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Formative Research on an Instructional Design Theory for Virtual Patients in Clinical Education: A Pressure Ulcer Prevention Clinical Reasoning Case

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by

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We hereby certify that this dissertation, submitted by Manon Schladen, conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirements for the degree of Doctor of Philosophy.

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An Abstract of a Dissertation Submitted to Nova Southeastern University
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Despite advances in health care over the past decades, medical errors and omissions remain significant threats to patient safety and health. A large number of these mistakes are made by trainees, persons who are just beginning to build the case-based experiences that will transform them from novices to expert practitioners. Clinicians use both intuitive and deductive problem-solving skills in caring for patients and they acquire expertise in applying these skills through interaction with many and varied cases.

The contemporary heath care environment, with decreased lengths of stay for patients and reduced duty hours for trainees, makes getting optimal patient exposure difficult. Virtual patients (VPs), online, interactive patient cases, may help close the case exposure gap. Evidence has shown that VPs improve clinical reasoning skills, but no formal instructional design theory of VPs has been advanced. The goal was to conduct formative research to develop an instructional design theory of VPs to help novice clinicians cultivate clinical reasoning and diagnostic skills. The instructional design theory, goal-based scenarios (GBS), grounded in the learning theory, Case-based Reasoning, provided methods that promised to be appropriate to the goal.

An existing, two-module, multimedia VP, *Matt Lane*, *A Pressure Ulcer Prevention Virtual Patient*, was tested with 10 medical trainees to determine which methods of GBS it incorporated and which of its methods were not part of GBS. Leaners' experience of what worked and didn't work to promote learning in the VP was analyzed. The VP was found to incorporate all GBS methods and one significant method, the Life Model, that was not part of GBS. The Life Model Method involved replicating, with a high degree of fidelity, the experiences of a real patient in creating the VP scenario.

Recommendations for customization of GBS for VPs included more explicit advertisement of learning goals and leverage of Internet search engines to provide just-in-time resources to support problem-solving. Incorporation of the Life Model was also recommended along with the Simplifying Conditions Method from Elaboration Theory to manage the complexity inherent in the Life Model. The resultant, enhanced GBS theory may be particularly relevant in teaching patient-centered care.

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Chapter 1

Introduction

Background

As the 20th century was drawing to a close, the Institute of Medicine published a landmark study revealing that between 44,000 and 98,000 people died each year in the United States (U.S.) as a result of medical errors (Committee on Quality in Health Care in America, 2000). To place this range in perspective, annual deaths from motor vehicles measured at the same time period numbered less than 42,000 (Martin, Smith, Mathews, & Ventura, 1999). Today, more than a decade later, despite diligent efforts on the part of both health care institutions and accrediting bodies to reduce errors, there is no clear evidence that the situation has significantly improved (Landrigan et al., 2010; Levinson, 2010; Liang & Mackey, 2011; Shreve et al., 2010). A reexamination of the evidence suggests that, in fact, the lower limit of deaths associated with preventable harm done in hospitals may be as high as 210,000 deaths per year (James, 2013).

System-level errors predominate, and a vast repertoire of interventions, from decision-support informatics to structured clinical protocols (Graber, 2009) to the emergence of an entirely new field of study – implementation science (May, 2013) – have appeared to address systematic errors in health care. Medical errors that result from the mistakes of individual health care providers, however, are not negligible (Norman & Eva, 2010). Among physicians, errors in *diagnosis* account for 5-15% of mistakes made (Berner & Graber, 2008; Graber, 2009). According to the Merriam-Webster online dictionary (2015), diagnosis, in the context of health care, is “the art or act of identifying a disease by its signs and symptoms”

(“Full Definition,” para. 1a). It is a special case of decision making under conditions of uncertainty (Graber et al., 2012) and involves understanding the symptoms presented in the context of the whole patient and providing appropriate care to support the patient’s health while mitigating risks.

