permission, or provide evidence of this if already gained.

Emails that contain survey details will be sent to QUT students and staff with the permission of faculty/school administration or through the DTSC mailing list – a list of healthcare professionals and consumers who have registered their interest in attending information and educational sessions about dementia and caring for people with dementia. Members of the DTSC mailing list will be approached to participate in the research through email invitation and/or advertisement at DTSC events. Permission to use the mailing list for this research will be sought from the director/manager of the DTSC.

B1.4 How will the participants provide their consent to participate?

Outline the consent process you will use, what type of consent will be requested (i.e. specific, extended or unspecified – see NS2.2.14), what material will be provided to participants, how long participants will have to consider their decision to participate and what discussion will occur with participants.

NOTE:

- A person's decision to participate in research must be voluntary and informed i.e. not forced, coerced or obtained by improper inducements AND based on sufficient information and adequate understanding of both the proposed research and the implications of participation in it (the purpose, methods, demands, risks and potential benefits of the research).
- The process of communicating information to participants and seeking their consent should not be merely a matter of satisfying a formal requirement. The aim is mutual understanding between researchers and participants. This aim requires an opportunity for participants to ask questions and to discuss the information and their decision with others if they wish.

In the emails and advertisement posts, we will provide details about the purpose of the survey, contact details of researchers and requirements of participant. Participants will be informed that the survey is voluntary and that they can withdraw at any time before they submit answers to the questionnaires. This information will also be provided at the beginning of the pre-sessional, survey questionnaire.

B1.5 Will the project involve participants who are unable to give voluntary or informed consent?

If **YES**, what special arrangements will be put in place to protect your participants' interests/welfare?

These questions refer to research involving:

- Children and young people whose particular level of maturity has implications for whether their consent is necessary and/or sufficient to authorise participation (see Chapter 4.2 of the National Statement).
- Persons with a cognitive impairment, and intellectual disability, or a mental illness (permanent or temporary) which impacts upon their ability to supply voluntary and informed consent (see Chapter 4.5 of the National Statement).
- Persons who are highly dependent on medical care, e.g. unconscious or unable to communicate their wishes (see Chapter 4.4 of the National Statement).
- Covert observation of behaviour, particularly if this relates to sensitive, contentious or illegal activity consent (see Chapter 2.3 and Chapter 4.6 of the National Statement).

NOTE: Where participants are unable to make their own decisions or have diminished capacity to do so, respect for them involves empowering them where possible and providing for their protection as necessary.

NO

B1.6 Do you propose to screen or assess the suitability of the participants for the project?

If **YES**, clearly state and explain the criteria (inclusion and exclusion, as applicable) for selecting potential participants.

YES. The participants will be nursing students/staff at QUT and registered nurses from the professional nursing community involved in the care of people with dementia. Participants may be male or female and of any age, so long as they have experience in working in hospital care settings.

B1.7 Will participants be offered reimbursements, payments or incentives?

If **YES**, also provide the specific details (type and value), how and when it will be provided and whether its offer could compromise the voluntary nature of the consent obtained from participants.

NOTE: Details of these should be provided on the Participant Information Sheet.

- It is generally appropriate to reimburse the costs to participants of taking part in research, including costs such as travel, accommodation and parking. Sometimes participants may also be paid for time involved. However, payment that is disproportionate to the time involved, or any other inducement that is likely to encourage participants to take risks, is ethically unacceptable (NS2.2.10)
- Decisions about payment or reimbursement in kind, whether to participants or their community, should take into account the customs and practices of the community in which the research is to be conducted (NS2.2.11)

NO

B1.8 Do you, or others involved in facilitating or implementing the research, have a pre-existing relationship with the proposed participants? Could this result in the proposed participants feeling obliged or coerced into participation?

Refer to Chapter 4.3 of the National Statement and the QUT Research Data Collection in Classrooms or Lecture Theatres guidance when considering/preparing your response.

If **YES**, describe this relationship and how you will address the special ethical issues this raises (e.g. potential coercion in recruitment). Also outline what special arrangements will be put in place to protect the interests / welfare of potential participants.

