

A Study of Undergraduate Health Science Students' Perceptions, Navigational
Choices, and Learning Outcomes with IPSims Simulative Learning Environment

By

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Abstract

Simulated learning environments are becoming a more popular format for the delivery of healthcare education. These environments include but are not limited to simulated online learning environments, serious games, task trainers, and, electronic mannequins. Presently there is a lack of understanding of how the learning environment impacts students' disposition to engage in learning processes and how learner satisfaction with the environment impacts learning outcomes. This preliminary descriptive study utilizes methods such as traditional statistical analysis and Association Rule mining. This study will investigate how students perceptions of the simulative learning environment IPSims (Interprofessional Simulations) usability impacts learning outcomes, and how these environments may impact student disposition to engage in learning. The participants (n= 58) were undergraduate health science students studying at the University of Ontario Institute of Technology. The data analysis provides insight into how simulative learning environments can impact student engagement in learning processes. Study strengths and limitations are identified along with future considerations.

Key Words: simulation, online simulated learning environments, misconceptions, IPSims

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CHAPTER 1

1.0 INTRODUCTION:

As healthcare education is making a move towards the use of simulated learning environments by incorporating technology based patient simulators, online virtual worlds, and serious games into pedagogy, we need to recognize that few evidence based frameworks have been employed during the transformation from traditional teaching methods to the use of digital media (Tashiro et al, 2011). The pressure for educational institutions to produce healthcare workers that are ready to hit the floor running (Jeffries & Battin, 2012) has led to the increased use of digital media and simulations as teaching-learning resources. This push towards finding teaching-learning-assessing methods to reduce cost, improve patient safety, and provide experiences that students may otherwise not receive, could result in educational materials and methods that lack empirical foundations supporting their efficacy in learning and ability for knowledge transfer to real world applications. There are few broadly-based generalizable studies probing how students are truly engaging with these environments and what the environmental impact has on the students' likeliness to engage in learning processes. Tashiro et al., (2011) have identified this as a critical gap in our current knowledge surrounding the use of simulated learning environments. Consequently, the researcher had the opportunity to begin filling in this gap through studying how healthcare students use online environments and how perceptions of the environment impact learning outcomes as well as what student navigational choices can tell us about their engagement with the learning environment and how these choices impact student learning outcomes.

1.1 INTRODUCTION TO ONLINE LEARNING AND TERMINOLOGY:

As the next generation and the millennial students' progress through the educational system and technology advances, so does the use of technologically based educational tools. Part of this deployment has been the dramatically increasing use of online learning environments over the past decade (Aldrich, 2009; Garcia et al, 2009; Romano and Ventura, 2010). Online learning can take the form of serious gaming, virtual worlds, simulated learning environments, learning management systems, and intelligent tutoring systems. To understand how, and why, simulated learning environments are being used and if they are effective teaching-learning-assessing methods, we must first define what is meant by the term simulation.

The term simulation refers to “the imitation of a process or real world experience for the purpose of practicing skills such as problem solving and situational judgement”(Rosen, 2008). Simulations can range in replication of similarity to the intended real world experience or the process it is intended to imitate. They can be close replications (high fidelity) to the process (steps taking in sequence for a desired outcome) or experience such as high fidelity patient simulators in healthcare education or low level replications (low fidelity) such as a hotdog wiener used to simulate human tissue for replicating intradermal injections (Medley & Horne, 2005). Computer simulations appear to have great potential for changing the approach for teaching content and skills to improve cognitive functioning (Garcia-Ruiz, Tashiro, Kapralos, and Vargas Martin, 2010). As computer simulations may range from high to low fidelity, their objectives also may vary from purely educational to mixed objectives of educational activities nested within an entertaining environment, often

called serious games. Essentially, these are interactive environments created for the purpose of learning. However, one must recognize that new taxonomies of simulation are emerging (e.g. high to low fidelity, completely educational to mixing educational aspects with entertainment). Consequently, we must be careful not to think different taxonomic categories of simulations are interchangeable, because these environments actually have different purposes (Aldrich, 2009).

Online educational simulations are abstracted from real world activities without impacting real processes or real people. Such simulations have specific levels and goals associated with learning objectives, while virtual worlds allow students to experience variations on the look and feel of real physical surroundings. Students from multiple locations can “meet” together online and experience socialization, collective knowledge, and structured or unstructured learning activities (Aldrich, 2009). The term “serious games” implies the intent for learning to occur but within the gaming environment (Garcia et al., 2011). Although there currently is not a clear definition of “serious games” the term is generally synonymous with games used for training, simulation, or education which are designed to run electronically on video game consoles, web-based portals, and personal computers (Garcia et al., 2011). Multimedia modalities and serious games can be designed to provide a high level of accuracy within the learning environment to focus on complex skills required in for practical real world application (Birds & Nadal, 2012). Online environments can present complex and interactive simulations or situations in an interactive context designed to engage the end user or learners (Garcia et al, 2011, & Pugh et al., 2002).

Serious games and more educationally based simulated learning environments appear to have considerable power for helping students achieve learning goals and improve high order reasoning such as problem solving. This has been attributed to the instructional design embedded in to the learning environment (Tashiro et al., 2011). Well-designed simulated learning environments have the goal of designing the learning environment so that ongoing interactions within the environment incorporate learning activities that result in improved learning outcomes. The actual learning interactions may fall along a gradient from purely educational (although engaging) to entertainment education to edutainment to simply entertain with some educational benefit. Additionally, multimedia environments can allow the user to experience a learning situation that may otherwise be impossible in reality due to financial constraints, safety issues, and time restrictions while providing definitive learning outcomes (Cowan et al., 2008, Garcia et al., 2011, Mikropoulos and Natsis, 2010). Mitchell & Savill-Smith (2004) argued serious games and simulated learning environments encourage the development of diverse analytical and spatial interpretation, recollection, psychomotor skills and critical decision making skills. Michael & Chen (2006) support the conclusions of Mitchell & Savill-Smith (2004) by stating serious games could be effective in improving self-efficacy, social skills, self-monitoring, and problem recognition skills. These are critical skills in healthcare education.

1.2 HISTORY OF SIMULATION AS AN EDUCATIONAL TOOL

Historically speaking, simulations have been used in healthcare education since the 18th century when Madame DuCoudray first introduced her foetal model and pelvis for training midwives (Ker and Bradly, 2010). As technology advanced so did our patient simulators. In the 1960's Asumund Laerdal developed Rescue Anne to simulate the human respiratory system for teaching CPR to medical staff and the general population. The first interactive patient simulator also evolved in the 1960's. Developed by Stephen Ashbrahamson, Sim-One was the first computer controlled simulated patient designed to aid anaesthesiologists in endotracheal insertion (Ker and Bradly, 2010). Laerdal continues to be a leading brand name in the development of educational simulation tools for healthcare education (www.laerdal.ca). Alongside Laerdal human patient simulators, METI (http://www.meti.com/products_ps_hps.htm) also produce a variety of simulated scenarios developed for the purpose of healthcare education which co-ordinate with their high fidelity, automatic mannequins. Currently METI offers a highly functional mannequin called "Stan" who is capable of replicating many human characteristics such as eyes that blink, an audible heart beat with the possibility of programming various cardiac arrhythmias, audible breath sounds with a chest that will rise and fall with inhalations and exhalations, replication of bowel sounds and a variety of palpable peripheral pulse sites (http://www.meti.com/products_ps_hps.htm).

Simulators have a lengthy history in education outside of healthcare. The military has used simulators for flight training, for modelling the progress of nuclear detonation during WWII, and computer war games to teach tactical strategies (Becker

and Parker, 2011). The networked virtual flight simulator was proposed in 1978 when Jack Thorpe argued aircraft simulators should be available to augment flight training and teach air-combat skills that would otherwise not be learned in peace-time flying (Lenoir, 2000). Originally the expense of the simulators was greater than the expense of the systems they were proposed to simulate. The SIMNET (Lenoir, 2000) project of 1982 was tasked to design computer-based simulations that would enable the training of military units and flight crews by combining training requirements and conceptual designs for simulator hardware and system integration. SIMNET was the first military project to focus on learning objectives over fidelity objectives making the cost of production much more affordable (Lenoir, 2000).

The origins of computer simulation and virtual reality in the military date back over thirty-five years when Ivan Sutherland created a head-mounted display in a project funded by the military, academia, and industry combined. The display relied on “input from servo-controlled cameras [that] would move with the users head and thus move the user’s visual field (Lenoir, 2000, Pg. 293)”. The head mounted display introduced what we know today as “virtual reality” (Lenoir, 2000).

1.3 INTRODUCTION TO THE PROBLEM:

Globally, educators struggle with very difficult questions: what really works in education, for whom, how, when, and with what outcomes (Tashiro, 2011). As digital media has become more common in daily life, educators have also discussed whether there are emerging generations that are fundamentally different in how they want to learn and if current practices simply are ill designed for new generations of

learners (Prensky, 2001). The Millennial generation (generally thought to be born after 1982) has been raised with technology. Marc Prensky refers to this generation as the digital natives, those who have self-taught technological competencies (2001). By the time these students reach the age of 21 they will have logged over 10,000 hours playing video games, as well as an additional 10,000 hours talking on cell phones and twice that watching TV. They will have sent and received over 200,000 electronic messages and have spent less than 5,000 hours reading books (Prensky, 2001). These stats are a strong indicator that traditional didactic teaching methods may not be appropriate for these technologically advanced students. In the 2005 article, *Engage Me or Enrage Me*, Prensky discusses how students expect to be engaged with their learning environments and resent environments that waste their time. When technologies or teaching methods do not match their expectations these students disengage and tune out (Prensky, 2005). This is a generation that multitasks, seeks immediate access to information, is spontaneous and craves haptic, audio, and visual cues in their learning environments. These students are connected through social networks and engage each other in multiplayer online games and through video consoles (Smith, 2006). Millennial students' have distinct learning preferences; such as teamwork, structured integration of technology into teaching methods, and experiential learning activities (Garcia-Ruiz et al., 2011). This is in contrast to previous generations who learned through text, limited task in an independent, disciplined, deliberate linear approach (Smith, 2006 & Sweeney, 2006). According to Garcia-Ruiz et al., (2010) understanding the mind set of this generation is crucial for educational planning and course development as this generation requires

stimulation and prefers interactive experiential learning methods over traditional lecture style passive learning.

In addition to their approach to learning, Millennial students also approach technology differently than previous generations. In a series of articles written by Prensky in 2001 through to 2004, he claims that student thinking patterns have changed as a result of their constant exposure to technology. Although the uptake of technology in the classroom is evident, how students utilize these technologically advanced environments is not. Educators and researchers are still unsure of exactly how these learning environments impact student learning, engagement in learning processes, and learning outcomes. Tashiro et al., (2010) have articulated 10 knowledge gaps pertaining to simulated learning environments which will be discussed in subsequent sections and chapters. As such, there is a need to conduct research related to how students are engaging with technology and more specifically simulated learning environments. As a part of such work, the researcher will have to assess students' perceptions of the online learning environments' usability, as well as the perceived impact on their ability to learn within a simulated learning space.

1.4 MOTIVATION:

The concern about the rapid adoption of vast amounts of simulated learning technologies is the lack of evidence to support the efficacy of these educational tools. As previously stated, access to and availability of online simulated learning environments is not the concern, but rather it is the quality of the products being used within such environments that raises alarm. Aldrich (2005) states that use of web-

based learning as pedagogy has erupted so quickly it is comparable to the delivery of fast food. Just as fast food chains produce food that compromises nutritional value and increases health risks; software companies are mass producing e-learning modalities that compromise content and may actually lead to dangerous misconceptions in healthcare education.

In 2005 over 100 experts from the Federation of American Scientist (FAS), Entertainment Software Association, and the National Science Foundation descended upon Washington DC for a Summit on Educational Games. The purpose of the summit was to explore how to best take advantage of digital games for learning. In addition to the 10 key feature recommendations on gaming attributes for learning, the FAS report concluded that many features of digital media games can be applied to meet the increasing requirements for high quality education (Federation of American Scientists, 2006). Based on advances in learning and cognitive science the FAS identified ten gaming features that are instinctively incorporated into game play which could be exploited to improve educational and professional training (Federation of American Scientists, 2006). These features are listed here in Table 1 verbatim from the 2006 report:

Table 1: FAS Recommendations (2006)

Recommendation #	Recommendation
1	Clear Learning Goals
2	Broad experiences and practice opportunities that continue to challenge the learner and reinforce expertise
3	Continuous monitoring of progress and use of this information to diagnose performance and adjust

	instruction to a learner's level of mastery
4	Encouragement of inquiry and questions, and response with answers that are appropriate to the learner and context
5	Contextual bridging (real world application of new knowledge)
6	Time on Task
7	Motivation and Strong goal orientation
8	Scaffolding
9	Personalization
10	Infinite Patience

In this synthesis, features 4 and 8 relate directly to the responsibility of education facilitators and researchers in the design of educational games. Encouragement of inquiry with appropriate response to learner and context provides the opportunity for the learner to discover resources that will aid in improving the game outcome thereby creating a learner that seeks new information to improve learning outcomes. The scaffolding available in games and simulated learning environments acts as a facilitator to the learner through the use of prompts, cues and hints until the learner has reached a level of mastery that enables them to control their own learning pathways. In addition to identifying key features of gaming and simulations that could improve leaning outcomes, the FAS also states that to help translate the art and technologies of gaming into sound instructional materials there is a need for rigorous research (Federation of American Scientists, 2006). Currently, the literature is describing a deficit in evidenced-based framework for designing and evaluating educational simulations (Tashiro, 2009). Furthermore, the educational sector has lagged behind other sectors (such as retail and finance) in capitalizing on the potential of the vast amounts of valuable educational data available through our

digital media learning modalities to launch large scale evaluations on educational simulations and games (Sachin & Vijay, 2012).

The literature indicates the need to promote healthcare education instructional design and learning outcome assessments that foster evidence-based practice in education, while providing an environment for improving students critical thinking, and clinical reasoning (Tanner, 2009). Aldrich concedes that well developed content and sound instructional design of simulated learning environments can aid in knowledge transfer to real life situations and prevent the learner from “mapping irrelevant interaction” (Aldrich, 2005, pg. 27) and developing misconceptions or flawed beliefs. Over a decade ago Tashiro and Rowland began to ask critical questions pertaining to what really works in education (Tashiro & Rowland 1997). From that work has stemmed the identification of deficiencies in the literature pertaining to the 10 key areas of focus related to simulated learning environments. The areas identified in Tashiro and colleagues’ most recent work is listed here in Table 2 verbatim: (Tashiro, Hung, & Vargas Martin, 2011).

Table 2: Current Identified Knowledge Gaps Related to Online Learning

Knowledge gap #	Knowledge Gap
1	How does an educational environment impact disposition to engage in the learning process?
2	What are the relationships between the level of realism in an educational environment and learning outcomes?

3	How do you define the threshold of experience within an educational environment that leads to measurable learning outcomes?
4	What are the knowledge domains being developed during learning?
5	In which knowledge domains is learning being retained and how stable is the retention?
6	What is the disposition to act on the knowledge gained during work within an educational environment?
7	How well can the knowledge be transferred?
8	What learning outcomes (conceptual and performance competencies) are developed during the learning process while working within an educational environment?
9	How are misconceptions developed during and sustained after working within an educational environment?
10	How do teacher-student and student-student social networks or e-communities impact learning?

In 2009 Tanner stated that there was little or limited evidence-based pedagogy to support healthcare education. A strictly linear content design of online modalities does not provide the learner with opportunities to repeat movements in the learning environments and learn from past experiences (Aldrich, 2009). Consequently, there is a need to invest more time to explore if these tools can be effective, for whom and why or why not. Educational virtual simulated learning environments are rapidly being considered a remarkable tool for supporting learning processes and various studies have indicated positive results of student perspectives on learning outcomes

(Mikropoulos and Natis, 2010). Mikropoulos and Natis (2010) stated that learning environment and learning processes are symbiotic to learning outcomes, and while simulated learning environments have been reported as being a useful pedagogical method, there are few studies evaluating the criteria for educational virtual environments. In a systematic review of how simulated learning environments are being used in healthcare education Harder (2010) indicates simulation has been deemed a practical model for teaching psychomotor skills and clinical reasoning. However, Harder also states a strong need for evaluating the effectiveness of these technologies.

When studied all of the aforementioned knowledge gaps can provide valuable insight into how students and professionals use learning environments and how these environments have the potential to impact learning outcomes. The researcher decided to address the first gap pertaining to how the educational environment impacts student disposition to engage in the learning process. From the data analysis the researcher was able to make inferences into how simulated learning environments impact a student's disposition to engage in learning processes and how such processes may impact competencies developed while immersed in the simulated learning environment.

1.5 PERFORMANCE AND CONCEPTUAL COMPETENCIES:

So how does one evaluate not only the efficacy of our learning environment but also evaluate student competencies? “Understanding is not cued knowledge: performance is never the sum of drills; problems are not exercises; mastery is not

achieved by the unthinking application of algorithms. In other words, “we cannot be said to understand something unless we can employ our knowledge wisely, fluently, flexibly, and aptly in particular and diverse contexts” (Wiggins, 1993, pg. 200).

When assessing competencies in healthcare providers or health science students, educators need to ensure they have the knowledge, skill and clinical judgement to perform competently (www.cno.org). Cognitive studies conducted over the past 25 years have indicated that cognition is “primarily concerned with characterizing the knowledge structures and cognitive processes underlying human performance (Patel, Glaser, & Arocha, 2000, pg. 256)”. Understanding how students will develop as professionals is a key element to understanding learning processes. According to Garcia-Ruiz et al., (2010) and Patel et al., (2009), when assessing students for professional competencies or standards, there are usually two related but distinct categories: performance competency and conceptual competencies. Simply stated performance competency translates to the act of demonstrating professional knowledge and skills whereas conceptual competency refers to the intellectual familiarity with concepts. Performance competencies can be assessed using a set of standards related to professional capabilities. One should be able to demonstrate flexibility and competence of applying knowledge beyond memorization and demonstrate adaptability from familiar to unfamiliar situations. Students should also be able to demonstrate an expansive knowledge base with an array of clinical and professional skills (Patel, Yoskowitz, Arocha, & Shortliffe, 2009). Student conceptual competency is demonstrated through a comprehensive understanding of general principles in a given domain such as nursing. The student must also

demonstrate that they have the ability to adapt such knowledge to fit a variety of contexts and multiple unfamiliar tasks and or situations (Patel, et al., 2009).

It is believed that assessing these competencies must be done on a continuum and be flexible to integrate the changing needs of the learner as they progress from novice to expert (Patel, et al., 2009). Performance assessments are strongly linked with curriculum evaluation and have been since the 16th century; ideally these assessments will be linked to educational frameworks and will prompt reflection on educational content, skills acquisition, course material, and learning processes (Madaus, G., & O'Dwyer, 2010). Traditionally student competency assessments have been in the form of standardized tests either written, verbal, or action (Harder, 2010; Cumming & Maxwell, 1999). Recently (within the last 20 years), there has been a shift to focus competency assessments on the complex intricacies of indicators of intended learning outcomes and a student's ability to contextualize learning (Cumming & Maxwell, 1999). But can these environments impact a student's disposition to engage in the learning process and does the environment impact the development of competencies? Patel and colleagues believe so, stating that the use of simulated environments in medical education can positively impact student development for both performance and conceptual competencies (Patel & Arocha, 2000). Additionally, educational data miners have been researching student online behaviours by investigating student engagement with course material, access to learning resources, learning assessment outcomes, and student online communication, with the desire to better understand how the learning environment impact student learning outcomes (Baker & Yacef, 2009)

1.6 TECHNOLOGY IN THE CLASSROOM

The current identified knowledge gaps in how simulated learning environments impact student learning is astounding. One such gap is how the environment impacts the students' disposition to engage in learning processes (Tashiro, 2010). A synthesis of the work done by Tashiro et al., (1997) has demonstrated the need for further investigation into *what really works* for healthcare education. Tashiro's conclusions regarding a lack of evidence as to how various pedagogies result in higher order thinking or how simulated learning environments impact student motivation to engage in learning have prompted this research.

A previous study related to how students engage with learning environments and how student usage has implications for learning processes was conducted at Queensland University of Technology in 2005 by Nelson and colleagues. Commonalities and patterns identified by Nelson et al., were student access, satisfaction with the virtual environment, and time spent online; however, conclusions indicated a deficit in understanding how student technology behaviours impact learning outcomes (2005). Consequently, they concluded that student that engagement and usage should have implications on the design of virtual learning environments.

In a review of technology integrations into classrooms, Cuban (2001) discovered that while teachers may be using technology, many are adapting it to fit traditional teaching methods rather than finding innovative means of adapting their teaching to the technological advances. Garcia-Ruiz et al., (2010) had a similar

argument stating that the use of emerging technologies has not been widely adapted in educational settings to address the specific learning needs of the Millennial students.