An analysis of malpractice experiences across the range of medical specialties (Jena, Seabury, Lakdawalla, & Chandra, 2011) showed that even among physicians in low-risk specialty areas such as internal medicine and family general practice experience 75% could expect to experience a malpractice claim over the course of their careers. The history of malpractice among the more recently evolved clinical decision making professionals, advanced practice nurses (NPs) and physician assistants (PAs), is short but their documented rate is comparable to that of physicians (Nicholson, 2008). A study of malpractice claims between 1984 and 2004 found that trainees (in this case, interns, residents, and fellows) contributed in a major way to 27% of all errors made (Singh, Thomas, Peterson, & Studdert, 2009). Singh and colleagues further found that trainees were more likely to make errors resulting from lack of knowledge/technical competence than were seasoned clinicians and that the most prevalent type of trainee error was *diagnostic* error. Lacking the ability to correctly identify the factors underlying a patient’s complaint or factors in a patient’s presentation that increase or morbidity, a clinician’s ability to intervene effectively is hit or miss.

Diagnostic (Clinical Reasoning) Skill Development in Medical Practice

How physicians advance from novice to expert diagnosticians has been a topic of research for at least the past 30 years (Schmidt & Rikers, 2007), however no single model of diagnostic reasoning in medicine has emerged to provide definitive guidance (Delzell, Chumley, Webb, Chakrabarti, & Relan, 2009). Theorists generally agree, however, that practitioners at all levels of expertise use both automated/intuitive, schema-driven, cognitive processes and deliberate, deductive reasoning in arriving at a diagnosis. Where theorists differ is on the relative contribution of each type of reasoning to diagnostic efficiency and accuracy (Elstein, 2009).

Irrespective, however, of the cognitive strategies that may or may not characterize expert thinking, physicians are thought to become experts in their disciplines commensurate to the practice they receive in performing diagnoses across many and varied patients (Norman, 2005). Receiving feedback on the quality of their diagnostic problem-solving is also an essential step in building physicians' expertise (Elstein, 2009).

PAs work under the supervision of physicians and, like physicians, are considered practitioners of medicine and follow the medical model of skill formation (Kess, 2011). PAs are recognized as a distinct demographic within the practice of medicine (Miller & Glicken, 2007), however there is a gap in the literature on the formation of diagnostic skills in PAs specifically. PAs, in fact, have only existed as a formal profession since the 1960's (Physician Assistant History Society, 2013). The PA education literature references models of diagnostic reasoning derived from studies of physicians' thinking (Howlett & Phelps, 2006; Quincy & Ragan, 2012) or those that characterize human thought processes generally (L. Davis & Jacques, 2008).

Diagnostic (Clinical Reasoning) Skill Development in Nursing Practice

Nursing is a health science with a history, tradition, and research base distinct from that of medicine. NPs are independent practitioners and, as of 2015 (in most instances), the credential for an individual as an NP will be a doctoral degree (Dennison, Payne, & Farrell, 2012). For this reason, this paper does not use the term “doctor” as a synonym for a physician to avoid confusion. Like diagnostic reasoning theory in the medical realm, cognitive research theory in nursing practice recognizes the existence of both logico-deductive and intuitive components in the clinical reasoning process, though they use different terminology and parse the diagnostic decision making process differently (Banning, 2008). Feedback on decisions (Overstreet, 2008) and experience (O'Neill, Dluhy, & Chin, 2005) with many patient are constants that apply to gaining clinical reasoning expertise in nursing as well as in medicine (Elstein, 2009; Norman, 2005).

Providing optimally varied patient experiences with timely expert feedback, however, is a challenge to today’s clinical educators (Maldonado, 2011; Tworek, Coderre, Wright, & McLaughlin, 2010). Among the most challenging constraints educators face are reduced patient length-of-stay requirements (Kalra, Fisher, & Axelrod, 2010), and in the specific case of physician education, resident duty-hour restrictions (Graber, 2007) and decreased federal support for graduate medical education (Steinmann, 2011).