NOTE:

- Pre-existing relationships may compromise the voluntary nature of participants' decisions, as they typically involve unequal status, where one party has or has had a position of influence or authority over the other.
- Examples may include relationships between employers or supervisors and their employees; teachers and their students; carers and people with chronic conditions or disabilities or people in residential care or supported accommodation; etc (see Chapter 4.3 of the National Statement for more examples).
- While this influence does not necessarily invalidate the decision, it does mean that particular attention should be given to the process through which consent is negotiated.

NO

B1.9 Will you conduct a debriefing session at the end of the research or at the end of each participant's involvement?

If **YES**, please provide the details of this session. **NOTE:** Such a session is required for research involving deception (see Chapter 2.3 of the National Statement), and may be appropriate if the research is likely to cause discomfort to participants.

NO

B1.10 Consider providing feedback to participants as this is encouraged by the National Statement.
Will feedback and/or the research results be reported to participants?

- If **YES**, explain how this will be done and in what form this reporting will occur.
- If **NO**, explain why the participants are not to be provided with such a report.

NO. This is due to the fact that this study focuses on the satisfaction if the participant who interacts with the system and provides feedback for any further development.

SECTION C: DATA MANAGEMENT

C1 Future Use of Data

C1.1 Is it likely / possible that any of the data collected will be used by you, or others, for any research other than that outlined in this application? See Chapter 2.2 and Chapter 3.2 when preparing your response.

If YES, describe below and ensure this is outlined in all your participant information sheets and consent forms.

- Participants should be fully informed of the possibility of any future use of data collected and their 'extended' or 'unspecified' consent gained. Failure to do this may restrict the future use of the data.
- Any restrictions on the use of participants' data should be recorded and the record kept with the collected data so that it is always accessible to researchers who want to access those data for research.
- Please note that data sharing is increasingly being encouraged to gain maximum benefit from research, so a **YES** response is encouraged in most cases. If **YES**, describe below and ensure this is outlined in all your Participant Information Sheets and Consent Forms.

YES. As the data will be recorded anonymously in the system, no personal data will be used by the researcher or others. The collected data may be re-used for future research or presented in journals, publications, or conference proceedings.

C2 Procedures & Protection

C2.1 What data collection procedures will be utilised?

Place an '**X**' in the relevant boxes below **AND** provide a copy (draft or finalised, labelled as such) of the relevant instrument, protocol or other written form used to guide (e.g. interview questions/guide) or collect data (e.g. survey) or include an explanation of the method by which the data will be collected. Clinical experimental measures / tools or creative works are considered "Other Instrument".

X	**Questionnaires/Surveys**		X	**Archival records**
	Interviews			**Focus groups**
	Other instrument – provide details:	(If there is insufficient space below, provide details in an additional separate document)		

C2.2 Have the data collection procedures been previously approved by QUT or are they an academic standard instrument?
If **YES**, provide brief details on prior approval or where instruments have been used previously, e.g. under a similar research context

NO

C2.3 In what form will the human data be collected, stored and used/reported?
In each row, indicate which form of data (eg. interviews, questionnaires etc) applies for your study.
At least one column must be completed in each row but if different data are in different forms, you will need to complete more than one box in each column or row.

	Individually Identifiable i.e. Data from which the identity of a specific individual can be reasonably ascertained eg. name, image, date of birth, and/or address.	**Re-Identifiable or Potentially Re-Identifiable** i.e. Data from which identifiers have been removed and replaced by codes, but it remains possible to re-identify individuals, eg. by using the code or linking different data sets.	**Non-Identifiable** i.e. Data that have never been labelled with individual identifiers OR from which identifiers have been permanently removed such that no specific individual can be identified by the researchers.
Collected			X
Stored			X
Used/Reported			X

C2.4 Is this project funded?
If **YES**, outline what rights the funder of the study will have to data obtained from the study, and in what format e.g. aggregate reports only, access to raw data or other. **NOTE:** Any access by the funder should be made clear to participants.

YES. The project is supported by Professor Elizabeth Beattie, Nursing School, and Faculty of Health, QUT, through funds provided by QUT. The aggregate report on how well the system performs will be provided to the funder with all recorded data anonymous.