There are some changes now emerging in classrooms, teaching environments and in the literature that are related to the integration of simulated learning environments. Specific examples of technology in healthcare literature include human patient simulators, task trainers, online simulations and various reality-based technologies for educational purposes, and serious games (Cooper & Taqueti, 2008). These emerging types of technology-rich educational environments can be and have been used in conjunction with traditional teaching methods or as standalone teaching methods replacing the traditional classroom altogether. A rich literature is appearing in these areas of integration of simulated environments in a diversity of courses which include hybrid or blended, as well as courses offered completely online (Pugh et al., 2002). As a clarifying note, a blended or hybrid learning environment assumes that there is a combination of face-to face teaching along with digital media learning environments, while the online course is delivered solely through the use of digital media (Aldrich, 2009). Learning management systems (such as WebCT and Moodle) are used as to enhance teacher capacities of providing flexibility to instructional models and for dissemination of course material (Ahmad & Shamsuddin, 2010). In addition to dissemination of course material and providing flexibility to course material, learning management systems are an excellent format for collecting vast amounts of educational data such as student access to course material, performance assessments, and online student interactions (Bresfelean et al, 2008). This

technology can be available on personal computers, gaming consoles and also cell phones.

1.7 INTRODUCTION TO IPSIMS AND RESEARCH PLATFORM:

Presently, the researcher believes that of the 10 current identified knowledge gaps (Tashiro, et al., 2011) related to any learning environment; the gap pertaining to the impact of the simulated learning environment on a student's disposition to engage in learning processes is a logical starting point and a critical area of study for understanding how learning takes place within simulated learning environments and how educators can improve the delivery of educational instruction. I feel one must firstly understand how the learning environment will impact a student's disposition to engage in learning prior to conducting research to address the remaining 9 knowledge gaps articulated by Tashiro et al., (2011).

This thesis will examine health science student perceptions regarding the usability and functionality of the IPSims learning environment. Additionally it will investigate how engagement with this environment impacts learning outcomes. The researcher believes understanding how students interact with the learning environment will aid our understanding of how people learn. The approach focuses more specifically on how people learn within simulated learning environments. This approach is justified because of the increase use of simulated learning environments in healthcare education. The researcher has chosen to use the simulated learning environment IPSims to begin the research into how health science students engage with digital media learning environments.

Interprofessional Simulations or IPSims is a standalone simulated learning environment created by Tashiro et al., (2011) as a method of teaching Interprofessional Care. This online simulative learning environment differs from serious games as it does not explicitly offer rewards to the user to encourage user progression through the system. However, much like a serious game this online simulative learning environment offers users a chance to repeat sections of the environment to progress learning at their own pace. The IPSims learning environment houses 6 separate simulated learning scenarios or case studies. Within each scenario or case study the learning environment houses learning resources (nodes or tabs) that can be accessed by the user to enhance their learning experience and learning opportunities. Referring to figure 1, a screenshot of the interface for simulation 1, one can see along the left hand side of the interface the user has access to resources which include the health care records for the simulated patients from the interprofessional team of healthcare providers. The IPP tab (interprofessional perspectives) provides various perspectives related to the simulated patient scenario and patient care from the interprofessional team across the continuum of care (acute care, long term care, and community care). The case records tab includes a case overview, medical history and physical assessment of the simulated patient, the progress notes written as a narrative note appropriate for each scenario, and the interprofessional care priorities related to that particular scenario. The case encounter tab allows the IPSims user to watch a video of the simulated patient encounter with the various interprofessional healthcare providers. For each simulated case study there are three separate videos which are accessed through the scenario 1, 2, and 3

tabs located at the top of the screen. The user can use the main menu option to return to the interface for selecting the appropriate case study or the logout function which will end their session within IPSims. Additionally, if the user has found a particular article or tab useful they can use the bookmark tab to have the system remember that particular location for future reference. Along the top of the interface below the scenario tabs are 3 additional resources. The library resource provides peer reviewed journal articles related to the simulated patient case scenarios as well as reputable websites for any additional inquiries the user may have. The SOP (scopes of practice) tabs highlights the scopes of practice for medical professionals (MD's), nursing professionals (Nurse Practitioners, Registered Nurses and Registered Practical Nurses), rehabilitation services (Physiotherapist, Speech language pathologist) and allied health professionals (Dieticians, Chiropractors, Social Workers, Personal support workers). The final tab, IPC (interprofessional competencies) consists of a PDF file highlighting the Interprofessional Core Competency Framework. The tab highlights the various domain competencies (there are six), and the domain competencies as they relate to each of the six simulated case studies or patient scenarios. Below in Figure 1 is a snap shot of the opening page user interface for simulation Case Study 1, Scenario 1.

and Dr. Tashiro. The researcher adhered to the ethical code of conduct, ensuring students they could refuse to participate in the study and withdraw from the study at any time should they chose to without any penalty. The participating students (71 in total) provided consent for the researches to use their data collected from IPSims and the data collected from a paper and pencil research survey along with learning outcomes from the learning assessment. This data was used in a preliminary descriptive study completed in two stages incorporating traditional statistical analysis and data mining applications to address the basic question of how student usage of IPSims impacts learning outcomes and what it suggests about a student's disposition to engage in learning processes while immersed in the IPSims learning environment.

1.8 EXPECTATIONS:

As with previous usability studies that have been conducted using the portions of the IPSims learning environment, the researcher would expect to find high levels of satisfaction with IPSims general usability. Additionally, based on previous works by Patel et al., (2009) the researcher would expect to find an association between high levels of IPSims usability with high levels of satisfaction with the IPSims learning environment.

Through the use of RoadMap (Tashiro et al, 2011), correlation analysis, multiple regression analysis, and Association rule mining the researcher suspects to note relationships and associations between student navigational choices and time spent within each learning resource, with learning outcomes. It is these key traces

that the researcher believes will help investigate how students are engaging in learning processes while immersed in digital media environments.

1.9 CONTRIBUTIONS:

As this thesis is a part of a larger study, my role in this research was to a) liaise with Health Science faculty after initial contact was made; b) develop learning assessment in conjunction with the faculty; c) introduce the learning environment to students; d) implement the research questionnaire; e) collect data; f) enter data; g) analyze data; h) disseminate research design at national and international conferences and through authoring and co-authoring publications. Through these activities my contributions have been addressing the knowledge gap of how learning environments impact students' disposition to engage in learning processes and learning outcomes. We have been able to provide evidence to support our expected results. Further contributions are the form of the four co-authored papers published over the duration of study:

- *A Knowledge Management Methodology for Studying Health Science Students' Development of Misconceptions* (Regts, Fernandez, Vargas Martin, Tashiro, 2012)
- *Prediction Model Based on User Profile and Partial Course Progress for a Digital Media Learning Environment* (Fernandez, Regts, Tashiro, Vargas Martin, 2012)
- *Neural Networks Prediction Model for a Digital Media Learning Environment* (Fernandez, Regts, Tashiro, Vargas Martin, 2012)

- *Cluster Analysis on User Profile Variables for Digital Media Learning Environment* (Fernandez, Regts, Tashiro, Vargas Martin, 2012).

My contribution as first author to the paper *A Knowledge Management Methodology for Studying Health Science Students' Development of Misconceptions* was to introduce the IPSims system to undergraduate health science student courses, collect and pre-process data and articulate new methods for studying how to investigate the development of misconceptions by health science students while immersed in the online learning environment IPSims. Personal contributions to the remaining papers were to aid in data collection and pre-processing of data for data analysis, as well as to review the narrative of these papers.

1.10 ORGANIZATION OF THESIS:

The remainder of this thesis is organized in the following manner. Chapter 2 is the literature review broken down into five sections: 2.1) Critical knowledge gaps, 2.2) How students learn, 2.3) Simulative educational environments, 2.4) Knowledge discovery and 2.5) How the learning environment impacts learning outcomes. Chapter 3 details the research methods which includes the research questions, significance of the study, research design, recruitment of subjects, research timelines and data collection along with limitation and strengths of the research design. Our data analysis is articulated in Chapter 4, while discussion and conclusions are presented in Chapter 5.

CHAPTER 2

2.0 Literature Review

The literature review for this project has been extensive and crosses over several disciplines. It was apparent that a literature review with a strict focus on serious gaming, online learning environments, and education was limiting in scope and did not provide the breadth or depth of the current available research literature related to teaching, learning, and development of misconceptions nor the advances in educational technology and knowledge discovery research. Consequently, the approach for this literature review blends virtual online simulated learning environments as a base for our research with educational data mining to inspire research methodologies and provide insight from an educational perspective. More specifically this literature review will address five areas of literature that helped frame our approach to studying how students are engaging with simulative learning educational environments and how these environments are impacting their disposition to engage in learning processes.

This literature review begins with relevant literature that exposed critical knowledge gaps that are applicable for the vast majority of educational setting, including simulative educational environments. This will be followed by an overview of important areas related to how students learn. Next, the review extends into current uses of simulative environments, with a focus on healthcare. The fourth section of the literature review examines the use of knowledge discovery models to provide clarity on the complexity of interactions and outcomes within educational

environments. Finally, there will be a review of the literature that examines how students' engagement with learning environments can impact student learning outcomes.

2.1 CRITICAL KNOWLEDGE GAPS

In their initial search of the literature Tashiro et al., (2011) identified eight knowledge gaps surrounding the use of simulated learning environments. To date, Tashiro et al., (2011) have currently identified 10 knowledge gaps. For the complete list please refer to Table 2 in Chapter 1. In addition to these 10 knowledge gaps, Garcia-Ruiz et al., (2011) propose that we also need to consider the effects of “student computer literacy (Millennial student versus previous generations), familiarity with gaming environments, age and gender differences in preference for design of environments and navigational schema, and differentials in access to gaming environments as well as machine power and graphics in computers being used”. These additional concerns posed by Garcia- Ruiz et al., (2011) will be addressed in Chapter 5: Discussions and Conclusions.

The identification of these knowledge gaps exposed interesting possibilities studying how to bridge gaps in knowledge surrounding our pedagogical choices for teaching-learning-and assessing health science students. As a starting point, Tashiro, Hung, and Vargas Martin (2011) defined two broad categories of competencies that could be considered when assessing the efficacy of a learning environment. These competencies are performance and conceptual. Conceptual competencies relate to one's understanding of a knowledge or skills domains that can be demonstrated in

non-real-world settings, such as papers, quizzes, and tests. In contrast, performance competency refers to demonstration knowledge or skill as well as knowledge transfer in a real world activity. Performance competency appears synonymous in the health science literature as clinical competence (Patel, Yoskowitz, & Arocha, 2009). Both conceptual and performance competencies are essential for healthcare practitioners as their ability to apply sound understanding and clinical judgement while executing psychomotor skills directly impacts patient outcomes (Tashiro, Hung, & Vargas Martin, 2011).

Given such knowledge gaps, the literature search was extended to review work related to how educators and researchers use simulative learning environments in educational settings. In 2010, Cant and Copper published a systematic review of simulation-based learning in nursing education. In the 12 articles discussed, the assessment measures for the simulated environments ranged from valid questionnaires, multiple choice exams, critical thinking disposition inventory, pre and post knowledge and confidence test, and systematic patient assessments. Some of the studies indicated the interventions effect on knowledge, critical thinking, or confidence. In 2010 Harder published a review on the evaluations of high fidelity simulations in healthcare education. The studies conducted included healthcare students and practicing healthcare professionals (Harder, 2010). Similar to Cant and Copper, these assessment of efficacy of simulation included pre and post simulation tests as well as objective structured clinical examinations (OSCE's). The OSCE is used to assess clinical skill performance and competence in various aspects of healthcare delivery.

Harder noted that in the majority of the studies the inclusion of simulation to teach clinical skills increased the student's ability to perform clinically and adapt to new scenarios better than those who did not engage in simulation. Self-confidence and perceived competence were also addressed in Harder's review. In the studies aimed to investigate the efficacy of simulation for teaching clinical skills, they also looked at how the simulation impacted the students' self-confidence and perceived competency (Harder, 2010). Students exposed to the clinical simulations typically scored higher on self-confidence and perceived competency. This is important to consider as self-efficacy beliefs can impact a healthcare practitioner's ability to perform in the clinical setting (Harder, 2010).

While these are valid areas of research to address, educational researchers are missing the opportunity to collect data on how students are using these simulated learning environments and how these environments truly impact their learning processes. As a part of her review Harder indicated that there was a lack of available tools for evaluating simulations. Additionally, it was noted that the methods used to evaluate student performance have not been developed to effectively evaluate student competencies using simulations (Harder, 2010; Tashiro, Hung, & Martin, 2011). This is why it is essential to investigate how students use these environments to demonstrate conceptual and performance competencies and how these environments impact their disposition to engage in learning processes within these domains. When assessing for efficacy of teaching methods that result in educational goals and objectives, Patel et al., (2009) caution towards a greater need to understand the nature

of learning that takes place within various learning environments included simulated leaning.

2.2 HOW STUDENTS LEARN

The difference in the demographics of today's undergraduate student requires us to critically think about the delivery of educational materials in relation to how students learn. More specifically, we need to address current critical gaps in knowledge related to how the learning environment will impact the student's disposition to engage in learning processes.

Traditional teaching methods or didactic instruction is often described as teacher centered, meaning the educator dictates the learning environment (Prensky, 2005). This type of teaching is a transmission of facts, concepts, procedural knowledge, and models of metacognitive thinking that are presented as unit lessons, and taught through lectures and various reading and homework assignments. Traditional teaching methods can be found in courses that are completely face-to-face, hybrid, or completely online. All too often with this type of transmission, students are passive learners and knowledge is presented as fact. The exploration of new methods or problem solving is not encouraged (Smerdon, Burkam, & Lee, 1999; Annetta, 2009). Prior to the mid 1990's, this more traditional mode, sometime called "sage on the stage" could be found in a majority of courses around the world, and was the pedagogical method of choice for educators across the continuum of learning through all academic levels for of teaching (Herrington & Herrington, 1998; Schwerdt & Wuppermann, 2011). Over the past thirty years, there has been a

paradigm shift away from such traditional teaching methods with a move towards a constructivist teaching-learning theory (Smerdon et al., 1999; Norman 2005). In a constructivist approach to teaching the teacher takes on more of a coaching or facilitator role opposed to the one who holds the answers. Furthermore, students are encouraged to actively create new knowledge (Clements & Battista, 1990; Patel et al, 2009). Students are able to create new knowledge when they are able to actively make the knowledge meaningful to them and are encouraged to reflect and build on existing knowledge structures. Additionally, the knowledge is constructed through experience and social interaction (Patel, et al, 2009). This is congruent with the writing of Saunders and Welk (2005) who believe social interaction leads to cognitive development. That knowledge is constructed through “interplay between learners and others” (Saunders & Welk, 2009. pg. 203). This is achieved as the learner begins using speech, memory and writing. According to Saunders and Welk (2009), students learn best when using scaffolding strategies such as assisted performance. With assisted performance the role of the educator is to stimulate and support the learner to move forward with their learning pushing beyond what would be capable without the facilitator, until the learner no longer requires the assistance of the educator to move to the next level. This type learning can be achieved in computer assisted learning environments, with video games and simulations, and concept maps. In this environment cognitive structuring occurs which is the organization of information into the memory that will allow students to have recall for future use. When assisted performance is achieved, the emphases have been placed on the learning processes rather than solely the content. This type of learning is essential

for health care professionals as it allows the learner to remove scaffolding as they progress through to the next level in the educational process and move towards becoming professionals capable of working through complex healthcare situations. As educational models begins to shift towards more constructivist models for praxis in education, the literature reveals increased use of new types of learning objects, including simulative educational environments (Murphy et al., 2010). Interestingly, as educational technology and computing power increased dramatically, the simulative environments moved from face-to-face simulations such as patient actors, role playing and paper and pencil simulations to more involvement of computer-based simulations.

In 2009 Annetta examined the theory and practice of using video games for learning. Much like Patel et al., (2009) who believe knowledge is constructed through experience; Annetta believes play is a form of learning and a method of contextualizing relationships within the world. Therefore, it is conceivable that playing will allow one to master various situations through role play, interaction, fantasy and social recognition. According to Annetta (2009), games increase student positive emotional responses which increase student motivation to engage and participate in learning. Specifically looking at video games or serious games Annetta states the instructional context is a greater predictor of learning outcomes than the game itself. As the contextualization of the game must present opportunities to collaborate, and assimilate into the environment. Additionally, the game must allow for disequilibrium which forces the learner/ user to seek resolution and construct new knowledge. Annetta's conclusions can be applied not only to the gaming

environment but also to computer assisted learning and simulative learning environments as demonstrated by Ozmen and colleagues in 2007 and again in 2009.

Under the same notion of creating disequilibrium, Ozmen et al., (2009) investigated the use of computer assisted learning to promote conceptual change among 11th grade chemistry students. Using the a constructivist approach in the instructional design of the computer assisted conceptual change packages, Ozmen et al., (2009) believed that in order to promote conceptual change, current beliefs and conceptions must be challenge and disproved with science to advance the learners knowledge and understanding of complex chemical compounds. This study demonstrated that students who were exposed to conceptual change packages and computer animations demonstrated greater understanding of complex concepts and also demonstrated greater knowledge retention than their counterparts that received only traditional instruction. Ozmen et al., (2009) believe that computer assisted learning enhances student understanding and that acknowledging and challenging students' alternative conceptions is paramount to creating an environment that promotes student understanding of complex concepts in chemical bonding. Earlier studies conducted by Ozmen et al., (2007) related to the use of computer assisted learning or computer assisted instruction (CAI) in Turkey on high school chemistry students. The results of their studies suggest that students not only indicate a greater understanding of the complex concepts but also have a greater appreciation and interest in chemistry (Ozmen, 2007). Ozmen (2007) attributes the student-centered approach to teaching using the CAI to the increase in student comprehension of complex concepts and understanding.

Similar to Ozmen et al., (2009), Aly et al., (2004) utilized multimedia programs to deliver undergraduate orthodontic curriculum using an experimental group and a control group. The experimental group used five 90 minute multimedia working sessions at three week intervals while the control group was exposed to traditional lecture and power point presentations over 10 weeks. While the results indicated that both groups were equally successful in post-tests, the experimental group did demonstrate greater comprehension of multidisciplinary orthodontic treatments. It is believed this is a result of greater discussion and collaboration of knowledge with the experimental group as this group had a greater tendency to work through the content together which fostered discussion and could have enhanced understanding. The authors concluded that computer assisted learning is as effective in delivering content and promoting understanding of content as traditional teaching methods.

The researcher has looked at the aforementioned studies on learning theories and learning environments and their efficacy to promote student learning. According to Norman (2005), clinical reasoning on the part of the practitioner is essential for effective healthcare. Studies have shown the approach to teaching clinical knowledge and reasoning can be paramount for instilling the cognitive competencies required for effective clinical reasoning. This is relevant to this research as it provides insight into previous attempts at informing clinical reasoning processes but also understanding how the undergraduate novice practitioner may approach various learning activities. As the researcher is seeking information regarding the impact of the learning environment on student learning outcomes through tracing student movements that

are believed to be traces of cognitive function, this work provides an overview of seminal work and current trends for research within this domain of how students learn in healthcare education.

Historically speaking, there has been a paradigm shift in pedagogical approaches in the literature. Looking back several decades for early studies related to pedagogical methods we are able to note that educators are already thinking about changing the delivery of education materials to optimize learning potential. In a study conducted by Graham and Wong (1993), students from grades 5 and 6 participated in a study comparing two teaching methods: traditional didactic and self-instructed training. The study was assessing which method would help improve student reading comprehension. The students who participated in the study ranged in reading comprehension abilities from below average to average. The results indicated that students who were self-instructed and able to improve metacognitive knowledge when constructing their own meaning of the content material, scored better on the post training reading comprehension assessments. The researchers concluded that the self-directed learning improves metacognitive abilities. Their argument was based on the data supporting how this form of learning encourages self-regulation, and self-evaluation. Additionally, the researchers claimed didactic teaching methods fall short of self-instructed methods due to their inability to promote self-regulation and self-evaluation the self-instructed (Graham & Wong, 1993). This article is of value for this research as it demonstrates the efficacy of the constructivist instructional approach to learning which as Lammers (2007) points out the instructional design commonly for simulated learning environments is.

More recently than Graham and Wong (1993), in a study looking into the efficacy of instructional methods, Ghali et al., (2000) introduced evidence-based problem solving in medical student education. The control group received traditional didactic methods for clinical topics, while the intervention group attended an evidence-based medicine mini-course (Ghali et al., 2000). Although the term constructivist was not applied to this study, the intervention group in the mini evidence-based medicine course used principles of constructivism and authentic learning. Such principles include but are not limited to collaboration in identifying clinical issues pertaining to patient care, self-reliance on locating evidence-based literature to inform clinical decisions, and self-evaluation. The results of this study indicated that the intervention group had significant positive changes in self-evaluation and use of computerized searches to aid in clinical decisions over the control group, therefore indicating that the non-didactic intervention was successful in changing third year medical students' approach to evidence-based medicine (Ghali et al., 2000).

In 1999 Burkham et al., published a research article which investigated access to various teaching pedagogies across the United States. At that time there had been a call for reform to move teaching methods away from the passive traditional didactic methods to the active student-centered constructivist model (Smerdon et al., 1999). Although there is evidence across the decades that argue for a move towards a student-centered approach, it appears there is a more urgency for the paradigm shift as students are now demanding the change. If we look at the Millennial generation student population they are demanding a learner-centered approach to teaching that

will engage them and promote learning through doing (Cowan et al., 2000). It appears that this generation of learners crave the blended experience of a constructivist, experiential and collaborative learning environment. As educators and researchers, we are striving for better methods for engaging our students with the core teachable content.