Health care utilization efficiencies have resulted in reduced lengths-of-stay for patients (Kalra et al., 2010). This reduction decreases the likelihood that clinical learners will have the opportunity to interact with the full range of patient cases their teaching hospitals admit. Then, as patients leave the hospital sooner and sooner after treatment, clinical learners are less likely to be able to observe the outcomes of the clinical decisions in which they *did* have the opportunity to participate (Tworek et al., 2010).

After a landmark study linking long work hours with high rates of error (Landrigan et al., 2010), the Accreditation Council for Graduate Medical Education (ACGME) required its accredited residency programs to limit residents’ duty hours. The resulting effects on patient safety and resident well-being have been equivocal (Browne, Cook, Olson, & Bolognesi, 2009; Committee on Optimizing Graduate Medical Trainee (Resident) Hours and Work Schedules to Improve Patient Safety, 2008; Mir, Cannada, Murray, Black, & Wolf, 2011; Nasca, Day, & Amis, 2010; Press et al., 2011). From a perspective focused only on opportunities for learning, duty hour limitations further restrict the number of cases residents experience on any given rotation and fragment experience (Graber, 2007).

Another negative impact of a tightening health care economy on residents' learning is the on-going threat of decreased federal support for graduate medical education despite rising program costs (Steinmann, 2011). Apart from the constraints decreased funding imposes on residency programs generally, decreased ability to reimburse faculty experts (who are esteemed clinicians with active practices) for participation in resident training translates to less mentoring and corrective feedback to help new physicians develop diagnostic skills.

Where lack of actual patient cases and decreased exposure to expert thinking threaten clinical trainees' ability to gain mastery of their areas of specialty, patient simulation may help bridge the gaps (Kneebone & Nestel, 2005). Face-to-face exercises with standardized patients (medical actors) and mannequin simulators are now established teaching strategies in both graduate and undergraduate medical education (Accreditation Council for Graduate Medical Education, 2011; Liaison Committee on Medical Education, 2011; Satava, 2009; Taylor & Swing, 2011), as well as in PA programs (Multak, Euliano, Gabrielli, & Layon, 2002) and Nursing (Overstreet, 2008). However, both of these approaches are costly in terms of time and resources, particularly where they incorporate expert feedback. Further, the effectiveness of live, simulation-based exercises in the specific area of diagnostic skills development has not been demonstrated (Graber et al., 2012). Several recent trends have made the *virtual patient* (VP), a web-based, interactive case simulation, a feasible alternative for augmenting residents' (and other clinical decision makers') actual patient case experience. These trends include: the increasing acceptance and validation of online learning in the health sciences (Gyurko & Ullmann, 2012; Norman, 2008a; Ruiz, Mintzer, & Leipzig, 2006; York, Nordengren, & Stumbo, 2009); the maturation of international standards promoting interoperability among digital clinical education modules (MedBiquitous Consortium, 2011); the emergence of a line of research focused on leverage of technologies developed for entertainment (particularly, gaming) in adult learning (Connolly, 2009; Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Dalgarno & Lee, 2010); the recent appearance of integrated, high-fidelity, digital simulation development environments (Games in Education, 2012; Unity, 2015); as well as the availability of low-cost, educator-friendly, lower-fidelity VP authoring systems (Decision Simulation, 2014; Karolinska Institutet, 2011). Research further suggests that VP cases, particularly those that incorporate feedback (Zary, Johnson, & Fors, 2009), may be the learning tools most suited to developing the clinical reasoning skills that underlie and support diagnosis (Cook, Erwin, & Triola, 2010; Cook & Triola, 2009; Saleh, 2010).