C2.5 How will confidentiality of the study records be protected during the study and in the publication of results?
NOTE: If you intend to identify participants or organisations, this needs to be made clear on the Participant Information Sheet.

Data will be collected anonymously and the publication will present aggregate data and will not individual contributions. No individual data will be made public.

C2.6 Is this a collaborative project?
If **YES**, also provide brief detail on data-sharing arrangements e.g. open – all parties have access to each other's data; partial – data held by collaborator completing particular component.

YES. The data collected will be available to collaborators. Collaborators will only have access to non-identified participant data.

C2.7 Who will own the resulting research data and the created intellectual property?
Place an '**X**' in the relevant box/es below – at least one box must be checked. If relevant you can check more than one box, ie QUT and an external organisation. Please refer to the D/3.1 Intellectual property (IP) policy for further information.

	QUT STAFF	– QUT is the owner of IP created by staff members in the course of their employment.
X	**STUDENT/S**	–The IP generated is personally owned by the student if not assigned to QUT or other organisation.
	BOTH QUT & STUDENT/S	– If the IP for the student project has been assigned to QUT, ownership of data and IP is shared. **– Please confirm an IP agreement has been signed by both the student and supervisor.**
	EXTERNAL ORGANISATION	– Give details:

NOTE: QUT requires an IP agreement to be in place if IP ownership is to deviate from that described in D/3.1 Intellectual property (IP) policy. Please contact the relevant section of the Division of Research & Commercialisation if you require any further assistance.

C3 Storage & Security

Ensure you refer to the QUT Data Management Checklist **BEFORE** completing this section.

- Data should be stored in a locked filing cabinet at QUT and/or electronically on a QUT mainframe drive.
- Data must not be stored solely at home.

C3.1 [X] **YES** **Confirm that your research data and other records will be stored for the required period.**
Refer to the Guidelines for the Management of Research Data at QUT

C3.2 HARD/PAPER COPIES... (e.g. **signed consent forms**, are required to be kept for **15 years** as per the Qld State Archives Schedule)
Qld State Archives: http://www.archives.qld.gov.au/Recordkeeping/Governance/Pages/Default.aspx
University Sector: http://www.archives.qld.gov.au/Recordkeeping/GRKDownloads/Documents/Universities.pdf

C3.2.1	**What is the location/s of storage?** (i.e. QUT room/building location and/or offsite storage location)	Researcher's workstation
C3.2.2	**How will access to the stored data be controlled?**	All data and results will be stored in a locked cabinet.
C3.2.3	**Who will have access to the stored data?**	Only the researcher
C3.3	**ELECTRONIC DATA...**	
C3.3.1	**What is the location/s of storage and back-up?** (i.e. a secure computer/server and/or offsite storage location)	The primarily data will be stored in QUT H Drive. Also, the

		backup copies will be kept in a portable hard drive which will be kept in a cabinet at the researcher's workstation.
C3.3.2	**How will access to the stored data be controlled?**	The folder and files will use password protection and also will be encrypted for security reason.
C3.3.3	**Who will have access to the stored data?**	The researcher.

Appendix B: Participant Information for Research Project

QUT Queensland University of Technology Brisbane Australia	PARTICIPANT INFORMATION FOR QUT RESEARCH PROJECT

Scenario-driven simulation framework for nurse training in dementia patient healthcare

Ethics Approval Number 1500000395

RESEARCH TEAM

Principal Researcher:	Sirinthip Roomkham	Masters student
Associate Researchers:	Dr Wei Song	Principal Supervisor
	Associate Professor Dian Tjondronegoro	Associate Supervisor

Mobile Innovation Lab – Information Systems – Science & Engineering Faculty
Queensland University of Technology (QUT)

DESCRIPTION

This project is being undertaken as part of a Master by research course for Sirinthip Roomkham.
The purpose of this project is to develop a computerized simulation based on scenario-driven framework involving dementia.

You are invited to participate in this project because you fulfil the participant criteria.