Students do not fail to notice the sharp divide between the pedagogies of the classroom and the effective pedagogies of situated teaching in the clinical setting, and they find the divide perplexing not only because they learn so well in one arena and struggle to learn in another, but because the classroom experience is at odds with the strong ethos that results in deep commitment of professional values (and many students noted deep personal transformation). Classroom teachers must step out from behind the screen full of slides and engage students in clinic-like learning experiences that ask them to learn and use knowledge and practice thinking in changing situations, always for the good of the patient. – Benner et al, 2010. Pg. 14

2.3 SIMULATIVE EDUCATIONAL ENVIRONMENTS

As noted in several articles (Cowan et al., 2000; Cooper & Taqueti, 2004; Lammers, 2007), implementing simulations into curricula is a multidisciplinary time intensive undertaking. Although there are limited empirical studies related to the efficacy of simulations in medical education, many instructors and faculty are taking simulation efficacy at face value. As researchers continue to look into how institutions and students are using simulated learning environments, and the origins of simulations in education, it is imperative to look at the intensions behind the integration of simulated learning environments. According to Lammers (2007), simulation is a means of providing a standardized experience with close supervision that the clinical setting may not offer and therefore the learner may not otherwise

receive. For the most part, simulated learning environments are integrated into curricula to optimize student learning in a time burdened with many constraints (Cannon-Diehl, 2009). Lammers (2007), also states reading and traditional didactic methods are necessary to provide basic knowledge to learners prior to experiencing complex situations within the simulated learning environment. The unprepared student will flounder in a simulation without the proper background. Ideally simulations will be utilized to expedite student learning curves when basic knowledge is already present.

The uses of simulations and simulative learning environments have been noted across disciplines for many years. The military has been using forms of simulations for centuries. Roman soldiers would use tree trunks with their swords to simulate hand to hand combat battle with their enemies. The tree trunks evolved into logs on ropes to incorporate movement into the simulation, and progressed further to have wooden figures tied to horseback (Becker and Parker, 2011). The advancement of technology also brought forth increased sophistication in simulated learning experiences. Militaries are now using simulation to replicate fighter jets, and tanks. Also noted is an uptake in the use of serious games by the military. These games are used to replicate battle fields and even as army recruitment tools (Birds & Nadal, 2012). These games offer a simulated experiential and social constructivist learning environment as the participants are able to engage in a safe learning environment where the consequences of participant's actions are not grave but can be learned (Ker & Bradley, 2010).

Simulation in healthcare education is not a new phenomenon. In the 18th century, Madame DuCudray introduced the foetal model and female pelvis for training birthing techniques to midwives (Ker and Bradly, 2010). In the 1960's Rescue Anne was developed by Austrian toy maker Asumund Laerdal as a part-task trainer for teaching Cardiopulmonary Resuscitation (Cooper & Taqueti, 2004; Bradley, 2006). We can also imagine the use of theater portrayals of disease signs and symptoms as a precursor to patient actors/standardized patients, and role playing in healthcare education (Rosen, 2008). Patient actors were introduced to medical training in Southern California in 1963. These patient actors were used to portray various patient conditions and eventually used as instructional and evaluation tools (Rosen, 2008).

Technological advances in healthcare education have been put to use in computer simulations, human patient simulators, serious games, and virtual worlds (Ker & Bradley, 2010). The concept behind simulation is that it is intended to provide a safe and controlled environment (Murphy et al., 2010). Across the globe students are experiencing limitations in clinical exposure as time, money, and patient safety are always a concern. One major benefit of a simulated learning environment is that it offers students an experience they may not otherwise have exposure to. In the UK, nursing programs have supplemented 300 clinical hours with clinical simulation hours as a method for providing students the clinical experiences they may otherwise not have encountered or been able to participate in (Murphy et al., 2010).

When simulation is coupled with learning theories that account for cognitive and performance domains, healthcare students discover knowledge through active

engagement, role socialization, problem solving and critical thinking and clinical reasoning (Ozmen,2007; Murphy et al., 2010). The integration of learning theories provides educational credibility and offers structure to formulates appropriate research questions (Ker & Bradley, 2010). The instructional design of most simulated learning environments rely heavily on the principals of learning theory (Murphy et al., 2010). Learning theories and instructional design are the foundation of simulated learning environments. According to Ker and Bradley (2010), there are several learning theories used in the development of these environments, interestingly, and sometimes confusingly, each theory has a set of instructional design principles that delineate objectives for learning. From each objective there can be expressed specific types of learning activities, learning resources, and specific types of learning outcomes assessments (Tashiro, et al., 2011).

Over the past decade educators have been exploring effective use of simulated learning environments and digital media technologies to enhance their teaching and outreach and capabilities (Mikropoulos and Natsis, 2010; Cant & Copper, 2009). In an editorial from the magazine University Affairs, Leo Charbonneau (2012) stated that 6.1 million American college students took an online course in the 2010. This is up from 2009 where at least half a million students accessed online courses. Not to mention the 160,000 people who enrolled in the first offering of Stanford’s professor Sebastian Thrun’s free online “Introduction to artificial intelligence” and the many others now offering free online education for example Khan Academy and MIT’s e-learning venture. So what does this mean for simulated learning environments? With

wider spread use, simulated learning environments are becoming more widely accepted.

According to the Horizon report of 2011 which highlights upcoming technologies in education, augmented reality will play a greater role within the next two – three years. The report states augmented reality provides students with visual and interactive learning environments that are aligned with situated learning theory. This type of environment blurs the boundaries between formal and informal learning which is what the millennial generation is seeking.

When looking at the use of simulation and technology specifically in healthcare education, there are many examples. Virtual reality is becoming a prominent educational tool for delivering content. An example of the use of virtual reality as an educational tool is discussed in an article written in 2008 when the University of Wisconsin integrated the 3-D virtual world Second-Life into its accelerated nursing program. The nursing students were to meet for course discussion weekly in small groups in Second-Life. Weekly discussions allowed the students to collaboratively work through ethical case scenarios. The university felt the experience was successful as students believed the simulated learning environment had a positive impact on their learning. Additionally, evidence supported the conclusions that the simulated environment provided students experiential learning and social construction of knowledge in a safe environment (Schmidt & Stewart, 2009). One of the original drawbacks to the experience was inappropriate dress of the Second Life student avatars, with both avatars and clothing chosen by the students. This was remedied for follow up cohorts and students were

made to dress their aviators in medical scrubs appropriate for a clinical setting. The appropriate dress speaks to the constructivist perspective on learning as the appropriate dress for the professional setting contributes to role socialization (Schmidt & Stewart, 2009).

Additional uses of computer simulated learning environments are presented in the work by Cowen et al., (2010). In Oshawa Ontario at the University of Ontario Institute of Technology, faculty, industry partners and researchers have built and incorporated serious games into their health science curriculum (Cowan et al., 2010). The simulations have been developed by clinical critical care experts, educators and game designers to simulate an interprofessional health care learning experience. In the game, the student interacts with other players and patients in a first person perspective. In the game, the patient's condition changes based on the appropriateness of the student's actions or inactions. The designers believe this environment will enable player to practice and apply skills in a safe student-centered learning environment that promotes self-efficacy and competence (Cowan et al., 2010). Further examples of the advancement and use of simulative learning environments in healthcare education are provided by Sabri et al., (2010) where a team of researchers and game developers from Mount Sinai Hospital (Toronto Ontario), Hospital for Sick Children (Toronto Ontario), University of Ontario Institute of Technology (Oshawa Ontario), and the University of Toronto (Toronto Ontario) published work related to the development of a first person shooter serious game for surgical residents to learn the procedures of a total knee arthroscopy (TKA). The game is intended to provide the user with challenges and rewards in a "fun and

engaging manner” (Sabri et al., 2010. Pg. 3487), while teaching the user the pattern recognition required for TKA surgery. The efficacy of the game will be indicated by two markers 1) the ability of the student to retain and transfer knowledge and cognitive process related to surgical steps, troubleshooting and decision making regarding the procedural steps involved in a TKA gleaned from the online learning environment, and 2) if surgical technical skills can be enhanced through the utilization of first person shooter online surgical simulated games (Sabri et al., 2010). It is believed that serious games and simulations can help reduce the cost of training surgical residents and aid in teaching when time restriction and availability of surgical suites is limited (Sabri et al., 2010).

Simulators and simulated learning environments are being used to not only expedite student learning curves but also to address the development of misconceptions by students. This is noted in works by Balkissoon et al., (2009), as well as the aforementioned work by Ozmen et al., (2008). Balkissoon et al., (2009) utilized a digital rectal exam simulator to study how the learning environment and content delivery impacts the learning outcomes. They were looking for the development of student misconceptions using the digital rectal exam simulator to demonstrate the shortcomings of traditional textbook learning. The sensors set up in the simulator were able to map the locations and pressure applied during the digital rectal examination (DRE). The simulator coupled with a paper and pencil documentation of findings allowed Balkissoon et al., (2009) to visualize the navigation pathways of the examiner during the DRE and measure the accuracy of the participant’s clinical findings. The results indicated that those with less experience

were less likely to perform a full examination in less time than those with greater experience. Interestingly Balkissoon et al., (2009), attributed the lack of ability to various teaching methods and the shortcomings of a teacher-centered or text book approach. These traditional methods are unable to provide the student with sufficient visualization of appropriate techniques and feedback to fully develop their performance and conceptual competencies, whereas the simulator can present an accurate description of areas palpated (through sensors) and missed as well as the pressure applied during the DRE. It was concluded that this type of simulator coupled with clinical real world experience would reduce the development of misconceptions as to how to perform a digital rectal exam. In healthcare an inaccurate exam can result in delayed identification of abnormal growths and delay time sensitive treatments resulting in unfavourable patient outcomes Balkissoon et al., (2009).

2.4 KNOWLEDGE DISCOVERY

All too often in teaching and research we have trended towards working in the silos of our respective expertise domains or discipline areas. However, just as is moving towards improved patient outcomes through the use of interdisciplinary teams, we should explore more interdisciplinary approaches to educational research. An emerging approach in such interdisciplinary works is the use of knowledge discovery tools and data mining. In fact, data mining and knowledge discovery are now routinely being integrated and the research literature reveals educational data mining is now an exploding field of research (Baker & Yacef, 2009). The need to collect, manage, analyze and interpret the vast amounts of data, along with greater

data availability from sources within the digital world and the world wide web, has driven industries and researchers to seek out new tools, methodologies, and processes that will facilitate knowledge discovery (Cios & Kurgan, 2005). Industries such as retail and finance were among the first to capitalize on the potential knowledge extraction from data mining methods dating back to the mid 1980's (Cios & Kurgan, 2005; McGregor, 2011). The education sector lagged behind as evidenced by publications contributing directly to data mining in education not emerging until 1995 (Baker & Yacef, 2009).

Data mining research has addressed a variety of complex and unique domains with applications in customer management, financial forecasting, gene mapping and fraud detection (Sharma & Osei-Bryson, 2008). Similar to the finance, retail, and health care sectors, educational data mining follows a process to guide its inquiry (Talavera & Gaudioso, 2004). The process includes identifying a problem, collecting data, pre-processing, cleaning and transforming the data, building a model, interrupting and evaluating the model, and dissemination or deployment of the research results (Ahmad & Shamsuddin, 2010; Talavera & Gaudioso, 2004). This process is used in applications of educational data mining methods in three key areas of study across the EDM domain: 1) domain knowledge, 2) pedagogical support, and 3) key factors impacting learning to refine educational theories and improve learning systems. These four key areas of study described by Baker and Yacef (2009) is reiterated throughout the themes presented by Romero and Ventura (2010) in the *Educational Data Mining: A Review of the State of the Art*, who describe key research areas as a) offline education in studying how students learn using variables

such as student behavior, curriculum, and learning environments, b) the study of e-learning and learning management systems for the purpose of web-mining student behavior within the online learning environment, and c) incorporating methods such as web logging and student models to review efficacy and tailor learning environments to meet individual specific students learning needs in Intelligent Tutoring Systems (ITS) and Adaptive Educational Hypermedia Systems (AEHS). As the data collected for by and for education is unique with distinct characteristics addressing both the practical and theoretical educational data mining is a vital process.

Educational Data and Educational Data Mining (EDM) processes are not limited to individual student interaction and collaborative efforts within the educational system (offline, e-learning or intelligent tutoring systems), but rather it spans to include interesting administrative data, demographic data, student psychological data (motivation and mental health), and physiological attributes such as posture, facial expressions, perspiration (Scheuer, McLaren. 2011). Scheuer and McLaren (2011) state that educational data mining as its own discipline contributes through the development and application of data mining techniques unique to education. Growth and recognition for educational data mining as an established field of research has been aided through the development of a scientific peer reviewed journal, *Journal of Educational Data Mining* which published its first issue in 2009. Additionally EDM started an international conference in 2008 with the first International Conference of Educational Data Mining (Baker & Yacef, 2009).

Educational data mining (EDM) began to surge in the 1990's and has seen dramatic changes in the utilization of data mining techniques for key applications of educational data mining methods (Baker & Yacef, 2009). Educational data mining focuses on answering theoretical and practical issues within education for education applications (Scheuer & McLaren, 2011). EDM is “concerned with developing methods to explore the unique types of data in educational settings, and using these methods, to better understand students and the setting in which they learn (Romero & Ventura, 2010. Pg. 601)”. Common educational data mining applications include, but are not limited to, student models, educational software, collaborative learning environments, web logging, and factors associated with student development of misconceptions (Baker & Yacef, 2009; Tashiro, et al., 2010).

The most prominent data mining method from 1995-2005 in educational data mining literature was relationship mining and sequential pattern mining (Baker & Yacef, 2009; Romero & Ventura, 2010). Association rule mining has been applied to educational data for exploration in student e-learning behavior (Carmona, Gonzalez, del Jesus. 2010; Garcia, Kloos. 2008; Zaiane (2001) and for association rules exploration for new knowledge leading to improving teaching and student learning (Merceron & Yacef, 2003). The rapid growth and development of e-learning and web-based simulated learning environments has generated and enabled the collection of vast amounts of data unique to the educational sector (Carmona et al, 2010). Educational data mining researchers such as Carmona et al (2010) have been using association rules for the discovery of descriptive rules of relational attributes within the data sets. Carmona et al., (2010) state that association rules can be applied to e-

learning data collected from learning management systems (LMS) for extracting useful patterns as they relate to student navigational choices and behaviors, sub-group discovery, and patterns that lead to success or student failure such as gaming the system and poor self-efficacy (Garcia & Kloos, 2008).

Association rule and sequential mining that lead to knowledge discovery can be used for improvements in course structure, course content, and student learning processes (Carmona et al, 2010; Garcia & Kloos, 2008; Merceron & Yacef, 2003). In addition to e-learning environments association rule mining has been applied to intelligent tutoring systems to extract theoretical and practical pedagogical information for teachers (Merceron & Kloos, 2008). At the University of Sydney in Australia Merceron and Yacef (2008) applied association rule mining to an intelligent tutoring system to provide relevant feedback to the teachers in relation to student progress as both individuals and as a group. The ITS used in this study is called Logic ITA. Logic ITA provides students the opportunity to practice and master formal proofs in propositional logic. Students can access exercises while the system provides feedback and corrections to student answers. Relational mining is then applied to the collected data to provide teachers with new knowledge related to individual student access to proofs, group access to proofs, which proofs students had the most difficulty with and which proofs were completed with minimal errors or difficulty. The usage of relationship mining with Logic ITA is effective as teachers can incorporate the information gleaned from the data mining process into their content delivery to provide additional instruction in areas noted with the greatest amount of student difficulty (Merceron & Yacef, 2003). Association rule mining has

also been applied to educational data mining for investigating learning material organization, student assessments, course/ instructor adaption to learning behaviors of students, educational web site evaluation, and relationships between system usage times and student assessment scores (Castro, Vellido, Nebot, and Mugica. 2007).

2.5 HOW THE LEARNING ENVIRONMENT IMPACTS LEARNING OUTCOMES

The research literature in cognitive neuroscience is providing new insights into how individuals learn, retain knowledge, reconstruct knowledge and behaviourally express that knowledge in real-world applications (Patel & Arocha, 2000). Cognition is defined as the “result of learning, perception and reasoning” (thefreedictionaryonline.com, 2012). “Higher reasoning and cognitive processes” refers to our ability to use our knowledge in various situations (Tashiro et al., 2011). Simulative educational environments provide interesting opportunities to study some elements of cognitive processing, knowledge development, and knowledge transfer in elicited behaviour. Importantly, with the dramatic increases in the use of digital media and computer-based simulation, we should be examining evidenced-based frameworks for helping design and implement simulative environments that actually improve learning (Tashiro, Hung, & Vargas Martin, 2011).

In 1997 Tashiro and Rowland began to ask the question of what really works in education, for whom, and why and with what outcomes? As a starting point we look to Baggio and Belderrain (2011) who published an article with the focus on Authentic Learning using technology in the classroom. They proposed to achieve an

authentic learning experience instructional designers creating the space must include Jonassen's (2001) 7 principals of for creating meaningful learning environments. When integrated into a simulative learning environment the environment would represent an active, constructive, collaborative, intentional, complex, conversational, and reflective space that promotes higher order reasoning, and respects the current learning needs of the learner (Baggio & Belderrian, 2011). Although the paradigm from traditional teacher-centered methods to a student-centered, constructivist approach has been a slow process, we are noting that faculty are reflecting on their choices and rational for integrating technologies into the classroom and how this will impact the learning outcomes of the student. As an example, Hayward and Coppola (2005) looked into using reflective practice to evaluate the efficacy of integrating technology into higher education course delivery. They considered the integration of technology into the delivery of graduate course work natural as when these students graduate into professional practitioners, they will be expected to be able to support clinical decisions through evidence-based research (Hayward & Coppola, 2005).

While continuing to assess various learning environments and their impact on education, Ellaway and Masters (2008) published a two part series reviewing e-learning in medical education. In Part 1 the authors introduce the reader to the various forms of e-learning that are available. Ellaway and Masters explicitly state that although technology integration into medical education curriculum is welcomed the goal is and always will remain education. The authors point out that many technologies are now incorporating into learning did not start out as educational resources but rather emerged as such through the creative process of educators

seeking to improve their practice (2008). Although the article introduces and focuses on various forms of e-learning from learning management systems to virtual learning environments we comment on the section pertaining to clinical practicum, simulations, virtual patients, and simulators as this is the particular area of focus for our research. Ellaway and Masters feel these environments offer highly valuable authentic learning that can be available on demand while managing cognitive load issues and helping the learner keep pace. Additionally, these environments promote higher order reasoning, problem solving, strategic thinking, and interruptive analysis. These skills demonstrated in such simulative environments promote knowledge in practice and higher order cognitive skills (Ellaway & Masters, 2008).

When assessing how the learning environment impacts the students disposition to engage in learning processes, an article written by Bull (2009) claims student engagement with multimedia incorporates three cognitive processes. In relation to the articles mentioned above, Bull claims these learning processes are aligned with the constructivist learning theory along with cognitive theory and multiple intelligence theory. These three processes are selecting, which ensures the learner is able to select various activities for learning within the multimedia environment. Organizing is the second process which allows the learner to place the text into context by placing images and or audio in the same visual field. The third process is integrating. Integrating is when the learner is able to connect pieces of the entire event into their repository of information. The integrating process in multimedia learning environments accounts for the learners' previous experiences and prior knowledge (Bull, 2009). In short, Bull argues when the instruction design

of the learning environment incorporates the constructivist teaching principals these three cognitive processes will evolve and result in positive learning outcomes.

When discussing factors affecting the efficacy of e-learning and e-learner satisfaction, Moseley and Pruitt (2008) discover computer literacy, learning style preference, and system usability, play a role in student disposition to engage with the environment. According to the Moseley et al (2008) and various other articles (Bull, 2008 and 2009; Johnson, 2011; Dalal, Brancati, & Sisson, 2012) determining the effectiveness of e-learning environments has been a goal for educational reformers. Understanding student preferences are crucial to informing a student's disposition to engage with the e-learning environment. Noted characteristics associated with successful e-learning outcomes are self-management and a willingness to electronically engage and communicate with others. Factors effecting student satisfaction with the learning environment are presence, community, feedback, and the ability to control the learning pace (Moseley et al., 2008).

The current simulation literature is rich with descriptive studies and research detailing the efficacy of simulation as a pedagogical tool for healthcare education (Cook et al., 2008). The deficiency in the literature lies within the domain of how, when, and why simulation works as an educational tool (Cook et al, 2012).

The initial study of student perceptions of IPSims usability will allow the researcher to determine if the system is suitable to be incorporated into health science curriculum for further studies. Secondly, the investigation into student usability perceptions and learning outcomes will add the current literature relating to how

students perceptions of the learning environment impact learning outcomes and their disposition to engage in learning processes. Finally, through the utilization of association rule mining the researcher will begin to look at the associations between learning outcomes and student usage. From the data analysis of student usage and learning outcomes the researcher can make initial inferences into how the learning environment impacted student disposition to engage in learning processes while immersed in IPSims.