Problem Statement

Multiple forces in today's health care environment – systematic, economic, and logistic – fragment clinical trainees' exposure to patient cases (Graber, 2007; Kalra et al., 2010; Steinmann, 2011), slow their development of diagnostic skills, and contribute to the problem of medical errors (Norman & Eva, 2010). Medical schools, residency and analogous clinical training programs need a way to compensate for this fragmentation of experience with patients. Virtual patients (i.e. online, interactive case simulations) offer an approach to rounding out new clinicians' learning that may be both effective (Cook et al., 2010; Cook & Triola, 2009; Saleh, 2010) and efficient (Botezatu, Hult, Tessma, & Fors, 2010) but the theories guiding the design of such instructional interventions are immature. Heuristics have been published for the design of general-use VPs (R. Ellaway & Masters, 2008; Posel, Fleiszer, & Shore, 2009) and a development framework described (Guise, Chambers, Conradi, Kavia, & Välimäki, 2012) but no formal theory has been proposed. Further, most studies have focused on the needs of pre-clinical medical students (Cook et al., 2010) with little exploration of use with trainees in the clinical phase of training who are actively engaged in patient care. The implication of this focus is that exposure to actual patients in the clinical phase of training provides adequate case exposure for refining trainees' diagnostic skills. However changes in the way care is provided in the modern health care environment (e.g. decreased length-of-stay, limited resident duty hours, decreased funding of graduate medical education) suggests that this is not the case. Health professions education research symposia both in the U.S. and Europe have recommended greater exploration of theory conceived outside of health sciences education to advise the development of theory within health sciences professional education (Triola, Huwendiek, Levinson, & Cook, 2012). Goal-based Scenarios, GBS, (Schank, Berman, & Macpherson, 1999) an instructional design theory applied in general education contexts, may provide such a candidate theory for the design of VPs.

Dissertation Goal

The goal was to develop an instructional design theory for VPs, online, interactive patient cases, to be used to foster development of diagnostic/clinical reasoning skills in medical trainees. Diagnostic skills are not usually generalizable across areas of clinical practice (Norman, 2008b), therefore a cross-cutting, multi-disciplinary clinical decision making process, pressure ulcer prevention, diagnosis, and treatment (Armstrong et al., 2008), provided instructional content for the VP around which theory was proposed. Pressure ulcers are a preventable consequence of the immobility that a wide variety of illnesses and disabilities impose on patients. The potentially devastating impact pressure ulcers can have on patient well-being and the cost of care has led to their being termed a “never event” (PSNet, 2013). As of 2008, the Center for Medicare and Medicaid Services stopped reimbursing health care facilities for treatment provided to address pressure ulcers acquired during a patient’s stay (Armstrong et al., 2008). The prevention of pressure ulcers in hospitalized patients is a highly interdisciplinary effort requiring vigilance and communication across the full range of health care professionals who participate in patient care. An existing VP instance, *Matt Lane, A Pressure Ulcer Prevention Virtual Patient*, focusing on developing clinician awareness of the risks to skin integrity people with physical disabilities face during hospitalization, was examined as the point of departure for theory development. Formative research methodology (Reigeluth & An, 2009), a type of case study research, provided the framework for tailoring GBS theory (Schank et al., 1999) to guide the instructional design of VPs.

Research Questions

The following research questions guided the investigation:

1. Which methods GBS theory are present in the *Matt Lane* VP instance and which features of the instance are not accounted for in the theory?
2. What aspects of the VP worked and didn’t work with learners?

3. What refinements should be proposed to GBS theory to extend its usefulness for design of instruction in the clinical context that was the subject of the VP studied and its target learners?

Relevance and Significance

Years after the publication of *To Err is Human: Building a Safer Health System* (Committee on Quality in Health Care in America, 2000), medical errors are still a significant problem in U.S. health care (Levinson, 2010; Liang & Mackey, 2011; Shreve et al., 2010). Errors result from many causes and clinicians' cognitive errors -- erroneous diagnoses, missed, or delayed diagnoses -- figure significantly among them (Berner, 2009; Liang & Mackey, 2011; Newman-Toker & Pronovost, 2009; Singh et al., 2012). Diagnostic errors are particularly prevalent among the mistakes made by new clinicians (Singh et al., 2009). A significant component of improving clinicians' diagnostic/clinical reasoning skills will involve improved instructional methods, both traditional and those leveraging computing technologies (Newman-Toker & Pronovost, 2009). Refining a theory of instructional design to enhance new practitioners' clinical reasoning skills and to help them correctly apply knowledge in patient diagnosis and treatment may have significant implications for improving patient safety and health outcomes.