PARTICIPATION

This study involves one participant at a time and your participation will take approximately 60 minutes. No personal identifiers are necessary, so once submitted, your responses to the questionnaires will be anonymous. Your participation will be conducted as follows:

1) Pre-Questionnaire: You will be asked about your gender, age, computer-based learning experience and experience in dementia healthcare. This will take approximately 10 minutes.
2) Researcher Demonstration: Then, you will be assisted through the system to allow you to become familiar with the procedure. This will take up to 5 minutes.
3) Using the scenario-driven simulation system: After the demonstration, you will interact with the system and your actions will be recorded anonymously based on your navigation through the system and decisions. This part will take about 35 minutes.
4) Post-Questionnaire: At the end, you will be asked to rate the system based on your experience. This final questionnaire will take around 10 minutes and consists of four parts:
   - Usability (e.g., you will be asked how you feel when you are using the system, especially with regard to the system's complexity and reliability).
   - Satisfaction (e.g., you will be asked about your satisfaction with the overall system interaction).
   - Realism (e.g., you will be asked whether you found the patient case and related multimedia realistic).
   - Interactivity (e.g., you will be asked about the extent to which the system engaged you).

Your participation in this project is entirely voluntary. If you agree to participate you do not have to complete any question(s) you are uncomfortable answering. Your decision to participate or not participate will in no way impact upon your current or future relationship with QUT. As the questionnaire is anonymous, once your responses have been submitted it will not be possible to withdraw them.

EXPECTED BENEFITS

It is not expected that this project will directly benefit you. However, after being exposed to the specific, clinical case scenario of caring for a person with dementia in hospital, it may benefit you indirectly through providing an opportunity to gain new insights into your clinical practice through self-reflection. The research is expected to benefit organizations which provide health care training and research, thereby benefiting future professional healthcare providers and healthcare consumers. The study will benefit research in similar fields, because it will provide important evidence on user satisfaction with computer-based learning, which is an essential component for simulated training.

RISKS

There are no risks associated with your participation in this project beyond normal, day-to-day living.

PRIVACY AND CONFIDENTIALITY

All comments and responses are anonymous and will be treated confidentially unless required by law. The names of individual persons are not required in any of the responses.

Any data collected as part of this project will be stored securely as per QUT's Management of research data policy.
Please note that non-identifiable data collected in this project may be used as comparative data in future projects or stored on an open access database for secondary analysis.

CONSENT TO PARTICIPATE

The return of the completed questionnaires is accepted as an indication of your consent to participate in this project.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

If have any questions or require further information please contact one of the research team members below.

Sirinthip Roomkham	0430 311 036	sirinthip.roomkham@hdr.qut.edu.au
Wei Song	07 313 80473	w1.song@qut.edu.au

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact the QUT Research Ethics Unit on 07 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Unit is not connected with the research project and can facilitate a resolution to your concern in an impartial manner.

Thank you for helping with this research project. Please keep this sheet for your information.

Appendix C: Participate in Research Information for Prospective Participants

Queensland University of Technology
Brisbane Australia

PARTICIPATE IN RESEARCH

Information for Prospective Participants

The following research activity has been reviewed via QUT arrangements for the conduct of research involving human participation.
If you choose to participate, you will be provided with more detailed participant information, including who you can contact if you have any concerns.

Scenario-driven simulation framework for nurse training in dementia patient healthcare

Research team contacts

Principal Researcher:	Sirinthip Roomkham	Master Student	sirinthip.roomkham@hdr.qut.edu.au
Associate Researchers:	Dr Wei Song	Principle Supervisor	w1.song@qut.edu.au
	A/Prof Dian Tjondronegoro	Associate Supervisor	dian@qut.edu.au
	Science and Engineering Faculty, Queensland University of Technology (QUT)		

What is the purpose of the research?

The purpose of this project is to develop a computerized simulation based on a scenario-driven framework involving dementia.

Are you looking for people like me?

The research team is looking for nursing students, nursing staff and registered nurses with professional experience in a hospital setting who would like to volunteer to participate in the study of a virtual, simulated, clinical case platform involving the care of a person with dementia in a hospital setting.