CHAPTER 3

3.0 RESEARCH METHODS

The researcher conducted a study of how students use an online simulated learning environment called IPSims, in order to determine if the researcher could analyze IPSims usability and functionality as well as associations between student usage and learning outcomes. The researcher proposes to look at how student use online simulated learning environments by tracking student movements and their use of educational resources available in the learning environment. To achieve these goals, the researcher needed to identify how students use a fairly typical online simulated learning environment. Specifically, the researcher wanted to investigate if perceived system usability impacts student learning outcomes and also how student navigational choices and time spent at each choice node or virtual place in the environment might affect student learning outcomes.

The basic logic was that:

1. If the simulative learning environment has a high perceived usability, then such a simulative environment could be further studied to analyze the choices that each student makes while engaging in a learning activity. If the learning environment did not have high usability then the researcher would have to revise the environment and retest usability prior to using the environment as a research platform.
2. If the students' perceptions of usability suggested the simulative environment had reasonable usability, then the researcher would proceed

to examine the complex relationships among learning outcomes and how each student engaged with the learning activities, learning resources, and educational scaffolding within the simulative environment.

The logic framework and the choice of the IPSims simulative environment led to a delineation of four objectives:

1. Enhance understanding of how simulated learning environments are currently being used in education, with a specific use case of web-based simulative environment- IPSims.
2. Ascertain health science students' perceptions of IPSims usability.
3. Ascertain if there are relationships between student navigational choices within IPSims and health science student learning outcomes.
4. Suggest methods for improving the evaluation of online simulated learning environments based on new knowledge from the investigation.

3.1 Research Questions

Stage One: Validation of IPSims usability.

Usability Research Stage 1: Measures of usability and analysis – how did students perceive the IPSims environment?

Stage Two: Learning Outcomes:

Research Questions pertaining to Learning outcomes

- a. Were there any correlations between learning outcomes and perceived usability measures?
- b. Were there any associations between learning outcomes and levels of usability?
- c. What are the correlations between learning outcomes and time spent in each learning resources visited by the students while immersed in the simulative learning environment IPSims?

3.2 Significance of this Study

The significance and primary outcome of the research has been a method of building systems for knowledge discovery that could be applied to analyzing the cognitive and behavioural paths represented by student usage of the IPSims environment. The researcher has chosen to focus on the study of processes for collecting, managing, and analyzing data for investigating how the learning environment impacts students' disposition to engage in the learning environment as represented by student usage

3.3 Research Design

The researcher argues here that both the usability validation and research questions pertaining to learning outcomes were most appropriately studied from a descriptive analytical framework. Descriptive studies can be used to identify patterns, correlations, and trends in the data (Neutons &Rubinson, 2010). The researcher has chosen a descriptive approach as the researcher is seeking to describe

and summarize our data as a means for evaluating the efficacy of the IPSims usability and investigate if student navigational choices impact student learning outcomes. As stated earlier the literature lacks a definitive method for evaluating the efficacy of online simulated learning (Tashiro et al, 2011). In such, a descriptive approach will investigate IPSims as a learning environment, and investigate how this particular environment impacts student learning outcomes. The researcher will be using correlation analyses with multiple regressions on the usability data as well as a correlation analysis on the navigational time place stamps with student learning outcomes. Cross-tabulations of select usability variables will be completed as well as cross-tabulation with time and place data stamps with learning outcomes.

Additionally, the researcher will be using an educational data mining technique; Apriori Association Rule Mining. Both the usability data and data collected reflecting student IPSims usage will be run through SPSS version 19 and Weka 3.6.

The role of the researcher in this project was to a) liaise with Health Science faculty after initial contact was made; b) develop learning assessment in conjunction with the faculty; c) introduce the learning environment to students; d) implement research questionnaire; e) data collection; f) data entry; g) data analysis; h) dissemination of research design at national and international conference and through authoring and co-authoring publications.

The various research methods utilized in this study were done so to provide insight into how to bridge the current knowledge gaps identified by Tashiro et al., (2010, and 2011) in what really work in education with the focus on digital media learning environments. All health science students involved in the study utilized the

simulated learning environment IPSims. Please refer to Section 1.7 in the Introduction for a full description of the IPSims learning environment.

This study was designed to assess student perception of IPSims system usability and track student navigational choices while immersed in the online learning environment IPSims.

The research design for this study included standard statistical analysis such as central tendencies and variability, quantitative correlation analysis and multiple regression analysis, and data mining applications.

3.4 Recruitment of Research Subjects:

Research ethics approval was obtained (please see REB # 09-027 in Appendices) and all student participants signed consent forms. As previously stated, the REB forms were written by Dr. Vargas Martin and Dr. Tashiro. As the research was using human subjects ethical standards were followed. Students were allowed to decide if they wanted to participate in the study without fear of harm or retribution in their course. Students were free to remove themselves and their data from the study at any time without fear of retribution or penalty in their course. All members of the research team were available via email to answer any questions the participants had regarding their participation in the study and how their data would be used.

To address the research objectives and questions we invited Health Science professors to participate in this study through the integration of IPSims into their classrooms. The initial invitation was sent out via email from a faculty advisor, while follow-up communications and implementation was handled through the researcher.

Although there were several positive initial responses to the invitation the researcher ended up with two participating classes. The first class/group comprised of third year health science students at the University Of Ontario Institute Of Technology, while the second consisted of two groups in a second year health science class. The first group was an online course where all course materials and communications occurred through the learning management system WebCT. The second group also utilized WebCT however, they also had face-to-face lectures. Never the less, only one student research subject volunteered from the first class, while 71 volunteered from the second class. Due to the lack of numbers the researcher dropped the first class from the research.

For the second group, the researcher was invited into the class lecture time in both time slots to introduce the study and invite students to participate. In this group the students were allotted the lecture time to access IPSims, complete the learning assessment and the research survey. Students were also given the opportunity to complete the survey and learning assessment over one week. Packages could be returned to the researcher at the beginning of the lecture the next week if they had been unable to complete in the time allotted for the course lecture.

All data has been kept confidential, and all student names and student numbers were removed from the data analyzed. The identification data was the ID number given to the students at the time of login to the IPSims system. This identification number was used for tracking student decisional sequelae and used as the identification number for the usability data and learning outcomes data.

All IPSims student usage data was extracted from the system by Arturo Fernandez, a graduate student working with the research team. This data was then compiled into a comma separated file then later transcribed to an Excel file for data analysis.

Of the potential 147 students registered in both sections of the undergraduate health science course (seventy-five in Section 1 and seventy-two in Section 2) approximately 100 research packages were taken by potential student participants between the two sections. Both sections were given the same introduction and opportunity to ask questions as well as opt out of participating without fear of repercussions. The researcher had 71 potentially usable research packages returned by the following week. The returned packages included signed informed consent, completed research surveys, and completed paper and pencil learning assessment. The final sample size was 58 due to incomplete data from some students.

The criteria for student participation in the study were followed as per research ethics guidelines and requirements.

What makes a student eligible to participate in the study?

1. Informed consent had to be signed
2. Research survey completed once and handed back to the researcher
3. Learning assessment completed and handed back to the researcher
4. Participant User ID for IPSims was included in research package returned to the researcher

5. IPSims and learning resources had to have been accessed in conjunction with learning assessment and research survey
6. No longer than 20 minutes spent in a single learning resource

3.5 Research Timelines

The initial recruitment process for participants began in November of 2010. Once there were participating classes the researcher worked with the course professors to build an appropriate learning assessment that incorporated the learning resources available within IPSims and met the learning objectives of the course in which IPSims was to be utilized. The participating class accessed IPSims in March of 2011. Completed research packages were collected on March 18 2011. Data analysis began in April 2011 and continued through to July 2012, with the final analysis and write up due by September 2012.

3.6 Data Collection

The participating research subjects received an introduction letter to the research study (please refer to research package in the Appendix). In addition to the introduction letter the participating research subjects had a verbal introduction from the researcher with an explanation as to why we were conducting the studying and how their participation could potentially impact the delivery of future course content.

UOIT has a laptop program making laptops available to all students. It is expected that laptops accompany students to classes to ensure students have access to course materials posted though the learning management system WebCT. UOIT is

wired to offer wireless internet access throughout campus to all students and faculty. This is how the students were able to access IPSims. The IPSims server is a standalone server that is housed on campus at UOIT. It can be accessed through a URL (http://199.212.33.78/LPSL_V2_040610/Main.html) that was provided to the students. Once at the login page the students had to answer some demographic questions, provide a valid email address, and record the user ID provided to them by IPSims. A few of the demographic questions on the login page are listed here:

1. Gender
2. Age
3. Undergraduate academic year
4. Number of hours a week spent surfing the web?
5. Number of hours a week spent playing video games?
6. How do you rate your computer literacy? (excellent –poor)
7. Interest in course material (very interested – not at all interested)
8. Experience with computer-based simulations (very experienced- not at all experienced)
9. Perceived educational value of computer-based simulations (very valuable- not at all valuable)

Figure 1 is an image of the IPSims login page students' will use to access the IPSims online simulated learning environment. Students can return to the system

through this login page using a confidential password and the user ID provided by the system. It is this ID number that is used to track and trace students' decisional sequelae and used to match learning outcomes with the decisional sequelae and usability attributes.

Figure 2: IPSims login page

Sign in to eLearning Platform Specification Language

User ID: Password:

For ones who already registered, please ONLY input the User ID and password. For others, please input BOTH blanks EXCEPT the User ID for registration.

Gender: Male Female

E-mail:

Course:

Faculty:

Term:

Age:

Undergraduate Academic year: 1 2 3 4 other

Undergraduate Major:

Number of hours/week surfing the web:

Number of hours/week playing video games:

How do you rate your computer literacy:

Likelihood of Choosing a Career in Health Sciences:

Interest in Course Material:

Experience with Computer-based Simulations:

Your Perceived Educational Value of Computer-based Simulations:

Expected Grade in the Course:

Current GPA:

As previously stated the demographic information from the login page and the student time-place stamps indicating navigational choices were collected and stored through the IPSims server. This information was later accessed and retrieved by Arturo Fernandez, a member of our research team for data analysis. Arturo Fernandez has extensive programming knowledge and was able to export the data onto a CSV (comma-separated values) file for data analysis. The CSV file was later converted to an Excel file for further data analysis. In addition to the demographic

data that the IPSims system collected, Arturo Fernandez extracted the student usage file for each individual user. The end result was a file containing individual student decisional sequelae and number of session each student recorded. Each time a student enters and exists the system is considered a session.

The usability data and additional demographic data, retrieved from the paper and pencil survey was transcribed into Microsoft excel to create our usability database. This file remained an excel spreadsheet for use in SPSS version 19 while it was converted to a CSV file and Arff file for use in Weka 3.6 for Apriori association rule mining.

3.7 Usability Research Survey

The usability research survey itself had been previously developed by Tashiro et al., (2010). The paper and pencil research survey had 166 questions and consisted of several sections: a) demographic information, b) rating of web-based course work, c) rating of IPSims Learning Environment, d) satisfaction with educational simulations and serious games, e) disposition to engage in effortful cognitive endeavour, f) expectancy-value questionnaire, and g) performance evaluation in interprofessional learning activities. There was discussion surrounding the length of the research survey with supervisors which resulted in the removal of selected questions throughout the survey as it was the intent of the writers to limit the time required to complete the survey to 30 minutes. Prior to the use of the research survey with study participants the student researcher assessed the duration for completion of

the survey. The initial duration testing was completed to provide an approximation for time allotment for research participants to complete the research survey.

3.8 Learning Assessment

The learning assessments were key aspects of the research design. As the literature indicates, incorporating key learning theories into the design of simulated the learning activities and learning assessments is vital to the success of student learning outcomes (Patel et al., 2009).

Learning assessments can be defined as quizzes, tests, exercises, or analyses that authentically assess student learning while completing a learning activity. The researcher worked with the participating class professor to explore possible appropriate learning theories such as constructivism and situated learning theory to be integrated into the learning activity and eventually the learning assessment.

The professor for the participating class opted for a multiple choice and short answer learning assessment. The intent for this assessment was also to encourage students to engage with their learning environment and make navigational choices that would lead to positive learning outcomes. This class used a simulation that could be applied to directly represent course content and course objectives. The student investigator and the course professor utilized IPSims Simulation number 4, Scenario 1. Simulation 4 refers to one of six potential case studies within the IPSims environment, while Scenario 1 refers to the particular scenario within that case study. Each case study contained three scenarios to work through. This simulation presented a fictional patient named Barb Johnson. Figure 2 is a screenshot of the user

interface for the simulation chosen by the student investigator and the course professor.

Figure 3: Screenshot of user interface for Simulation 4, Scenario 1



Barb Johnson is a middle-age woman who has been progressively gaining weight over the last two years. Her legs have been getting progressively more swollen and red. Her husband has growing concerns related to her health and her current issues with her legs. Barb also had mobility issues related to her current health status. A multidisciplinary team has been assembled to work with Barb and her husband to attain her healthcare goals.

3.9 Administration of the Research Survey and Learning Assessment

The specific date and time for student access to IPSims were setup to meet the needs of the course instructor.

Introduction to IPSims for the participating class was at the discretion of the course professor. The researcher was granted access to the students attending lecture in both sections on March 11 2011. At the time of administration each student was to sign into IPSims and receive a User ID number that was to be recorded on the student learning assessment and the research survey. When the research packages were returned, each package was numbered and colour-coded according to the lecture section that the students attended.

Once the paper and pencil survey information had been collected, all data was transcribed onto a working database. IPSims user IDs were the only identifiers used to connect student research surveys to learning outcomes and IPSims time-place stamps. As per REB requirements, all student identifiers were removed at the end of the study period to maintain student/participant confidentiality. Cases that met the aforementioned inclusion criteria were used in the data analysis.

3.10 Strengths Associated with Research Design

Although randomized control trials are generally thought to yield the most rigorous results, this mixed methods approach would allow the researcher to capture relevant and pertinent information using IPSims PathFinder. The PathFinder is an algorithm that evolved from the algorithms presented by Czyzowicz et al., (2004) and which monitors students' choices within an IPSims simulation scenario and records

the choice and the time spent at a particular choice point. The choice point and the time spent there are recorded in a database which provides the Decision Sequelae for each of a student's sessions. Many studies have already been conducted using pre-post-test formula when investigating the efficacy of simulated learning environments. However, the few studies actually investigate how the students are using simulated learning environments to improve learning outcomes (Tashiro, 2011). This is what the researcher was aiming to accomplish through the utilization of PathFinder, descriptive analysis, and educational data mining algorithms.

3.11 Limitations Associated with the Research Design

Limitations associated with the research design of this study include the following. Educational data mining has been on the rise since 1995, and small sample sizes within the educational sector have been used and considered acceptable. However, there is a concern that the smaller sample size has the potential to decrease the validity of the rules produced from association rule mining.

Nevertheless, students were given the time to participate in the study within the scheduled lecture time, the research survey along with the learning assessment did take longer than expected. As a result the researcher allowed the students to complete the package over a one week period and return it the following week, which limits the researcher's ability to control for shared communication regarding the learning assessment. Additionally, some of the students experienced difficulty with the login page and the internet connection. The sometimes poor internet connection periodically caused student progress to slow and impeded students ability to watch

simulated case encounters. The study was set up to have students access IPSims during lecture time on personal computers. As such, the researcher was unable to fully monitor and capture student engagement with learning activities while immersed in the simulated learning environment; however, limitations were noted in collected accurate time stamps as some students neglected to use the log out tab resulting in not closing out sessions or opened several tabs at the same time which resulted in longer time stamps with one tab while actually utilizing another. Therefore, it is difficult to verify if place-time stamp data correlates to actual time spent engaged with the learning resource. As a result, the researcher collapsed all student sessions into one time stamp for the resources utilized and discarded any data which included time stamps at one resource greater than 20 minutes.

3.12 Summary

As this is a descriptive study the researcher had to be aware that potential associations and correlations do not equate causal relationships. This study is designed to describe the data and seek out new methods for identifying IPSims usability and how the system usability impacts learning outcomes as well as associations between student usage and learning outcomes. Upon completion of this study, the new information gleaned should identify potential navigational choices associated with learning outcomes that represent cognitive pathways indicating student disposition to engage with the learning environment, and how student perceptions of the learning environments usability and functionality impact learning outcomes.

The subsequent chapters present the research findings of the usability data and time-place stamp data that was collected and analyzed. Discussions, future considerations and conclusions stemming from our analysis will also be presented in Chapter 5.

CHAPTER 4

4.0 DATA ANALYSIS MODELS AND TECHNIQUES

This chapter will focus on the data analysis processes, provide an introduction to the analytical software utilized, and discuss our data analysis.

The purpose of this research is to analyze the impact of usability of the IPSims simulated learning environment on learning outcomes and initiate an investigation into methods for studying how undergraduate health science students perceive IPSims usability and functionality, and how the learning environment usability impacts student learning outcomes. Additionally, the researcher looked into relationships between student usage (represented by time and place stamps) of the learning environment and learning outcomes. The usability data was captured in paper and pencil format in a survey the health science students completed after being immersed in IPSims simulated learning environment. The students learning assessment was a paper and pencil multiple choices and short answer quiz which was done alongside their engagement in IPSims. The completed paper and pencil learning activity and research survey needed to be transcribed into an accessible database for which we could export the data to various analytical software suites. The full paper and pencil research survey is available in the appendix (Usability table 3). Consequently, the usability data analysis and learning outcomes analysis commenced upon completion of the pre-processing phase which was discussed in Chapter 3 and will be discussed further in Section 4.2.

The participant user data collected yielded 71 potential cases. Of the initial 71 cases the researcher eliminated 13 cases based on the inclusion and exclusion criteria mentioned in the previous chapter. The 13 cases were eliminated from both the usability data and the collected time user time stamps data.

To satisfy the mandate of the research methods, the researcher combined the use of SPSS statistical software Version 19 and Waikato Environment for Knowledge Analysis (Weka) Version 3.6 to analyze the usability data and the learning outcomes data (for both usability and time stamps data). Microsoft Excel 2010 was used to transcribe the data and create our datasets during the pre-processing phase.

For the data analysis the researcher chose to begin with descriptive statistical analysis on the usability data. The researcher then proceeded to utilize a standard correlation analysis and a multiple regression model with cross-tabulation of selected attributes to address the research questions related to learning outcomes. The utilization of these descriptive methods would allow the researcher to make inferences regarding the relationships between key attributes; such as student navigational choices and learning outcomes as well as student perceived usability of the IPSims learning environment and learning outcomes (Polit, 2010). The correlation analysis would describe the connection between the key attributes; while a multiple regression model would be able to provide insight into how select attributes will influence on another.

In addition to inferential statistics the researcher also chose to use the Apriori association rule mining algorithm. This particular popular algorithm was chosen for

several reasons. The Apriori algorithm in Weka 3.6 is set up to be intuitive and require less data mining expertise than other models. Additionally, the Apriori algorithm is the most popular and frequently studied association rule mining algorithm. As the researcher is a novice data miner this feature was particularly useful.

Association rules can be used to seek out interesting relationships and patterns in the data that may not be expressed using traditional inferential statistics.

Association rules are expressed as $X \Rightarrow Y$, where a set of items are expressed as X and Y. Meaning when you have X (known as the antecedent), then you should also have Y (known as the consequence). The probability of the items sets containing both X and Y is known as the rule confidence. Association rules are produced using two main parameters. The first is the rule support. Rule support is simply the number of transactions within the database that contain item set $X \Rightarrow Y$. The second parameter is rule confidence. Rule confidence is described as the number of transactions containing Y and X in relation to the overall transactions containing X (Hipp, J., Guntzer, U., Gholamreza, N., 2000) Association rules are produced when the algorithms used for discovering item sets scan the data by making multiple passes through the data to determine large item sets (those which meet the minsup). Each pass through the data produces candidate item sets which meet the minimum support while others are pruned out. This process is repeated until no new large item sets are located. For further explanation on Apriori association rule mining please refer to *Fast Algorithms for Mining Association Rules* (Agrawal & Srikant, 1994).

4.1 Validation of IPSims Usability:

Research Question 1: How usable is the IPSims learning environment?

The concept of usability was based on the individual interpretation of how user-friendly the individual felt the various learning resources were to use, and how well one believed they could navigate through the system. The intention was to allow the participants to express their perception of how user-friendly the system was through a series of question directly pertaining to the learning resources and the general usability of the simulative learning environment based on a 1-6 Likert scale.

To assess student perceptions of IPSims usability and functionality the researcher ran the data through SPSS version 19, distribution analysis to obtain the mean for select usability variables (please refer to Table 3 below). All usability and functionality data was collect by paper and pencil which meant the data needed to transcribe data onto an Excel spreadsheet to create an electronic data set prior to being able to run the data through SPSS version 19. IPSims user identification was used to link the usability paper and pencil data with the IPSims time stamps and navigational pathways.