There is evidence that VPs are effective training tools for clinical reasoning (Botezatu et al., 2010; Cook et al., 2010; Guise et al., 2012; Maldonado, 2011; K. Williams et al., 2011) but theory-based research to guide their design and implementation across medical curricula is lacking (Colloquium on Educational Technology, 2007; Cook et al., 2010; Cook & Triola, 2009; Triola et al., 2012). Advances in computing technologies paired with essentially ubiquitous availability of Internet access (Cook et al., 2008), the proliferation of turn-key development environments (Games in Education, 2012; Unity, 2015), the low-cost availability of authoring tools appropriate to educators without programming skills (Decision Simulation, 2014; Karolinska Institutet, 2011), and the dissemination of standards for reuse and sharing of VP cases (MedBiquitous Consortium, 2011) would seem to open the way to intense experimentation, but the body of published VP research is still small. Recent studies (Botezatu et al., 2010; Maldonado, 2011; K. Williams et al., 2011) confirm the effectiveness of VP implementations in the development of diagnostic reasoning, but none advances an instructional design theory. The medical education research community has repeatedly called for theory-based research on design of computer-assisted instruction (CAI) in general (Colloquium on Educational Technology, 2007; Triola et al., 2012), and on VPs, a type of CAI, in particular (Cook et al., 2010; Cook & Triola, 2009; Poulton & Balasubramaniam, 2011). There is also an interest among medical education researchers to explore instructional theories developed outside of the domain of medicine (Triola et al., 2012). This openness creates potentially important possibilities for sharing of ideas between education research communities that have had surprisingly little exchange of ideas and methods. Understanding how to provide more effective instruction in clinical reasoning holds the promise of training more effective clinicians and reducing medical errors, both toward an end of increasing patient safety and well-being.

Barriers and Issues

Of the 48 total VP studies analyzed by Cook et al. (2010), only 11 described learning interventions involved residents, PA or NP trainees. Of the 3,285 learners described across the 48 studies examined, only a relatively small number, 257, were residents (89), PA students (90) or NP students (78). The majority of VP interventions were carried out with medical students (2,115). The relative paucity of exploration of VPs in residency and advanced clinical practice programs suggests that they may not be perceived as relevant to enhancing learning in individuals who are immersed in actual patient care on a daily basis. This perception might prove a barrier to the implementation of VPs in residencies and advanced practice programs and to recruitment of those individuals for the proposed study.

In contrast to their low use of VPs (Cook et al., 2010), residents have been the principal recipients of hands-on, non-virtual simulation in training. (Cook et al., 2011). In a 2011 systematic review and meta-analysis of technology-enhanced, hands-on simulation, Cook and co-authors reported that 324 of the 609 studies they examined were focused on resident learning. No data were specifically reported for PA or NP trainees. Traditionally, highly realistic, high fidelity, hands-on activities (for instance, practice on cadaver specimens in preparation for surgery on live patients) have been reserved for the later years of training (Wiet et al., 2009). Even though the need to explicitly and exactingly incorporate clinical reasoning skills training in residency curricula is recognized (Bowen, 2006) and VPs have been identified as the candidate best technology for developing clinical reasoning skills, hands-on, simulation training has received significantly more focus among residency programs and VPs have largely been the domain of undergraduate medical education. The perception that high-fidelity, hands-on simulation is more appropriate to residency than lower-fidelity VPs may present a barrier to their implementation in residency training as well as to recruitment in the proposed study.