What will you ask me to do?

This study involves one participant at a time and will be completed in approximately 60 minutes. No personal identifiers are necessary so responses to the study's questionnaires will be anonymous. Participation in the study will conducted as follows:

1) Pre-Questionnaire (anonymous): You will be asked about your gender, age, computer-based learning experience and experience in dementia healthcare. This will take approximately 10 minutes.
2) Researcher Demonstration: Then, you will be assisted through the system to allow you to become familiar with the procedure. This will take up to 5 minutes.
3) Using the scenario-driven simulation system: After that, you will interact with the system and your actions will be recorded anonymously, based on your navigation through the system and your decisions. This part will take about 35 minutes.
4) Post-Questionnaire (anonymous): At the end of the session, you will be asked to provide feedback based on your experience. This final part of the session will take around 10 minutes and consists of four parts:
    - Usability (e.g., you will be asked how you felt when you were using the system, especially your feelings regarding complexity and reliability).
    - Satisfaction (e.g., you will be asked how satisfied you were with the overall system interaction).
    - Realism (e.g., you will be asked whether you found the patient case and related multimedia realistic).
    - Interactivity (e.g., you will be asked questions to assess the extent to which you became engaged with the system).

Your participation in this project is entirely voluntary.

Are there any risks for me in taking part?

The research team does not believe that there are any risks beyond normal, day-to-day living associated with your participation in this research.

It should be noted that if you do agree to participate, you can withdraw from participation at any time during the project without comment or penalty.

Are there any benefits for me in taking part?

It is not expected that this project will directly benefit you. However, after being exposed to the specific, clinical case scenario of caring for a person with dementia in hospital, it may benefit you indirectly through providing an opportunity to gain new insights into your clinical practice through self-reflection. The research is expected to benefit organizations which provide health care training and research thereby benefiting future, professional healthcare providers and healthcare consumers.

Will I be compensated for my time?

No, but we would value very much your participation in this research.

I am interested – what should I do next?

If you would like to participate in this study, please contact the research team for details of the next step. You will be provided with further information to ensure that your decision and consent to participate are fully informed.

Thank You! **QUT Ethics Approval Number: 1500000395**

Appendix D: Email Recruitment

Approach Email

Subject Title:
Opportunity to participate in a novel research study testing diagnosis of a virtual dementia patient in a hospital setting

Dear colleagues

My name is Sirinthip Roomkham from the Information Systems School at Queensland University of Technology (QUT) and I am undertaking a degree of Masters of Research in Information Technology. My research is focusing on building a virtual, clinical case scenario depicting a person with dementia in a hospital setting. The purpose of the research is to create a realistic, teaching tool to prepare students for challenging, clinical situations.

I am looking for nursing students, nursing staff and registered nurses with professional experience in a hospital setting who would like to volunteer to participate in the study of the virtual, simulated clinical case platform. Participation in this study will take approximately 60 minutes to complete.

Firstly, you will need to complete a short questionnaire that asks general demographic questions and some questions relating to your general experience of using virtual technology. Prior experience of this kind of technology is not essential. Then, you will be asked to use the system. The researcher (me or one of my helpers) will provide preliminary training to familiarise you with the interface of the system. Testing the system is envisaged to take between 30 and 40 minutes. On completion of the virtual scenario in the system, you will be asked to evaluate the system performance via a questionnaire (approximately 10-15 minutes).

The testing will take place at the QUT Garden Point campus or at Kelvin Groove, depending on your preference. All data from the questionnaires will be confidential, non-identifiable and coded numerically.

Please view the attached recruitment flyer for further details on the study and how to participate.

Should you wish to participate or have any questions, please contact me via email.

Please note that this study has been approved by the QUT Human Research Ethics Committee (approval number 1500000395).

Many thanks for your consideration of this request. I look forward to hearing from you.