The usability and functionality data was scored by students using a Likert scale 1-6 scoring. The scale started at 1 with a rating of not at all user friendly and ranged from there up to 6 which is very user friendly. The output data indicated the mean values for the usability data on the attribute general usability of IPSims was 3.79 on a scale ranging from 1-6. From this score we can infer that the student participants felt the IPSims learning environment overall usability was

acceptable. The mean value of 3.79 was considered acceptable as this rating was above the mid value of three in the Likert scale; I considered that an overall higher rating could have introduced possible user bias. The additional variables related directly to IPSims usability and the relevance of IPSims learning resources scored mean values that ranged from 3.28- 4.86. The mean values for the selected usability variables were all above the mid-range mark. Therefore, the researcher can interpret that the students perceived IPSims to be a user friendly learning environment with relevant learning resources.

Below in Table 3 is distribution analysis for the IPSims usability variables. SOP refers to scopes of practice, IPC stand for interprofessional competencies, IPP is interprofessional perspectives. The variables reflect the student perception of both the usability in terms of how user-friendly the resource was as well as the relevance of each learning resource within IPSims.

Table 3: Distribution Analysis on Select Usability Variables and Learning Outcomes

Attribute	Number of values recorded	Minimum	Maximum	Mean	Std. Deviation
General Usability	56	1	6	3.79	1.498
Simulation Selection	56	1	6	4.13	1.453
User-friendly Library	41	1	6	3.41	1.466
User-friendly SOP	54	1	6	3.48	1.539
User-friendly IPC	44	1	6	3.93	1.485
User-friendly IPP	45	2	6	4.2	1.455

User-friendly Case Records	57	2	6	4.86	1.043
User-friendly Case-Encounter	58	1	6	4.81	1.27
Satisfaction with IPSims	56	1	6	3.68	1.363
Time in IPSims	48	1	2	1.15	.357
Relevance of learning activity	57	1	6	4.02	1.275
Satisfaction with learning activity	57	1	6	3.82	1.390
Satisfaction with realism of IPSims	58	1	6	4.14	1.330
Relevance of SOP	55	1	6	3.64	1.458
Relevance of Library	43	1	6	3.28	1.533
Relevance of IPC	45	1	6	3.84	1.381
Relevance of IPP	49	1	6	4.0	1.41
Relevance of Case Records	55	2	6	4.69	1.086
Relevance of Case encounter	56	1	6	4.75	1.210
IPSims improved Learning	57	1	6	3.40	1.348

A point of interest from this was the lowest usability mean value of 3.28 and 3.41 were connected with the IPSims library learning resource. The mean of 3.41 was the mean value for the usability variable user-friendly library while 3.82 was the mean value for the usability variable Relevance of library. According to the student time stamp and navigational data, this learning resource was accessed the least with

the least amount of student total time being spent utilizing this learning resource, with some students not accessing this resource at all.

It was important for us to acknowledge student perception of IPSims learning environment usability. If the overall perception of IPSims usability was poor, the researcher would have to address how this could impact the remainder of the data, and address the usability of the system prior to moving forward with the learning outcomes data analysis and restart the study. I was satisfied that the IPSims learning environment was perceived by the student participants to be user-friendly and therefore the researcher could continue with the learning outcomes data analysis. As previously mentioned, I felt that the mean values of IPSims usability at above 3 indicated participants generally perceived the system as usable without introducing a bias.

4.2 Learning Outcomes:

Research Questions:

- A) Were there any correlations between learning outcomes and perceived usability measures?

In the initial investigation, the researcher ran the data through a correlation analysis to determine if there were any obvious statistical correlations between student learning outcomes and student IPSims usability perceptions. The correlation analysis revealed that the grade attribute did not have a strong positive or negative correlation to any of the usability and relevance attributes. The highest Pearson correlation score was .228 pertaining relating to user-friendliness of the library. What the researcher did find was that the usability variables and attributes related to

relevance of learning activities had strong correlations to each other, but not to learning outcomes as represented by the grade attribute.

The researcher then ran the usability data through SPSS using cross-tabulation. The cross-tabulation analysis utilized the same usability variables as above with learning outcomes/grades represented as 1, 2, and 3; low (6-9), mid-range (10-11) and high respectively (12-14). The cross-tabulation analysis was conducted to note any direct relationships between the selected usability factors and the grade variable to determine if student perceptions of IPSims usability and functionality had an impact on their learning outcomes.

The cross-tabulation table indicated that the largest student cluster ranking for general usability was a mid-range score of 4. As previously mentioned the researcher had taken the grade value and categorically clustered the students in to three groups based on learning outcomes. Group 1 scores range from 6-9, Group 2 score range from 10-11, and Group 3 had test scores ranging from 12-14. When comparing perceived usability with grade in General Usability the researcher noted that of the 18 students who had the highest tests scores 11 of them scored IPSims general usability in above the mid-range marking. At the other end of the spectrum with students who were not successful in passing the learning assessment; 15 of the 22 students from Group 1 ranked general usability at a score of 4 or higher. Rationale for having such a mix with learning outcomes and usability ratings can be two-fold; the first being that students generally found the IPSims system to be user-friendly across the board regardless of learning outcomes. The second possibility is unreliable user reporting. Meaning students just arbitrarily selected a value on the Likert scale. This could

attribute for the large number of general usability rating scores of 4 with students that had poor learning outcomes. Consequently, although we can infer from the data we have that the student perceptions of IPSims usability and functionality did not impact student learning outcomes, the relationship between student perceptions of system usability and learning outcomes is inconclusive. As it is unknown to us why a large number of students with low grade scored the general usability of IPSims at a rating of 4 or greater further research would be required to investigate to confirm both the usability of IPSims and the relationship between student usability perceptions and learning outcomes.

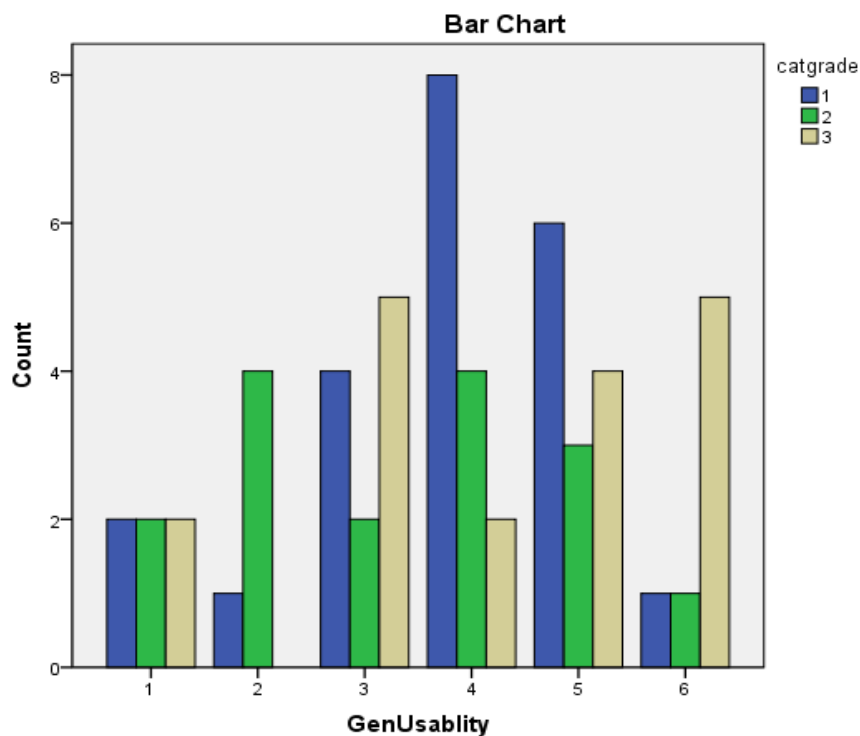
Table 4: Cross-Tabulation of grades variable defined as 1 (low), 2 (mid-range), and 3 (high) with the General Usability Variable

		1 (grade value 6-9)	2 (grade value 10 & 11)	3 (grade value 12, 13, & 14)	Total
General usability variable score = 1	Count % with grade value % of Total	2 9.1% 3.6%	2 12.5% 3.6%	2 11.1% 3.6%	6 10.7% 10.7%
General usability variable score =2	Count % with grade value % of Total	1 4.5% 1.8%	4 25.0% 7.1%	0 0% 0%	5 8.9% 8.9%
General usability variable score =3	Count % with grade value % of Total	4 18.2% 7.1%	2 12.5% 3.6%	5 27.8% 8.9%	11 19.6% 19.6%
General usability variable score =4	Count % with grade value % of Total	8 36.4% 14.3%	4 25.0% 7.1%	2 11.1% 3.6%	14 25% 25%
General usability variable score =5	Count % with grade value % of Total	6 27.3% 10.7%	3 18.8% 5.4%	4 22.2% 7.1%	13 23.2% 12.5%
General usability variable score =6	Count % with grade value % of Total	1 4.5% 1.8%	1 6.3% 1.8%	5 27.8% 8.9%	7 12.5% 12.5%
Total	Count % with grade value % of Total	22 100% 39.3%	16 100% 28.6%	18 100% 32.1%	56 100% 100%

This data has also been represented in a bar graph (Chart 1.0, Cross-tabulation of IPSims General Usability with grades) to provide a visual demonstration of the occurrence of general usability scores with the categorical grade values. This chart demonstrates the majority of the users with higher learning outcomes score (represented as 1 = 6-9, 2 = 10, 11, 3= 12, 13, 14) scaled the general usability of the IPSims online learning environment at a 4 or higher. This could be attributed to the possibility that the students who performed better on the learning assessment also

engaged more fully with the research tool. It is also important to note that a large number of students with low learning outcomes scores rating the general usability of IPSims at 4. The rationale for this phenomenon is unknown to the researcher and would need to have further clarification with additional research that investigated individual variables related to student perception of system usability.

Chart 1.0: Crosstabulation of IPSims General Usability with Grades



The final piece of analysis within this stage was to run the usability data with the learning outcomes data through a multiple regression model to inquire about how the usability attributes may impact the predictability of the learning outcomes, and if indeed there was a relationship between student IPSims usability perceptions and learning outcomes. The multiple regression analysis indicated that as a group the set

of independent usability variable did not statistically impact the dependant variable grade as a representative of learning outcomes.

Using a correlation analysis, cross-tabulation analysis, and multiple regression analysis the data analysis indicated that student participant perceptions of the IPSims learning environment's usability did not directly impact their learning outcomes. This could be explained through understanding that even students with poor learning outcomes still perceived IPSims as a user-friendly system.

B) Were there any associations between learning outcomes and levels of usability?

This was the final stage in the usability analysis. The researcher wanted to introduce the usability and learning outcomes data to a data mining algorithm. The researcher was interested in exploring the data for hidden relationship or patterns within the student usability and learning outcomes data. Association rule mining was deemed the most practical and applicable approach using the Apriori algorithm within Weka 3.6.

According to Romero et al., (2007) Educational Data Mining is a multidisciplinary approach for exploring unique data arising within an educational domain. Multiple reports have been written and discuss the use of data mining applications for exploring data collected by digital media environments, and learning management systems (Romero, et al, 2007, 2010; Vranic et al, 2007; and Castro et al, 2007). The Association rules mining algorithm selected to use in exploring the usability data was Apriori Association rule mining algorithm. In an article written by

Garcia and colleagues (Garcia et al., 2007) Apriori Association rule mining algorithm is discussed as an appropriate technique for Knowledge Discovery in Databases (KDD) corresponding to data collected from learning management systems. While IPSims is an independent standalone simulated learning environment is possesses similar qualities as LMS that allows it to collect the same type of data as learning management systems with similar data collection capabilities. The researcher's interest in utilizing association rule mining techniques was twofold 1) to explore the possibility that there may be previously unknown relationships within the usability data, and 2) confirm the results from research question 1 on the usability data and learning outcomes analysis.

The researcher wanted to know if there would be similar assumptions (as noted above) with the production of “if this X (antecedent) then Y (consequent)” rules. The production of these rules would allow the researcher to extract unknown “interestingness” or existing patterns (Garcia et al, 2007) from the data such as associations with usability scores across the variables.

To run the data through Weka's association mining algorithms the researcher needed to pre-process the data according to following steps:

1. Convert the CVS file to an Arff file.
2. Import Arff file into Weka 3.6 Explorer.
3. Select appropriate variables and remove select variables from the data set.
4. Select the number of desired rules to be produced.

5. Run the algorithm.
6. Interpret data output.

Although association rule mining is traditionally an excellent tool for extracting interesting or previously unknown knowledge from large datasets, the research has applied it to the smaller sample size as a preliminary introduction to incorporating educational data mining algorithms with IPSims datasets. While the researcher recognized that the sample size is small it has been accepted in Educational Data Mining (EDM) literature that educational data sample sizes generally run between 10-100 cases (Garcia et al, 2007). The researcher does not contest that a smaller sample sizes may not offer an absolute certainty, and produce uninteresting rules; however, as per the recommendations of Hamalaien and Vinni, (2006) to improve the likelihood of extracting new knowledge the researcher combined an Apriori Association Rule Mining in Weka 3.6 with the aforementioned descriptive analysis to help the researcher analyze meaning in the rules produced. The data was run through the Apriori algorithm in Weka 3.6 five times to produce 10, 25, 50, 75, and 100 rules. The outputs from these algorithms were compared for similarity of rules produced and accuracy of rules produced (based on confidence levels). Additionally, subjective parameters were applied when evaluating the interestingness of the rules produced as was the use of domain knowledge. In 1999 Liu and colleagues wrote an article articulating subjective parameters that can be applied to rules produced from association rule mining to help discover patterns and various levels of interestingness of the rules produced. All rules are subjected to objective measures such as statistical significance, and predictive performance which

is noted as confidence levels and strength in association rule mining (Liu, Society, Hsu, Mun, & Lee, 1999). The subjective parameters applied to association rules are twofold; 1) Unexpectedness and 2) Actionability. Patterns are considered unexpected if they “surprise” the user, and are considered actionable if the user can be prompted to use the information in some way to achieve goals or objectives (Liu et al., 1999). Rules produced that are expected are known as expected or conforming rules as they confirm previous domain knowledge (Liu et al., 2000). The rules produced within the small dataset were all expected and referred to as conforming rules.

When comparing the rules produced by the Apriori algorithm with the data analysis from research question A regarding correlations between IPSims system usability and student learning outcomes, it was not a surprise that the grade value was not a factor as either the antecedent or the consequent in our if X then Y rules in any of the runs to produce 25.50, 75, or 100 rules. Grades came up when the researcher ran the data for top 10 rules and was associated with time rather than usability. Consequently, there was no notable relationship between student perception of IPSims usability and functionality and student learning outcomes. However, three themes did emerge from the discovered rules. The Interestingness Analysis System (IAS) categorized rules as conforming rules, unexpected or actionable rules. Conforming rules are described as rules that contain both an antecedent and a consequence which match previous domain knowledge, while actionable rules would have researchers and educators critically assess how this discovered rule impacts our current knowledge and provide new information to use to an advantage to obtain goals and objectives (Liu et al., 2000; and Garcia et al., 2007). Using the IAS all 3 of

the themes fell within the conforming rules category as the rules produced would be considered expected to someone with domain knowledge.

The first cluster of discovered rules indicated relationships between high levels of perceived usability (user friendly) high level of satisfaction with the simulated learning environment IPSims. Below in Table 3: Usability Association Rules is an example of select rules produced.

Table 5: Usability Association Rules, theme 1: Usability, satisfaction and relevance of learning resources.

Antecedent (X)	Usability score	# of time occurred	Antecedent (X)	Usability score	# of time occurred	Consequence (Y)	Usability score	# of times occurred	Confidence
User-friendly library	5	7	User-friendly SOP	5	7	Satisfaction with IPSims	5	7	1
Satisfaction with IPSims	5	7	Relevance of IPC	5	7	Relevance of IPP	5	7	1
Satisfaction with IPSims	5	7	Relevance of IPC	5	7	Relevance of Case Records	5	7	1
User-friendly SOP	5	7	Relevance of Case Records	5	7	Satisfaction with IPSims	5	7	1
User-friendly library	5	7	User-friendly case Record	5	7	Satisfaction with IPSims	5	7	1

This theme of rules is considered a conforming rule or expected rules as situated and constructivist educational learning theories and research demonstrates (Patel et al, 2007) it would be expected to have high scores of satisfaction with a learning environment if students perceived the learning resources within that learning environment to be user friendly (Jeffries, 2012). Within this theme the researcher noted that the antecedent and the consequence are interchangeable stating similar associations that if there is noted satisfaction with the IPSims learning environment there will also be noted students perceived the system to be user-friendly.

The second theme that emerged from the discovered rules indicated that there was an association between high levels of usability and relevance of learning resources with high levels of satisfaction with the realism of IPSims learning environment. This rule is also considered conforming as one would expect to see associations between high levels of simulated environment fidelity and relevance of learning resources. The rule does coincide with simulation fidelity research (Kim et al, 2004). Simulation fidelity research focuses on the impact of the level of realism within the simulated learning environment and its impact on learning (Beaubien and Baker, 2004).

Table 6: Usability Association Rules, theme 2: Satisfaction with fidelity, relevance of learning resources and usability.

Antecedent (X)	Usability score	# of time occurred	Antecedent (X)	Usability score	# of time occurred	Consequence (Y)	Usability score	# of times occurred	Confidence
User-friendly Case-records	6	7	Satisfaction with realism of IPSims	5	7	User-friendly Case encounter	6	7	1
Satisfaction with realism of IPSims	5	7	Relevance of Case encounter	5	7	Relevance of Case records	5	7	1

According to the IAS the final theme that emerged from the discovered association rules would also be expected and therefore considered conforming. This theme suggests that students' who had high levels of satisfaction with the IPSims learning environment usability, and high levels of satisfaction with the relevance of the IPSims learning resources also reported that they believed IPSims improved their learning. Additionally these students were also highly satisfied with the learning activity they were ask to complete. The rules produced within this theme look at association in student beliefs and perceptions of how the learning environment impacted their learning experience but did not associate grade values with high or low levels of satisfaction. This is consistent with the original statistical data analysis that the relationship between actual learning outcomes and IPSims usability remains inconclusive. Although this theme presents an interesting twist by looking at student perceptions of learning outcomes rather than actual learning outcomes, it is still

unclear of exactly how the learning environment usability will impact actual learning outcomes. It is because Association Rule mining can uncover patterns within the data that would otherwise go undiscovered that the researcher chose to add Apriori association rule mining algorithm to the data analysis. Although the statistical data analysis was inconclusive, this information is considered expected and therefore a conforming rule as student satisfaction with the learning environment has been linked as a predictor of learning outcomes (Dalal, Brancati, & Sisson, 2012). Domain knowledge would have one expect to note associations between student satisfaction with the learning environment and it learning resources and the learning activity they were asked to complete, as well as relationships associations with perceptions that the learning environment improved student learning with relevance of the learning resources available within the learning environment. Below in Table 7 provides an example of some of association rules produced related to the 3rd theme.

Table 7: Usability Association Rules, theme 3: Satisfaction with learning activity, relevance of learning resources and perceptions of IPSims improved learning.

Antecedent (X)	Usability score	# of time occurred	Antecedent (X)	Usability score	# of time occurred	Consequence (Y)	Usability score	# of times occurred	Confidence
Satisfaction with learning activity	5	7	Relevance of Case encounter	5	7	Relevance of case records	5	7	1
Satisfaction with learning activity	5	7	Relevance of IPC	5	7	Relevance of IPP	5	7	1
Relevance of IPC	5	7	IPSims improved learning	5	7	Relevance of SOP	5	7	1
Relevance of Case Records		5	7 IPSims improved learning	5	7	Relevance of SOP	5	7	1

Relationships between learning outcomes and time spent in learning resources:

C) What are the relationships between student learning outcomes and the time spent in each learning resource visited by the students while immersed in the IPSims learning environment?

The approach to the user time stamp data analysis was a multilayer approach. Using the analytical software suite SPSS version 19 the researcher ran the time stamp

data through a descriptive statistical analysis and a correlation analysis to investigate if there were relationships within the data that indicated learning outcomes were dependant on time spent within the IPSims learning environment. The variables used were; Case Records, Case Encounter, Interprofessional Perspectives, and Scopes of Practices, and Grades. For the following analysis time stamps have been converted from the original transcribed seconds into minutes. Additionally the navigational pathways were also condensed to fit under the main tab of each learning resource such as scopes of practice, interprofessional perspectives, interprofessional competencies, case records and case encounter. Each of the main learning resources has 3 additional tabs students can access that demonstrate unique navigational choices. As there was great variation in the navigational choices and time stamps it was decided to condensed the resources into one node per case with total times. Additionally, the researcher collapsed multiple user session into one session. This was done to reduce the noise in the data.

Table 8: Descriptive Statistics for time-place data

Descriptive Statistics			
	Mean	Std. Deviation	Number of cases
Case Records rounded minutes	4.9914	4.63065	58
Case encounter rounded minutes	2.3534	3.62981	58
Interprofessional perspectives rounded minutes	3.3793	5.09757	58
Scopes of practice rounded minutes	3.1121	4.45547	58
Grade	10.3621	1.98855	58

The descriptive statistics indicate the majority of the students fell into the mid-range category for learning outcomes. The student average total time spent within IPSims learning environment was under 15 minutes, although self-reports of usage with usability variables was approximately 1 hour. The descriptive statistics was run to give the researchers an overview of student IPSims usage.