Sirinthip Roomkham
Masters Student
sirinthip.roomkham@hdr.qut.edu.au

Dr Wei Song
Principle Supervisor
w1.song@qut.edu.au

Associate Professor Dian Tjondronegoro
Associate Supervisor
dian@qut.edu.au

School of Information System
Faculty of Science and Engineering
Queensland University of Technology

Appendix E: Background Information Survey

PRE-SESSION QUESTIONNAIRE

1. Please select your gender
   O Male
   O Female

2. Please select your age group
   O Under 17
   O 18 - 24
   O 25 - 34
   O 35 - 44
   O 45 - 54
   O 55 - 64
   O 65 or older

3. How many years of experience have you had in providing clinical care?
   O 0
   O 1-3 years
   O 4-5 years
   O 5-8 years
   O more than 8 years

4. Have you had any experience of computer-based software to assist learning?
   O No (Please go to question 6)
   O Yes. Please, briefly describe your experience of computer-assisted learning:

5. If you have experience of computer-based learning software, how useful was the system to you to acquire new knowledge?

Completely useless	Not very useful	Neutral	Somewhat useful	Very useful
O	O	O	O	O

6. Do you have any experience in dementia healthcare?
   O No
   O Yes

Appendix F: System Evaluation Survey

POST-SESSION QUESTIONNAIRE

PART A – USABILITY

Please rate your level of agreement with each of the following statements based on the system that you have used.

	Strongly disagree	disagree	neutral	agree	Strongly agree
1. I think the system is easy to use.	O	O	O	O	O
2. I found that the various components such as video, clinical data and virtual patient are well integrated.	O	O	O	O	O
3. I found various components such as video, clinical data and virtual patient to be inconsistent.	O	O	O	O	O
4. I would imagine that most people would learn to use the system very quickly.	O	O	O	O	O
5. I needed to learn a lot of things before I could get started with the system.	O	O	O	O	O
6. I feel confident to use the system.	O	O	O	O	O
7. I think I would like to use this system to improve my skills in caring for dementia patients.	O	O	O	O	O

PART B – Realism

Please rate your level of agreement with each of the following statements based on the system that you have used.

1. To what extend were the following options helpful in making the clinical scenario seem realistic for me?

	Not at all	Very little	Somewhat	To a great extent	No opinion
Videos	O	O	O	O	O
Virtual Patients	O	O	O	O	O
Clinical Data	O	O	O	O	O

2. If this virtual scenario were to be designed as a learning scenario, to what extent do you think the following would be helpful for your learning?

	Not at all	Very little	Somewhat	To a great extent	No opinion
Videos	O	O	O	O	O
Virtual Patients	O	O	O	O	O
Clinical Data	O	O	O	O	O

PART C– INTERACTIVITY

Please rate your level of agreement with each of the following statements based on the system that you have used.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
i1. I felt fully immersed and engaged in the clinical situation.	O	O	O	O	O
2. I found the system to be interactive.	O	O	O	O	O
3. I found the system interesting.	O	O	O	O	O
4. I felt that it suited me to type responses when the system asked me "What will you do now?"	O	O	O	O	O
5. I feel that it would suit me to choose from multiple options in response to the question "What will you do now?"	O	O	O	O	O
6. I found that navigation from one scene to another scene made sense to me.	O	O	O	O	O
7. I found that the system allowed me to navigate into different parts of the clinical data easily.	O	O	O	O	O
8. I found that the way the system related factors made it more challenging to work through the scenarios.	O	O	O	O	O

PART D – SATISFACTION

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. I was able to complete the tasks and scenarios quickly using the system.	O	O	O	O	O
2. I felt comfortable using the system.	O	O	O	O	O
3. It was easy to find information which I needed.	O	O	O	O	O
4. The information (e.g. medical chart, medical records and other documents) provided by the system was clearly presented.	O	O	O	O	O
5. There was enough information available in the system.	O	O	O	O	O
6. The interface of the system is well-organized.	O	O	O	O	O
7. This system has all the functions and capabilities I expected it to have.	O	O	O	O	O
8. Overall, I am satisfied with the multimedia components (e.g. video, clinical data, and virtual patient) in the system.	O	O	O	O	O

What things do you like most about John (Patient)?

………

………

………

………

………

What things do you dislike most about John (Patient)?

………

………

………

………

………

Do you have any suggestions to improve the system?

………

………

………

………

………