While the descriptive statistic provided the researcher with an overview of the time – place data what the researcher really wanted to investigate the possible relationships between time students spent engaged with the learning resources and student learning outcomes. For this the researcher ran correlations analysis in SPSS with the time-place data. The results from the correlations analysis is available in Table 7 below.

Table 9: Correlation Analysis on time-place data

Correlations

		CRrounded min	Ceroundedmins	IPProundedmins	SOProundedmins	grade
Case Records rounded minutes	Pearson Correlation	1	.027	.201	-.081	-.104
	Sig. (1-tailed)		.419	.065	.272	.218
	N	58	58	58	58	58
Case Encounter rounded minutes	Pearson Correlation	.027	1	.342*	.172	.145
	Sig. (1-tailed)	.419		.004	.098	.139
	N	58	58	58	58	58
Interprofessional perspectives rounded minutes	Pearson Correlation	.201	.342*	1	.076	.002
	Sig. (1-tailed)	.065	.004		.286	.495
	N	58	58	58	58	58
Scopes of practice rounded minutes	Pearson Correlation	-.081	.172	.076	1	.240
	Sig. (1-tailed)	.272	.098	.286		.035
	N	58	58	58	58	58
Grade	Pearson Correlation	-.104	.145	.002	.240	1
	Sig. (1-tailed)	.218	.139	.495	.035	
	N	58	58	58	58	58

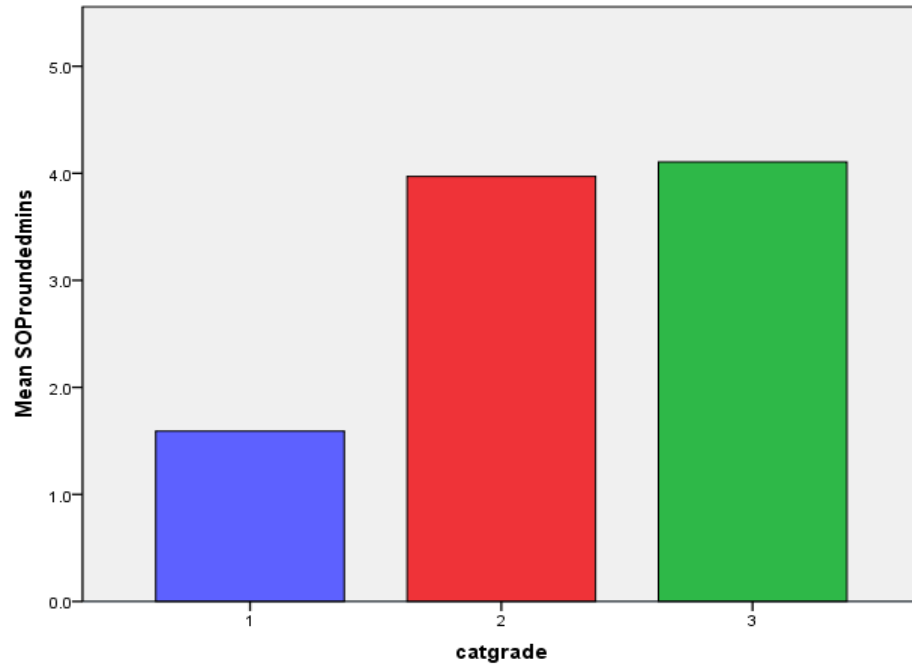
** . Correlation is significant at the 0.01 level (1-tailed).

* . Correlation is significant at the 0.05 level (1-tailed).

The results of the correlation analysis were interesting. The analysis indicated that the only statistically correlated navigational time stamp with the dependent variable of grades was the scopes of practice resource with a significance of .035. As navigational choices have been identified as key traces of understanding cognitive processes, it would have been expected to see either a positive or a negative

correlation with all navigational nodes and the dependant variable of grade (Tashiro et al, 2011). The interestingness of this particular correlation is twofold. The first being that one question from the learning outcomes data is directly related to health professionals' scopes of practice. This particular question can yield a potential of 3 marks out of the total 18. In addition to understanding the health care professionals' scopes of practice another 3 marks have been allocated for simply identifying the various multidisciplinary team members. These two questions are closely related. If a participant is unable to identify who the multidisciplinary team members are, they are not likely to understand their scopes of practice. However, if a student participant can understand the various scopes of practice for the individuals within the healthcare team it is likely they will be able to identify the various multidisciplinary team members. The second point of interest is that the concept of scopes of practice was reported by the course professor to be one of the more difficult concepts for student comprehension related to course content. The researcher can infer from the data that students who spent more time utilizing the scopes of practice resource had greater learning outcomes as reflected by the grade value. As demonstrated in the graph below in Chart 2.0, cross-tabulation with categorical grades and the means for the time stamps for scopes of practice.

Chart 2.0: Cross-tabulation of scopes of practice and grades



The separation of grades into the three categories is the same as described above; 1 reflects grades 6-9, 2 reflects grades 10-11, while the third category, 3 reflects the highest grades of 12-14. The simple bar graph is using the mean values for scopes of practice time stamps in rounded minutes for each grade category. From this graph it is easy to visualize the students with the highest learning outcomes scores represented in green category 3 (grade value of 12, 13, or 14) remained engaged with this critical learning resource within IPSims the longest.

As demonstrated in Table 7 above there was limited statistical significance of correlations between our dependent variable and the independent variables. As the researcher was using descriptive statistics to investigate relationships within the time-place data the researcher had no set hypothesis. However, it was concerning that

there were limited noted relationships between time-place navigational choices and learning outcomes. As a result the researcher felt this oddity needed further investigation.

Using Weka 3.6, the researcher ran the data through a several data clustering algorithms (Simple K-Means, and EM). To do so the researcher completed the pre-processing of the data and set the parameters for the grade bins. Starting with a grade value of low, medium, and high (three clusters) the researcher noted the grades were mostly distributed across two clusters medium and low. The researcher then reconfigured the algorithm to cluster the grades into two groups. From here the researcher could visualize that the grade data was evenly distributed across the various usage of the learning resources thus indicating that there was an even spread of grades throughout the varying levels of resource usage. This even distribution of grades across the learning resource usage would explain why the researcher saw limited statistical significance in the correlation analysis when investigating the correlation between our dependant variable grade and independent variables of Case Records, Case Encounter, Interprofessional Perspectives, and Scopes of Practice. Thus indicating the researcher cannot conclusively state the relationships between usage of learning resources and learning outcomes.

In addition to running a cluster analysis the researcher also ran the data through Apriori Association Rule Mining in Weka 3.6. The researcher ran three rounds, each time increasing the number of rules (table 3 in appendix) ascending from 10, 20, and 50. Using the same attributes and values through each iteration, the three rounds produced the same two rules;

- 1) grade='(10.8-11.6]' 7 ==> Ceroundedmins='(1.7-3.4]' 7 [conf:\(1\)](#)
- 2) grade='(9.2-10]' 10 ==> IPProundedmins='(-inf-2.8]' 9 [conf:\(0.9\)](#)

Both of these rules have demonstrated interesting relationships within the small dataset. Although these rules are not considered actionable or unexpected (according to the IAS) they are still interesting as they demonstrate a relationship not previously indicated by traditional statistical analysis methods. Association Rules are read as if then statements (Tan et al, 2006). In rule 1 we can see 100% (as indicated by the confidence level of 1) of the time that the grade of 10.8-11.6 was observed, the same case also observed the time stamp for Case Encounter as 1.7 minutes – 3.4 minutes. Additionally the researcher observed in rule number 2 that 90% of the cases (as indicated by the 0.9 confidence level) observed with a grade of 9.2-10, students engaged in IP Perspectives for a maximum of 2.8 minutes.

The mean grade within the dataset was 10.36 out of a possible 18 marks, while the mean time stamp for Case Encounter was 2.35 minutes. Consequently, the researcher could infer that there is an association between time spent within the individual learning resources and learning outcomes as the mean grade of 10.36 was associated in 100% of the cases with the Case Encounter time stamp of 1.7 minutes – 3.4 minutes. Additionally, the researcher can note in Rule 2 that a lower than average grade is observed in 90% of the cases with a minimal time stamp in key learning resource of Interprofessional Perspectives. This rule is of particular interest as the Interprofessional Perspectives tab highlights not only the various healthcare perspectives but also lends itself to demonstrate various roles and responsibilities of

the healthcare professionals. Questions 3 and 4 in the learning assessment were directly related to understanding the various roles, responsibilities, and scopes of practice for the healthcare professionals involved in the patient care. Cumulatively the two questions accounted for 6 of the 18 possible marks. A lower than average time spent within this particular learning resource could account for a lower than average learning outcome; therefore, reinforcing that there is a relationship between time spent utilizing key resources within the digital media learning environment and learning outcomes.

4.3 Summary

From the descriptive analysis with the usability data the researcher was able to infer that the student perceptions of the IPSims learning environment was that it was user-friendly with relevant learning resource. Additionally, the researcher was able to look into the relationships and associations between the learning outcomes data and the usability data as well as the time stamps navigational data. From the data analysis the researcher was able to infer that the IPSims learning environment usability did not directly impact student learning outcomes. The rules produced using the usability data and learning outcomes data produced three themes. Using the Interestingness Analysis System (IAS) the researcher was able to classify all three categories as expected or conforming rules. If one would look to the literature related to learning outcomes and learner satisfaction with learning environments, and usability of learning environment and learner satisfaction with the learning environment (Khodabandeh & Afshari, 2010) all rules produced from the association rules mining would be expected.

The correlation analysis with the learning outcomes data and time stamps data provided some interesting insight into student IPSims system usage and learning outcomes. The correlation analysis using time and place stamps data and learning outcomes data indicated a positive correlation between time spent in the scopes of practice learning resource and learning outcomes. While this was the only learning resource that was considered having a significant statistical correlation the association rule mining was able to confirm additional association the researcher did not see with traditional statistical analysis. The associations noted indicated lower levels of learning outcomes (below average grade) with minimal time spent in key areas of learning resources such as Interprofessional perspectives. Consequently, the researcher also noted average time spent in key learning resources such as case encounter were associated with average learning outcomes. Therefore, indicating that there is a possible relationship between time and place stamps with learning outcomes.

CHAPTER 5

5.0 DISCUSSION:

With the use of simulation technology and simulated learning environments on the rise in healthcare education it is crucial to identify how students are using these environments and how their satisfaction with the learning environment may impact student disposition to engage in learning processes. As well it is critical to understand how these attributes may contribute to student learning outcomes. In Chapter 1 the critical knowledge gaps articulated by Tashiro et al., (2011) pertaining to the use of simulative learning environments commenced with the knowledge gap “how does an educational environment impact disposition to engage in learning processes?” This knowledge gap was the motivation for this research.

The purpose of this study was to examine how the learning environment impacts the student’s disposition to engage in learning processes. Additionally, the researcher was interested in examining if and how student perceptions of IPSims usability and functionality would impact learning outcomes. While none of the statistical analysis methods demonstrated a clear relationship between student usability and functionality perceptions, and learning outcomes the researcher did note in the descriptive data analysis that the mean values for key attributes related to successful learning outcomes (Dalal et al., 2012) such as relevance of learning activity, satisfaction with the realism of the learning environment, and belief that the learning environment improved student learning, were all above the mid value of 3. The attribute mean values were 4.02, with a SD of 1.2, 4.14 with a SD of 1.3, 3.4 with a SD of 1.3 respectively. Although student learning outcomes were varied, their

disposition to engage in learning processes was not hindered by learner satisfaction with the learning environment and relevance of learning activity. The variance in time –place data stamps could be attributed to an inappropriate design of learning assessments and learning activities. However, I had to work with what IPSims offered the way it was designed as designing learning assessments and activities was out of the scope of my thesis. According to Dalal et al., (2012) learner satisfaction can be a marker of learner gains in knowledge as well as teacher teaching effectiveness. This is relevant to the research as it demonstrates that the students’ perceptions of IPSims usability, functionality and relevance did not impede their disposition to engage in learning. From the cross-tabulation analysis the researcher noted 60.9% of the student participants rated IPSims usability at 4 or above. 19.6% of those students achieved the highest categorical grade value of 3. Although the analysis is inconclusive as to what the relationship is between student perceptions of usability and learning outcomes the researcher can infer that student perceptions of IPSims usability did not impact learning outcomes. The lowest general usability score of 1 was equally distributed across all categorical grade values at 2 students per grade value rating general usability at 1 for a total 10% of the students’ rating the IPSims general usability at 1, while 12.5% of the students rated IPSims general usability at 6. The researcher also noted that 27.8% of the students rating IPSims general usability at 6 scored within the highest categorical grade value of 3. Again although this is not definitive of a correlation between the two attributes of grade and general usability it does bare identification as it may provide insight into how system usability may

impact student learning and student disposition to engage in learning processes while immersed in simulative learning environments.

The Apriori association rule mining algorithm produced three themes of associations between student participant evaluations of the IPSims learning environment and learning outcomes. Although none of the rules produced were unexpected, these rules were able to confirm previous domain knowledge and provide insight into student perceptions of the usability of the IPSims learning environment. For example, the researcher noted associations between high levels of IPSims usability associated with high levels of satisfaction with the environment. According to Dalal (2012) who conducted a meta- analysis of current studies looking at student achievement and learner satisfaction, there was a demonstrated link between learner satisfaction with the learning environment and learning outcomes. This presents an interesting perspective when assessing how the learning environment will impact the student's disposition to engage in learning processes. From the first theme presented through the association rule mining the researcher can infer that the IPSims system when considered highly usable and functional it will encourage students to engage with the environment for learning purposes. Consequently, when one looks at the third theme produced through association rule mining we note a strong association between high levels of satisfaction with the learning environment and student perceptions that the learning environment improved learning outcomes. In addition to believing IPSims improved learning the researcher also noted these students reported believing the resources available to them within the learning environment were very relevant to the learning experience. According to Jeffries (2012) it is

expected to see high levels of user satisfaction with the learning environment if they perceive it the learning environment to be relative to their learning and user friendly. In addition to Jefferies (2012), Khondabandeh et al., (2010) found student satisfaction with the learning environment to be an indication of student decisions to drop out of e-learning environments (Khodabandeh & Afshari, 2010). Students who were unsatisfied with the learning environment were more likely to be unsuccessful than those who were satisfied.

When discussing the navigational choices of students within the learning environment the researcher is referring to the locations or learning resources accessed by the students within the learning environment. Each individual resource or link accesses by the students while immersed in the simulative learning environment are considered a navigational choice as a part of the student decisional sequelae. The navigational choices students use to explore the online simulated learning environment which are tracked and recorded using PathFinder software (Tashiro et al, 2010) are the second piece in our investigation into how undergraduate health science students use simulative learning environments and how the usage of the environment will impact learning outcomes. Through the examination of learning outcomes and student navigational choices the researcher noted that both the statistical data analysis and the Association rule mining indicated there was a correlation between student navigational choices and time spent engaged with key learning resources with student learning outcomes. The correlation analysis indicated a positive relationship between time place data stamp of scopes of practice

with learning outcomes with statistical significance at .035 and a Pearson correlation of .240.

Although statistical data analysis did not indicate any further correlations with the other key learning resources and learning outcomes the Association rules mining produced rules that suggested lower grades were associated with minimal time spent with key resources such as Interprofessional perspectives. This suggests that students who engaged with the learning environment (as represented by navigational time stamps) achieved greater learning outcomes than the students who did not actively engage with the learning environment.

This preliminary study indicates that tracing student navigational choices within online learning environments will help researchers and educators learn more about student cognitive processes and their disposition to engage in learning processes while immersed in simulative learning environments. The researcher can justify this statement by looking at the learning outcomes and the correlations and suggested association with student decisional sequelae from the data analysis. From the data analysis the researcher can infer that following the student navigational choices and time sent engaged with those learning resources provides insight into the student's disposition to engage in learning processes.

5.1 Limitations of Study and Future Considerations

As mentioned in Chapter 3, one limitation of this preliminary study is the sample size. Although it has been accepted in the literature that educational data mining algorithms can be applied to smaller sample sizes (Garcia & Kloos, 2008),

one would be remiss if one did not discuss the current changes within online learning that would make it more difficult to accept small sample sizes in educational data mining. Coursera is an online learning environment that opens access to course materials to approximately 100,000 students per course (Markoff, 2012). This type of access and numbers opens up new opportunities for studying student usage of online learning environments. Educational data mining algorithms can be applied to such environment and provide a rich, diverse database for data analysis. Although the development of web-portals for online learning such as Coursera make it much more difficult to accept EDM applications with small sample sized one must realize that not all researchers who choose to use EDM as a method for studying online learning environments with have the access or funding to support the usage of vast learning portals such as Coursera and therefore we must remain tolerant of smaller sample sizes utilizing EDM methods as a means of knowledge discovery.

Further limitations of this study include the inability to monitor direct student engagement with the IPSims learning environment. As each student was giving extra time outside of the classroom to complete both the learning assessment and the research survey, the researcher could not control for instants were students might login to the IPSims learning environment and walk away from the computer or engage in another online activity while still having the IPSims learning environment open. Consequently, the researcher limited our time allowance for each individual learning resources (based on outliers in the data) to a maximum of 20 minutes per resource per student. Additionally, as mentioned in Chapter 3 the researcher was unable to control for shared communications both verbally and online between

students when completing the learning assessment and using the IPSims learning environment. Furthermore, the learning assessment was given to students with all questions available at one time which makes it more difficult to break down the decisional sequelae and relate navigational choices with individual questions. A suggestion to remedy this would be to release questions one at a time with separate IPSims user sessions. This would enable the researcher to match each IPSims session and student decisional sequelae with individual questions.

Additional limitations of the study could be addressed by the instructional design of the learning activity in relation to the simulative environment. As the learning assessment was supposed to provide insight into learning processes and learning outcomes, perhaps the choice of learning assessment was not properly matched to the learning environment. Specifically speaking, should I have sought to evaluate the situated learning experience of the students within the simulative environment perhaps a more comprehensive assessment would have been more appropriate. Further research to address this issue could be to have a comparative study between two groups with similar learning assessments, yet have one group use the system for grades while the other group not have grades assigned to the assessment. Having the grades associated with the learning experience may change or alter the situated learning experience of the students and their attitude towards the learning assessment.

In addition to the identified knowledge gaps articulated by Tashiro et al., (2010, 2011) the researcher must also consider the gaps exposed by Garcia-Ruiz et al., (2010). Understanding the effects of computer literacy and the difference

between digital natives and digital immigrants usage patterns might also provide interesting insight into the development of cognitive pathways by such students when engaged with simulated online learning environments. Additionally, to consider student demographics such as age, marital status, previous history with simulated learning environments, average time spent surfing the web per week, and possibly most importantly average time spent playing video games per week. Clustering demographic information with learning outcomes could provide interesting insights into variations of navigational schemas.

Additional future considerations for further research into methods into other key knowledge gaps such as studying student development of misconceptions would be to incorporate sequential mining into the research methods. Sequential mining would provide greater detail and insight into the decisional sequelae of students while engaged with the simulated online learning environment such as IPSims.

5.2 Conclusions

With the continued interest and push to move towards simulation and simulated online learning environments in healthcare education it is our responsibility as educators and researchers to ensure that we continue to ask key questions such as what really works in education and for who (Tashiro & Rowland, 1997). As such, it is crucial for educational institutions and policy makers to continue to seek out evidence-based teach-learning-assessing methods that will benefit students and maximize the potential for transferring knowledge gleaned from within simulated learning environments to real world application.

Moving forward, we must continue to evaluate the learning environments, learning resources and the impact of such environments on the students. Additionally, researchers and educators need to remain diligent in ensuring the ability of these online learning environments to provide a safe environment for which students can maximize learning through learner satisfaction with the environment and exposure to authentic learning experiences. This will be achieved through the use of evidence-based frameworks for teaching, learning, and assessing simulative learning environments and through continued research in this area.

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Appendices

The REB file # 09-027 was written and submitted by Dr. Tashiro and Dr. Vargas Martin for approval by the Research Ethics Board.

Appendix A: Research Survey with Paper and Pencil learning Assessment; Consent Form and IPSims Introduction

Dear Health Science Student:

It is with great pleasure that I invite you to participate in a research project. This research project will potentially impact course content and the delivery of course material. We value your opinion and through your participation we will be able to explore your learning values and goals. For our research we are examining students' learning outcomes and their disposition to learn in Theory and Practice of Patient Centered Care course. The data collected is strictly confidential and our methods are approved by the UOIT Research Ethics Board REB file #: 09-027. This research is being conducted by Dr. Miguel Vargas Martine of the faculty of Business/IT and by Dr. Jay Shiro Tashiro, Faculty of Health Sciences.

The benefits of this research evolve mostly from participation in the research that helps create evidence-based frameworks for educational simulations for healthcare students and providers. Such frameworks can then be incorporated into educational training materials in order to create educational options that “really work” to improve learning and identifies elements of educational materials that are likely to improve dispositions to learn. Consequently your participation and your input may shape the processes that improve courses at UOIT.

If you wish to participate the data collected within IPSIMS and the follow-up questionnaire will remain confidential. Although this is a graded assignment your participation in the research is completely voluntary and refusal to participate will involve no penalty whatsoever. Specifically your grade in the course will not be impacted by your decision to participate or by your responses to the questionnaire and demographic survey. If you participate you have the option to of discontinuing your participation at anytime, again without penalty. **All data collected during the session will be treated with confidentiality and no individuals' data will be**

identified by name. The questionnaire responses and learning outcomes for each participant will be coded so that no individual can be identified. This work will be done by myself, Meaghen Regts, a research assistant at UOIT, and presented as data summary to the researchers. In this manner Lisa Kitchen will remain blind to any individual's identity as data analysis and summaries will never identify any individual. Data collected will be stored and managed by the Faculty of Health Sciences. You have the right to examine the data analysis and summaries.

Based on similar research, we do not anticipate any risks to you. The questionnaire will not contain any questions of a personally intrusive nature. Because you participation is voluntary you do not have to participate and can remove yourself from participation at anytime without risk of penalty. You may also speak with Dr. Miguel Vargas Martin, Dr. Jay Shiro Tashiro or me, Meaghen Regts at any time for a debriefing of the research participation experience.

Thank you for your consideration to participate. If you should choose to participate, please sign the consent form provided in this document.

If you have chosen to participate and have signed the consent form please fill out the questionnaire after you have completed your assignment for Introduction to Health Management.

Again, thank you for your consideration in to participating in this valuable research project.

Sincerely

Meaghen Regts RN, BScN, MHSc(C)

Faculty of Health Sciences
University of Ontario Institute of Technology

Interprofessional Collaborative Patient Centred Care
Research Survey

Course Name:

Course Instructor:

Consent Form for Research Participation

REB FILE #: 09-027

Dear Health Science Student:

Please read this consent form. If you decide that you want to participate in the research, then sign the form at the end by typing your name in the appropriate location.

This is an invitation to participate in a research project that will examine learning outcomes and your disposition to learn competencies in Interprofessional Care.

This research has been approved by the UOIT Ethics Research Board.

This research project is being implemented by Dr. Miguel Vargas Martin Faculty of Business and IT and by Dr. Jay Shiro Tashiro, Faculty of Health Sciences.

The research will be conducted during the period of February 01 2011- June 30 2012.

If you wish to participate, you will need to complete a questionnaire at the end of your assignment. The questionnaire measures: (1) your disposition to engage in critical thinking; (2) your expectations for success and value placed on success in the use of IPSim, (3) your satisfaction with simulations, the realism of the simulations, the simulation delivery on the Web, and simulation content.

The questionnaire also contains a short demographic survey that provides researchers with information related to your work and other activities (study time, working, socializing with friends, and so on), age, and general academic performance in prior courses.

In addition, the research would examine your learning outcomes and measured by your performance working on learning activities in the simulation.

Your participation in this research is completely voluntary and refusal to participate will involve no penalty whatsoever. Specifically your grade in your course will not be negatively influenced by your decision to participate or by your responses to the questionnaire and demographic survey.

If you participate, you have the option of discontinuing participation at anytime, again without penalty of any kind.

You may also contact a grants officer who can provide answers to pertinent questions about research subjects' rights (905) 721-8668 ext. 2156.

We want to thank you for considering participation in this research.

Results of this research will be published in professional journals as well as presented at national and international conferences that focus on educational research. Again, we would like to emphasize that no individuals can be identified from the types of data analysis and summaries that are used for journal articles and conference presentations. If you would like to be informed of articles and presentations containing the research results, please place an X on line below.

_____ I want to be so informed

We may want to use your data in secondary analyses of the data not described in this consent but generally related to focus of this research. If you allow your data to be used for secondary purposes please place an X on the line below.

_____ I allow secondary use of my data without revealing my identity.

If you decide to participate, please sign this form below in the space provided.

I have read this consent form and I understand the intent of the research and my role as a participant in the research. I know that I can ask questions about the research in the future and I can withdraw from the research at anytime without consequences or penalties of any kind. I act with free and informed consent to participate in the research by typing my name in the space below.

Signature: (Please print and sign your name)_____

Date:_____

Researcher: Miguel Vargas Martin, PhD, PEng

Jay Shiro Tashiro, PhD, BSN, RN

Research Assistant: Meaghen Regts RN, BScN, MHSc(C)

Arturo Fernandez

Demographic Information

1. Please provide your banner ID number? _____

2. Today's date (month/day/year): _____

3. Sex: Male Female

4. Birthday (month/day/year): _____

5. Marital status:

- Single
- Married, living with spouse
- Married, not living with spouse

6. # of children:

- None
- 1
- 2
- 3
- 4 or more

7. Canadian citizen: Yes No

8. In what year did you graduate from high school?

<input type="checkbox"/> 2006	<input type="checkbox"/> 2005	<input type="checkbox"/> 2004	<input type="checkbox"/> 2003	<input type="checkbox"/> 2002	<input type="checkbox"/> 2001	<input type="checkbox"/> 2000	<input type="checkbox"/> 1999
<input type="checkbox"/> 1998	<input type="checkbox"/> 1997	<input type="checkbox"/> 1996	<input type="checkbox"/> 1995	<input type="checkbox"/> 1994 or sooner			

9. Mark the one that best describes your average high school marks?

- 70% or less
- 70%-75%
- 75%-80%
- 80%-85%
- 85%-90%
- 90%-95%
- 95%-100%

10. Which courses did you take in your last year of high school (or university preparation program at college)?

- English
- Calculus
- Algebra and Geometry
- Physics
- Chemistry
- Biology
- Other? Please specify: _____

11. Did you have college or university education before admission to your UOIT?

<input type="checkbox"/> Yes. Please specify: _____	<input type="checkbox"/> No
--	-----------------------------

12. Which cohort are you in (Academic year you entered UOIT)?

- 2003-2004
- 2004-2005
- 2005-2006
- 2006-2007
- 2007-2008
- 2008-2009
- 2009-2010
- 2010-2011

13. What is your Health Sciences Program?

- Health Information Management
- Kinesiology
- Medical Laboratory Technology
- Nursing 2007-2008
- BAHSc
- BHSc Honors
- Not In Health Sciences

14. Are you enrolled as a:

- Full-time student
- Part-time student

Rating of Web-based Course Work

Background Information	
Item	Rating
For the (WINTER 2011) Semester, how many (courses OR professional development programs) are you taking?	Circle Number of Courses 1 2 3 4 5 6
Of the courses you are taking this term (WINTER 2011), how many require that you work within a Web environment each week?	Circle Number of Courses 1 2 3 4 5 6
Rate Your Computer Skills.	Poor 1 2 3 4 5 6 Excellent
How many hours a day do you spend on the computer?	1 2 3 4 5 6 >6
Of these hours spent on the computer, how many are for (Nutrition in Health Sciences OR professional development) work?	1 2 3 4 5 6 >6

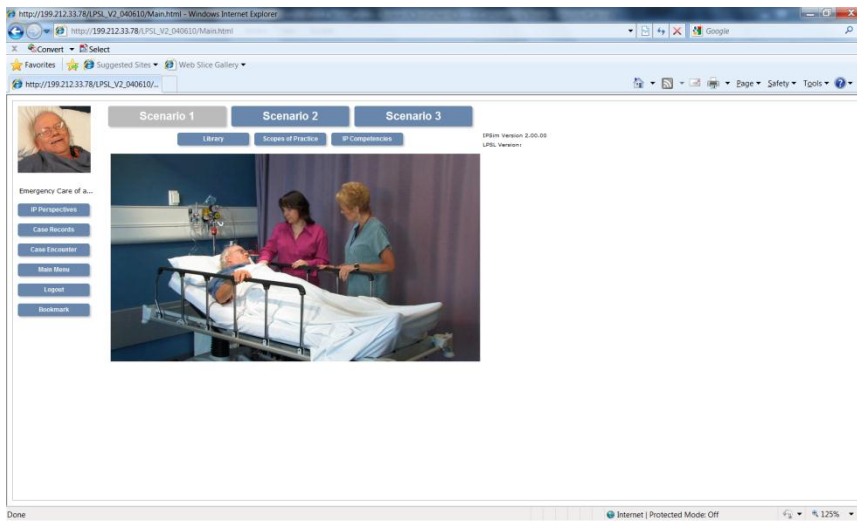
Preferences for Learning Resources, and Educational Scaffolding

Item	Rating
Please rate how much you like having both the Course Tools and My Tools menus as well as icons for representing the tools in your WebCT Course Home Page. [If not applicable check here ____]	Dislike Like Very Much 1 2 3 4 5 6 Very Much
Please rate how much you would like your course assignments provided within the WebCT Course so you could complete all assigned exercises online. [If not applicable check here ____]	Dislike Like Very Much 1 2 3 4 5 6 Very Much
Please rate how much you would like your assigned readings all provided within the WebCT Course so you didn't need a textbook or readings provided in hardcopy. [If not applicable check here ____]	Dislike Like Very Much 1 2 3 4 5 6 Very Much
Please rate how much you would like all of your courses to be totally online without face-to-face instruction by a faculty member, but with a faculty member available online.	Dislike Like Very Much 1 2 3 4 5 6 Very Much
Please rate how much you would like some of your courses to be totally online without face-to-face instruction by a faculty member, but with a faculty member available online.	Dislike Like Very Much 1 2 3 4 5 6 Very Much
Please choose the percentage of face-to-face instruction by a faculty member you would like for a course. <ul style="list-style-type: none"> ▪ 100% = Faculty present in face-to-face instruction each week of the semester. ▪ 75% = Faculty present in face-to-face instruction about 9 weeks of the semester, with online work for remaining weeks. ▪ 50% = Faculty present in face-to-face instruction about 6 weeks of the semester, with online work for remaining weeks. ▪ 25 % = Faculty present in face-to-face instruction about 3 weeks of the semester, with online work for remaining weeks. ▪ 0% = Course is totally online, with faculty providing support online. 	Select Preference <ul style="list-style-type: none"> <input type="checkbox"/> 100% <input type="checkbox"/> 75% <input type="checkbox"/> 50% <input type="checkbox"/> 35% <input type="checkbox"/> 0% <input type="checkbox"/> Depends on Course If face-to-face instruction depends on course, list courses where more face-to-face instruction would be desirable: _____ _____ _____ _____

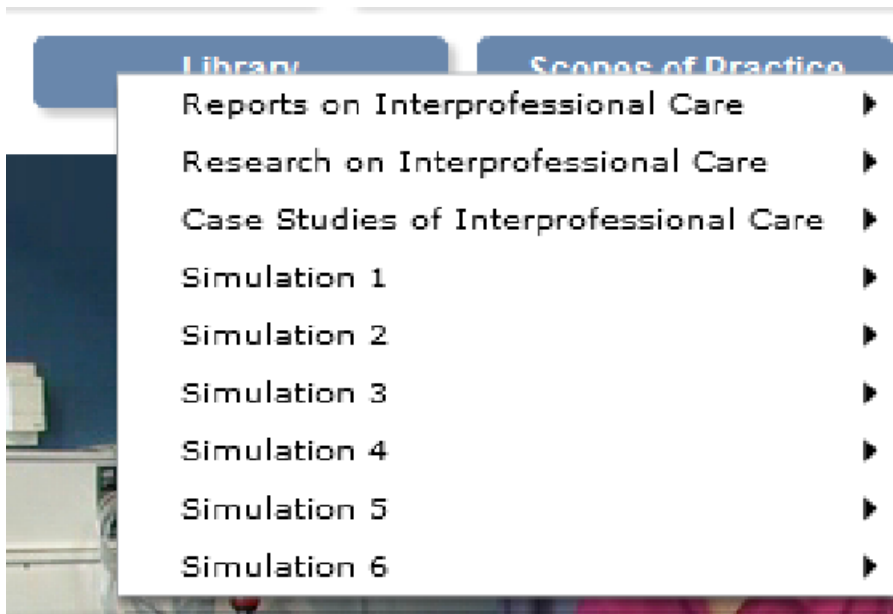
Rating of IPSim Learning Environment

You have just completed a Learning Activity developed by your instructor. For this Learning Activity you worked within the IPSim Learning Environment. Within the simulation, you used a variety of Learning Resources, which were accessed by the buttons in the top navigation bar (Library, Scopes of Practice, IP Competencies) as well as in the left-side navigation bar (IP Perspectives, Case Records, Case Encounter). We would like you to help us improve this environment by answering the following questions. Please be honest and as constructive as possible to help us develop learning environments that will benefit all students. You may not have used all of the Learning Resources, in which case you check that you did not use the function. If you did use a function, then rate that function based on what the survey item is asking.

OPENING PAGE

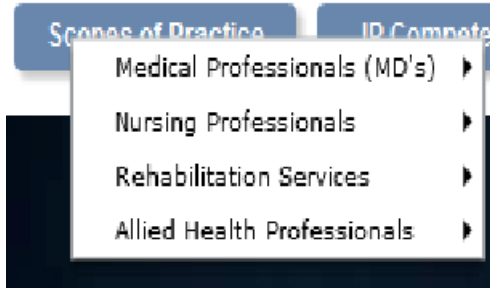


LIBRARY MENU





IP COMPETENCIES



SCOPES OF PRACTICE

Please rate how user-friendly you found the Library. (If you did not use this function check here____.)	Not at all User-Friendly 1 2 3 4 5 6 Very Friendly
Please rate how user-friendly you found the Scopes of Practice. (If you did not use this function check here____.)	Not at all User-Friendly 1 2 3 4 5 6 Very Friendly
Please rate how user-friendly you found the IP Competencies. (If you did not use this function check here____.)	Not at all User-Friendly 1 2 3 4 5 6 Very Friendly

Describe how you used these learning resources in the learning activity you just completed?

OPENING PAGE



Emergency Care of a...

- IP Perspectives
- Case Records
- Case Encounter
- Main Menu
- Logout
- Bookmark

Scenario 1 **Scenario 2** Scenario 3

Library Scopes of Practice IP Competencies



IP PERSPECTIVES



Senior Care

- IP Perspectives
- Case Records
- Case Encounter
- Main Menu
- Logout
- Bookmark

Scenario 1 **Scenario 2** Scenario 3

Library Scopes of Practice IP Competencies


IP:
LP

Acute Care **Long-Term Care** Primary Care Community Health

Interprofessional Care Perspectives related to Acute Care for the patient, situation, or health issue(s) portrayed in this Simulation:

- Falls assessment conducted by ER Team to include ER Nurse and Physician
- Mood and substance abuse assessment plus referral to Community Care Access Centre conducted by Geriatric Emergency Management (GEM) Nurse

CASE RECORDS



Emergency Care of a...

- IP Perspectives
- Case Records
- Case Encounter
- Main Menu
- Logout
- Bookmark

Scenario 1
Scenario 2
Scenario 3

Library
Scopes of Practice
IP Competencies

Case Overview
History & Physical
Progress Notes
IP Care Priorities

The patient, Mr. Fred King, is a 72-year-old male brought to the emergency room by his daughter. The daughter responded to her father's telephone call for help. He had fallen at home. He can walk with a limp but has a bruised and sore hip. The daughter noted that the home was unusually messy and that his personal hygiene has slipped. There is an odour of alcohol on his breath.

The triage nurse and the emergency room physician see the patient and his daughter in the emergency room. The patient is physically examined including X-ray of the hip and routine blood work. The X-ray is negative and his liver enzymes and blood sugar are slightly elevated. The decision is to send him home in the care of his daughter with follow-up with his family doctor.

However, after the daughter's expressed concern regarding his personal hygiene, home environment and possible alcohol abuse, the Geriatric Emergency Management nurse (GEM) becomes involved. The daughter is married, works outside the home and lives independently from her father. A more detailed assessment of the patient and discussion with the daughter reveal that Mr. King has a long history of depression and episodic alcohol abuse. The patient is discharged home with the daughter plus the GEM nurse's referral to the Community Care Access Centre for community nursing and community supports that include a recommendation for a mental health and substance use assessment.

IP:
LP

CASE ENCOUNTER



Emergency Care of a...

- IP Perspectives
- Case Records
- Case Encounter
- Main Menu
- Logout
- Bookmark

Scenario 1
Scenario 2
Scenario 3

Library
Scopes of Practice
IP Competencies



Play
Rewind

Please rate how user-friendly you found the IP Perspectives. (If you did not use this function check here____.)	Not at all User-Friendly 1 2 3 4 5 6 Very Friendly
Please rate how user-friendly you found the Case Records. (If you did not use this function check here____.)	Not at all User-Friendly 1 2 3 4 5 6 Very Friendly
Please rate how user-friendly you found the Case Encounter. (If you did not use this function check here____.)	Not at all User-Friendly 1 2 3 4 5 6 Very Friendly
Please rate how user-friendly you found the Exit and Logout function	Not at all User-Friendly 1 2 3 4 5 6 Very Friendly
Describe how you used these Learning Resources in the Learning Activity you completed.	

Satisfaction with Educational Simulations and Serious Games

Item	Rating
Relative to computer-based educational simulations or serious games you have used, please describe your satisfaction with IPSim	Not Satisfied Very Satisfied At All 1 2 3 4 5 6
How much time did you work within the IPSim environment?	<input type="checkbox"/> 0 hours <input type="checkbox"/> 1 hour <input type="checkbox"/> 2 hours <input type="checkbox"/> 3 hours <input type="checkbox"/> More than 3 hours
Did you find the Learning Activity you were assigned for IPSim relevant to your course?	Not Relevant Very Relevant At All 1 2 3 4 5 6
Rate your satisfaction with the Learning Activity you completed within IPSim.	Not Satisfied Very Satisfied At All 1 2 3 4 5 6
Briefly describe the most satisfying elements of an educational simulation or serious game you really enjoyed. This experience could be within IPSim or some other simulation environment.	

Realism of Simulations	Satisfaction
Rate your satisfaction with the realism of the IPSim Learning Environment.	<p style="text-align: center;">Not Very</p> <p style="text-align: center;">At All 1 2 3 4 5 6 Satisfied</p> <p style="text-align: center;">Satisfied</p>
<p>Rate your satisfaction with the relevance of each IPSim component that you used. Do not rate if you did not use.</p> <p style="text-align: center;">Scopes of Practice</p> <p style="text-align: center;">Library</p> <p style="text-align: center;">IP Competencies</p> <p style="text-align: center;">IP Perspectives</p> <p style="text-align: center;">Case Records</p> <p style="text-align: center;">Case Encounter</p>	<p>Not Very</p> <p>At All 1 2 3 4 5 6 Satisfied</p> <p>Satisfied</p> <p>Not Very</p> <p>At All 1 2 3 4 5 6 Satisfied</p> <p>Satisfied</p> <p>Not Very</p> <p>At All 1 2 3 4 5 6 Satisfied</p> <p>Satisfied</p> <p>Not Very</p> <p>At All 1 2 3 4 5 6 Satisfied</p> <p>Satisfied</p> <p>Not Very</p> <p>At All 1 2 3 4 5 6 Satisfied</p> <p>Satisfied</p> <p>Not Very</p> <p>At All 1 2 3 4 5 6 Satisfied</p> <p>Satisfied</p>
Rate how well the IPSim experience improved your learning.	<p>Not Very</p> <p>At All 1 2 3 4 5 6 Satisfied</p> <p>Satisfied</p>

What types of Web-based simulations or serious games would you like to see for this course?

Delivery Modality for Simulations	Satisfaction
How satisfied are you with the ratio of online work to face-to-face instruction for this course?	Not Satisfied At All 1 2 3 4 5 6 Very Satisfied
Rate your satisfaction with the instructional support for online instruction that is provided by the faculty member?	Not Satisfied At All 1 2 3 4 5 6 Very Satisfied
Rate your satisfaction with the instructional support provided within the online components of the course?	Not Satisfied At All 1 2 3 4 5 6 Very Satisfied

Content of Simulations	Satisfaction
Rate this course in terms of difficulty relative to other courses or programs you are currently enrolled in or have completed at UOIT.	<input type="checkbox"/> Much easier than most courses <input type="checkbox"/> A little easier than most courses <input type="checkbox"/> About the same as most courses <input type="checkbox"/> More difficult than most courses <input type="checkbox"/> Much more difficult than most courses
How satisfied are you with the content of the (simulations OR paper-pencil learning activities)?	Not Satisfied At All 1 2 3 4 5 6 Very Satisfied
Did the instructions for IPSim provide a kind of map for you to follow as you worked through the IPSim Learning Activity?	No, Not At All 1 2 3 4 5 6 Yes, Very Much So

<p>What overall performance evaluation do you expect to get for your work in the IPSim environment?</p>	<input type="checkbox"/> Excellent <input type="checkbox"/> Good <input type="checkbox"/> Average <input type="checkbox"/> Below Average <input type="checkbox"/> Poor
<p>What overall grade do you expect to get for your work in this course? Please pick a level. Each level includes + or – grades. For example, the A level includes A+, A, and A-.</p>	<input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D <input type="checkbox"/> F

Critical Thinking - 1

Please indicate the extent to which you agree or disagree with each of the following items, using the scale below. There are no correct answers; we are only interested in how you feel about the statements. Write a number between +4 and -4 in the blank by each item to indicate your agreement/disagreement with it.

- +4 = very strong agreement
- +3 = strong agreement
- +2 = moderate agreement
- +1 = slight agreement
- 0 = neither agreement nor disagreement
- 1 = slight disagreement
- 2 = moderate disagreement
- 3 = strong disagreement
- 4 = very strong disagreement

- ____ 1. I would prefer complex to simple problems.
- ____ 2. I like to have the responsibility of handling a situation that requires a lot of thinking.
- ____ 3. Thinking is not my idea of fun.
- ____ 4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.
- ____ 5. I try to anticipate and avoid situations where there is a likely chance I will have to think in depth about something.
- ____ 6. I find satisfaction in deliberating hard and for long hours.
- ____ 7. I only think as hard as I have to.
- ____ 8. I prefer to think about small, daily projects to long-term ones.
- ____ 9. I like tasks that require little thought once I've learned them.
- ____ 10. The idea of relying on thought to make my way to the top appeals to me.

- ___ 11. I really enjoy a task that involves coming up with new solutions to problems.
- ___ 12. Learning new ways to think doesn't excite me very much.
- ___ 13. I prefer my life to be filled with puzzles that I must solve.
- ___ 14. The notion of thinking abstractly is appealing to me.
- ___ 15. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.
- ___ 16. I feel relief rather than satisfaction after completing a task that required a lot of mental effort.
- ___ 17. It's enough for me that something gets the job done; I don't care how or why it works.
- ___ 18. I usually end up deliberating about issues even when they do not affect me personally.

Critical Thinking - 2

Please do not spend too much time on the following items. There are no right or wrong answers and therefore your first response is important. Mark *T* for true and *F* for false. Be sure to answer every question.

- ___ 1. A problem has little attraction for me if I don't think it has a solution.
- ___ 2. I am just a little uncomfortable with people unless I feel that I can understand their behaviour.
- ___ 3. There's a right way and a wrong way to do almost everything.
- ___ 4. I would rather bet 1 to 6 on a long shot than 3 to 1 on a probable answer.
- ___ 5. The way to understand complex problems is to be concerned with their larger aspects instead of breaking them into smaller pieces.
- ___ 6. I get pretty anxious when I'm in a social situation over which I have no control.
- ___ 7. Practically every problem has a solution.
- ___ 8. It bothers me when I am unable to follow another person's train of thought.
- ___ 9. I have always felt there was a clear difference between right and wrong.
- ___ 10. It bothers me when I don't know how other people react to me.
- ___ 11. Nothing gets accomplished in this world unless you stick to some basic rules.
- ___ 12. If I were a doctor, I would prefer the uncertainties of a psychiatrist to the clear and definite work of someone like a surgeon or X-ray specialist.
- ___ 13. Vague and impressionistic pictures really have little appeal for me.
- ___ 14. If I were a scientist, it would bother me that my work would never be completed (because science will always make new discoveries).

___ 15. Before an examination, I feel much less anxious if I know how many questions there will be.

___ 16. The best part of working a jigsaw puzzle is putting in the last piece.

___ 17. Sometimes I rather enjoy going against the rules and doing things I'm not supposed to do.

___ 18. I don't like to work on a problem unless there is a possibility of coming out with clear-cut and unambiguous answers.

___ 19. I like to fool around with new ideas, even if they turn out later to be a total waste of time.

___ 20. Perfect balance is the essence of all good composition.

Expectancy-Value Questionnaire

INSTRUCTIONS: For all items that have a rating scale, mark one number only. On all other types of items, follow the directions given. Remember, it is very important to complete all the items on the questionnaire! Please note that when an item refers to course it refers to the course Nutrition in Health Sciences.

1. How successful do you think you would be in a career which required knowledge of the course material in Nutrition in Health Sciences?

<i>not at all successful</i>	1	2	3	4	5	6	7	<i>very successful</i>
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2. If you were to take a similar course as Nutrition in Health Sciences, next semester, how well do you think you would do?

<i>not at all well</i>	1	2	3	4	5	6	7	<i>very well</i>
------------------------	---	---	---	---	---	---	---	------------------

3. How well would you expect to do in advanced courses in your program?

<i>not at all well</i>	1	2	3	4	5	6	7	<i>very well</i>
------------------------	---	---	---	---	---	---	---	------------------

4. How well would you expect to do in Nutrition in Health Sciences?

<i>not at all well</i>	1	2	3	4	5	6	7	<i>very well</i>
------------------------	---	---	---	---	---	---	---	------------------

5. Compared to other students in your class, how well do you expect to do in Nutrition in Health Sciences semester?

<i>not at all well</i>	1	2	3	4	5	6	7	<i>very well</i>
------------------------	---	---	---	---	---	---	---	------------------

6. How well do you expect to do on your next Nutrition in Health Sciences?

<i>not at all well</i>	1	2	3	4	5	6	7	<i>very well</i>
------------------------	---	---	---	---	---	---	---	------------------

7. If you are taking other courses this semester, how well do you think you will do in these courses?

<i>not at all well</i>	1	2	3	4	5	6	7	<i>very well</i>
------------------------	---	---	---	---	---	---	---	------------------

8. If you were to rank all the students in this class from the worst to the best in Nutrition in Health Sciences, where would you put yourself?

<i>the worst</i>	1	2	3	4	5	6	7	<i>the best</i>
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9. In comparison to most of your other academic subjects, how are you at Nutrition in Health Sciences?

<i>not at all good</i>	1	2	3	4	5	6	7	<i>very good</i>
------------------------	---	---	---	---	---	---	---	------------------

10. How good at Nutrition in Health Sciences does your mother/female guardian think you are?

<i>not at all good</i>	1	2	3	4	5	6	7	<i>very good</i>
------------------------	---	---	---	---	---	---	---	------------------

11. How good at Nutrition in Health Sciences does your father/male guardian think you are?

<i>not at all good</i>	1	2	3	4	5	6	7	<i>very good</i>
------------------------	---	---	---	---	---	---	---	------------------

12. How good at Nutrition in Health Sciences Centered Care does your professor in this course think you are?

<i>not at all good</i>	1	2	3	4	5	6	7	<i>very good</i>
------------------------	---	---	---	---	---	---	---	------------------

13. In general, how difficult is Nutrition in Health Sciences for you?

<i>not at all difficult</i>	1	2	3	4	5	6	7	<i>very difficult</i>
-----------------------------	---	---	---	---	---	---	---	-----------------------

14. Compared to most other students in your class, how difficult is Nutrition in Health Sciences for you?

<i>not at all difficult</i>	1	2	3	4	5	6	7	<i>very difficult</i>
-----------------------------	---	---	---	---	---	---	---	-----------------------

15. Compared to most other university subjects that you have taken or are taking, how difficult is Nutrition in Health Sciences for you?

<i>not at all difficult</i>	1	2	3	4	5	6	7	<i>very difficult</i>
-----------------------------	---	---	---	---	---	---	---	-----------------------

16. How difficult does your professor in this course think Nutrition in Health Sciences is for you?

<i>not at all difficult</i>	1	2	3	4	5	6	7	<i>very difficult</i>
-----------------------------	---	---	---	---	---	---	---	-----------------------

17. How hard do you have to try to get good grades in Nutrition in Health Sciences?

<i>not at all hard</i>	1	2	3	4	5	6	7	<i>very hard</i>
------------------------	---	---	---	---	---	---	---	------------------

18. How hard do you have to study for Nutrition in Health Sciences tests to get a good grade?

<i>not at all hard</i>	1	2	3	4	5	6	7	<i>very hard</i>
------------------------	---	---	---	---	---	---	---	------------------

19. To do well in Nutrition in Health Sciences I have to work... (Mark one).

- Much harder in Nutrition in Health Sciences than in other subjects.
- Somewhat harder in Nutrition in Health Sciences than in other subjects.

- A little harder in Nutrition in Health Sciences than in other subjects.
- The same as in other subjects.
- A little harder in other subjects than in Nutrition in Health Sciences.
- Somewhat harder in other subjects than in Nutrition in Health Sciences.
- Much harder in other subjects than in Nutrition in Health Sciences.

20. How much time do you spend on Nutrition in Health Sciences homework?
(Mark one).

- An hour or more a day
- 30 minutes a day
- 15-30 minutes a day
- About 1 hour a week
- About 30 minutes a week
- About 30 minutes every two weeks
- I rarely do any Nutrition in Health Sciences homework

21. How hard do you try in Nutrition in Health Sciences?

<i>not at all hard</i>	1	2	3	4	5	6	7	<i>very hard</i>
------------------------	---	---	---	---	---	---	---	------------------

22. Compared to most other students you know, how much time do you have to spend working on your Nutrition in Health Sciences assignments?

<i>not some much time</i>	1	2	3	4	5	6	7	<i>a lot of time</i>
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23. How useful is learning the content in Nutrition in Health Sciences for what you want to do after you graduate and go to work?

<i>not at all useful</i>	1	2	3	4	5	6	7	<i>very useful</i>
--------------------------	---	---	---	---	---	---	---	--------------------

24. How useful do you think the things you have learned from the content in Nutrition in Health Sciences for your other school courses?

<i>not at all useful</i>	1	2	3	4	5	6	7	<i>very useful</i>
--------------------------	---	---	---	---	---	---	---	--------------------

25. How useful is what you would learn in university Nutrition in Health Sciences for what you will do when you finish school and go to work?

<i>not at all useful</i>	1	2	3	4	5	6	7	<i>very useful</i>
--------------------------	---	---	---	---	---	---	---	--------------------

26. I feel that being good at solving problems which involve knowledge of Nutrition in Health Sciences is:

<i>not at all important</i>	1	2	3	4	5	6	7	<i>very important</i>
-----------------------------	---	---	---	---	---	---	---	-----------------------

27. How important is it to you to get good grades in Nutrition in Health Sciences?

<i>not at all important</i>	1	2	3	4	5	6	7	<i>very important</i>
-----------------------------	---	---	---	---	---	---	---	-----------------------

28. How upset would you be if you got a low grade in Nutrition in Health Sciences?

<i>not at all upset</i>	1	2	3	4	5	6	7	<i>very upset</i>
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29. In general, I find working on Nutrition in Health Sciences assignments:

<i>very boring</i>	1	2	3	4	5	6	7	<i>very interesting</i>
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30. How much do you like working with Nutrition in Health Sciences?

<i>not at all</i>	1	2	3	4	5	6	7	<i>very much</i>
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31. How much do you like your professor in this course?

<i>not at all</i>	1	2	3	4	5	6	7	<i>very much</i>
-------------------	---	---	---	---	---	---	---	------------------

32. In Nutrition in Health Sciences, most of the time, how well do you do in each of the following things?

a. when taking a test you have studied for:

<i>not at all well</i>	1	2	3	4	5	6	7	<i>very well</i>
------------------------	---	---	---	---	---	---	---	------------------

b. when doing Nutrition in Health Sciences homework problems:

<i>not at all well</i>	1	2	3	4	5	6	7	<i>very well</i>
------------------------	---	---	---	---	---	---	---	------------------

33. How have you been doing in this course, so far this semester?

<i>not at all well</i>	1	2	3	4	5	6	7	<i>very well</i>
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34. What is the lowest grade you would be satisfied with in this course? (Mark one).

- A A- B+ B B- C+ C C- D+ or lower

35. Would you take more Nutrition in Health Sciences if you did not have to?

<i>definitely would <u>not</u> take more</i>	1	2	3	4	5	6	7	<i>definitely would take more</i>
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36. If it were your decision alone, how much more Health Sciences courses would you take?

- I would not take any more Health Sciences courses
 I would take one or two more Health Sciences courses
 I would take Health Sciences courses in my 4th-Year
 I would take Health Sciences courses through undergraduate, plus some graduate work
 I would take Health Sciences courses through a master's degree
 I would take Health Sciences courses all the way through a doctoral degree

37. In the past, how often have you performed very well on Nutrition in Health Sciences tests?

<i>not at all often</i>	1	2	3	4	5	6	7	<i>very often</i>
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38. In the past, how often have you performed very poorly on Nutrition in Health Sciences tests?

<i>not at all often</i>	1	2	3	4	5	6	7	<i>very often</i>
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Please indicate which of the following you plan to do after you graduate from university.

39. a) Continue your education (please mark all that apply)
- Master's degree
 - Doctoral degree (PhD. Or EdD.)
 - Doctoral degree (M.D. or other medical degree)
 - Law or other professional degree
 - Other (Please describe: _____)
- b) Look for a job
- c) Go into business
- d) Military service
- e) Public service (Peace Corps, etc.)
- f) Other plans

In the following sections we are interested in learning some of your impressions of the course in which you received this questionnaire. Please refer only to this course, Nutrition in Health Sciences, in filling out the sections below. In the following section we are interested in the difficulty of the course:

40. How difficult is it to understand the assigned reading materials? (If not applicable check here ___)

<i>very easy</i>	1	2	3	4	5	6	7	<i>very difficult</i>
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41. How difficult are the problem sets? (If not applicable check here ___)

<i>very easy</i>	1	2	3	4	5	6	7	<i>very difficult</i>	<i>does not apply</i>
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42. How difficult are the writing assignments? (If not applicable check here ___)

<i>very easy</i>	1	2	3	4	5	6	7	<i>very difficult</i>	<i>does not apply</i>
------------------	---	---	---	---	---	---	---	-----------------------	-----------------------

43. How difficult are the exams in Nutrition in Health Sciences? (If not applicable check here ___)

<i>very easy</i>	1	2	3	4	5	6	7	<i>very difficult</i>
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44. How difficult is it to understand the terminology used in Nutrition in Health Sciences?

<i>very easy</i>	1	2	3	4	5	6	7	<i>very difficult</i>
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45. How difficult is the Nutrition in Health Sciences overall?

<i>very easy</i>	1	2	3	4	5	6	7	<i>very difficult</i>
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In the following section we are interested in how well the course meets your expectations. For each of the following course characteristics, please indicate the extent to which it matches the expectations you had when you first entered the course:

46. Readability of assigned readings:

<i>not at all close to my expectations</i>	1	2	3	4	5	6	7	<i>very close to my expectations</i>
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47. Work load:

<i>not at all close to my expectations</i>	1	2	3	4	5	6	7	<i>very close to my expectations</i>
--	---	---	---	---	---	---	---	--------------------------------------

48. Overall level of difficulty:

<i>not at all close to my expectations</i>	1	2	3	4	5	6	7	<i>very close to my expectations</i>
--	---	---	---	---	---	---	---	--------------------------------------

We would like to know if you are aware of the reasons for your instructor's choices to teach you in a particular way. Your responses should reflect your general level of awareness and not specific feelings about this specific course.

49. The logic of the course:

<i>not at all clear</i>	1	2	3	4	5	6	7	<i>very clear</i>
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50. The reasons for the choice of the text or other readings:

<i>not at all clear</i>	1	2	3	4	5	6	7	<i>very clear</i>
-------------------------	---	---	---	---	---	---	---	-------------------

51. The reasons for the course format (lecture, laboratory, discussion, etc.):

<i>not at all clear</i>	1	2	3	4	5	6	7	<i>very clear</i>
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52. The reasons for the instructor's choice of assignments:

<i>not at all clear</i>	1	2	3	4	5	6	7	<i>very clear</i>
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53. How the level of difficulty was chosen by the instructor:

<i>not at all clear</i>	1	2	3	4	5	6	7	<i>very clear</i>
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54. Why group activities are assigned: (Check here if not applicable __)

<i>not at all clear</i>	1	2	3	4	5	6	7	<i>very clear</i>
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55. Why writing assignments are used: (Check here if not applicable __)

<i>not at all clear</i>	1	2	3	4	5	6	7	<i>very clear</i>
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When student discussions occur in this course, Nutrition in Health Sciences, what do they typically focus on? Please indicate the approximate percentage of time devoted to each of the items below:

56. Textbook material: (Check here if not applicable __)

<input type="checkbox"/> <10%	<input type="checkbox"/> 20%-30%	<input type="checkbox"/> 40%-50%	<input type="checkbox"/> 60%-70%	<input type="checkbox"/> 80%-90%
<input type="checkbox"/> 10%-20%	<input type="checkbox"/> 30%-40%	<input type="checkbox"/> 50%-60%	<input type="checkbox"/> 70%-80%	<input type="checkbox"/> >90%

57. Non-textbook material: (Check here if not applicable __)

<input type="checkbox"/> <10%	<input type="checkbox"/> 20%-30%	<input type="checkbox"/> 40%-50%	<input type="checkbox"/> 60%-70%	<input type="checkbox"/> 80%-90%
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<input type="checkbox"/> 10%-20%	<input type="checkbox"/> 30%-40%	<input type="checkbox"/> 50%-60%	<input type="checkbox"/> 70%-80%	<input type="checkbox"/> >90%
----------------------------------	----------------------------------	----------------------------------	----------------------------------	-------------------------------

58: Ideas raised by the instructor: (Check here if not applicable __)

<input type="checkbox"/> <10%	<input type="checkbox"/> 20%-30%	<input type="checkbox"/> 40%-50%	<input type="checkbox"/> 60%-70%	<input type="checkbox"/> 80%-90%
<input type="checkbox"/> 10%-20%	<input type="checkbox"/> 30%-40%	<input type="checkbox"/> 50%-60%	<input type="checkbox"/> 70%-80%	<input type="checkbox"/> >90%

59: Ideas raised by the students: (Check here if not applicable __)

<input type="checkbox"/> <10%	<input type="checkbox"/> 20%-30%	<input type="checkbox"/> 40%-50%	<input type="checkbox"/> 60%-70%	<input type="checkbox"/> 80%-90%
<input type="checkbox"/> 10%-20%	<input type="checkbox"/> 30%-40%	<input type="checkbox"/> 50%-60%	<input type="checkbox"/> 70%-80%	<input type="checkbox"/> >90%

60. If course grades were assigned today, what grade do you think you would get?

<input type="checkbox"/> A	<input type="checkbox"/> B+	<input type="checkbox"/> C+	<input type="checkbox"/> D+ or lower
<input type="checkbox"/> A-	<input type="checkbox"/> B	<input type="checkbox"/> C	
	<input type="checkbox"/> B-	<input type="checkbox"/> C-	

61. Do you speak any languages other than English?

<input type="checkbox"/> Yes. Please specify: _____ If yes, which language do you prefer? _____	<input type="checkbox"/> No
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62. Which option best describes how you learned your language(s). Mark one only.

- Learned only English
- Learned English first, then a second language
- Learned another language first, then English
- Learned English and another language at the same time

63. Since you have been in university, about how much time do you typically spend per week in each of the following activities?

<u>Activity</u>	<u>Hours Per Week</u>							
	None	Less than 1	1-2	3-5	6-10	11-15	16-20	Over 20
Classes/labs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Studying/homework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Socializing with friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Talking with faculty outside of class	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Exercising/sports	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reading for pleasure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Partying	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Working (for pay)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Volunteer work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Student clubs or groups	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Watching TV	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Commuting to campus	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Religious services/meetings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hobbies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Child or family obligations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Social networking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Surfing the Web and playing video games for fun	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Surfing the Web and playing video games as part of course work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

64. Which option below best describes where you are living this semester?

- With parents or relatives
- Your own home or apartment
- UOIT/DC residence
- Off-campus student housing
- Other

65. How many kilometres is this university from your permanent home? Mark one only.

<input type="checkbox"/> 5 or less	<input type="checkbox"/> 51-100
<input type="checkbox"/> 6-10	<input type="checkbox"/> 101-500
<input type="checkbox"/> 11-50	<input type="checkbox"/> More than 500

66. What is the highest level of education obtained by your parents/guardian? Mark one in each column.

	Father or Male Guardian	Mother or Female Guardian
8 th grade or less	<input type="checkbox"/>	<input type="checkbox"/>
Some high school	<input type="checkbox"/>	<input type="checkbox"/>
High school graduate	<input type="checkbox"/>	<input type="checkbox"/>
Some college or university	<input type="checkbox"/>	<input type="checkbox"/>
College or university degree	<input type="checkbox"/>	<input type="checkbox"/>
Some graduate school	<input type="checkbox"/>	<input type="checkbox"/>
Graduate degree	<input type="checkbox"/>	<input type="checkbox"/>

This is the end of the questionnaire

THANK YOU VERY MUCH FOR YOUR COOPERATION

Appendix B: IPSims Learning Assessment

Nutrition Assessment :

SIM 4: Scenario 1: The activity you are engaging in relates to Simulation #4 scenario #1. Barb is the patient the interdisciplinary team is working with. She has been brought to the hospital to receive care for a leg wound.

1. Using the learning resources to guide you list three social determinants of health that apply to Barb's current situation.
 - a)
 - b)
 - c)

2. Barb has several co-morbidities. Using the case encounter identify Barb's current medical issues.
 - a) Type II diabetes

- b) Hypertension
- c) Hypotension
- d) Type I diabetes
- e) Cellulites
- f) Anorexia nervosa
- g) obesity

3. List three of the multidisciplinary team members.

- a)
- b)
- c)

4. Utilizing scopes of practice identify one aspect of the roles and responsibilities of each of the above mentioned team members relating to Barb's care.

- a)
- b)
- c)

5. List two factors that should be considered when recommending a diet for Barb.

- a)
- b)