As Cook et al. (2009) indicated in their mapping of the continuum of clinical competency to a range of learning interventions, clinical reasoning is not the exclusive domain of VPs, though they may be most suited to developing that competency. High-fidelity simulation also supports clinical reasoning as decisions naturally precede actions in carrying out patient care procedures. Perhaps significantly for the uptake of VPs is the hypothesis that learning may be enhanced when high fidelity simulation is preceded by lower fidelity simulation (Alessi, 1988), a relationship consistent with Scaffolding Theory (Yelland & Masters, 2007). A study of 45 medical students demonstrated that those who learned by progressively moving from a low fidelity (VP) simulation to a high fidelity simulation (hybrid standardized patient/mannequin simulator) achieved higher performance than did either the group who trained exclusively in low fidelity or the group who trained exclusively in high fidelity (Brydges, Carnahan, Rose, Rose, & Dubrowski, 2010). Among the studies identified by Cook et al. (2010) involving VPs and residents was one that reported better performance by residents on a mannequin-based anesthesia simulator (high fidelity) when preceded by a screen-based anesthesia simulation (low fidelity, VP) with debriefing (Schwid, Rooke, Michalowski, & Ross, 2001). The current lack of understanding of the interplay of low- and high-fidelity simulation in clinical reasoning training is a barrier to VP use in a medical learning environment, residency, already tuned to high-fidelity simulation.

Residents who have used VPs have rated them as highly satisfactory when compared to no other learning intervention (Boyd et al., 2008; Ferguson II, Kleinert, Lunney, & Campbell, 2006; K. Williams et al., 2011). When a VP intervention was compared to a content-matched standardized patient intervention, however, preclinical (second-year) medical students rated the learning experience more highly than did fourth-year students who had already been exposed to actual patients (Gesundheit et al., 2009). Gesundheit and colleagues caution that VP content should be matched to the level of target learners to maintain interest and challenge. Matching VP content and complexity to the needs of advanced clinical learners may be even more difficult since their experiences diversify as they rotate through different services at different times and are exposed to different real patient cases. The inherent difficulty in meeting the needs of advanced learners who develop different competencies at different times, despite being at the same year of training, presents a further barrier to the proposed study.

Cook et al.'s 2011 study of hand-on simulation revealed not only that residency programs are the most frequent consumers of simulation training but also that simulation training has most frequently occurred (in 564 out of 609 reviewed cases) in a dedicated simulation center. The organization and management of high-fidelity, simulation center-based learning experience is very different from that required to operationalize VPs. A small number of high-fidelity simulators serve a large number of residents who gather in the same location at the same time for learning or assessment. The simulators are typically the responsibility of a distinct staff. Select faculty may be engaged in planning the simulations, but the time commitment for most faculty is typically not significantly greater than that of the residents engaged in practice or skills assessment on the simulators.

In contrast, faculty who are interested in enhancing their curricula with VPs will spend a large amount of time in planning and executing their VP interventions. This constitutes a novel task for most faculty and has been perceived as an inhibitor in at least one study of VPs in graduate medical education (K. Williams et al., 2011). Low-cost, user-friendly authoring systems only partly address the organizational barriers to implementing VPs in clinical training programs. VP pioneers from St. George's University, London (Poulton & Balasubramaniam, 2011) write, "it is likely that in terms of technical development, the next generation of VPs will depend not upon the existing VP development community, but upon groups of bio-scientists and technologists from an entirely different background" (p. 936).

The preceding discussion suggests that the design of instruction during residency, and by extension to PA and NP training programs as well, is in a state of transition. Whereas advances in technology make VPs increasingly more feasible to create and tailor to individual clinical training programs, the workflow required to best leverage this technology has not yet been accommodated in programs' organizational roles or cultural expectations. Integration of experts from disciplines outside of medicine, implicitly biostatisticians, simulation scientists, and instructional designers, into preparation of clinical practitioners may well be the vision of the future, but is not the current state of affairs in graduate medical education or similar advanced clinical training programs. Work done now to a design theory for VPs in advanced clinical training anticipates practical application by persons whose roles have yet to be defined in the graduate medical education hierarchy.

Limitations and Delimitations

Limitations

The following aspects of the study were outside the control of the researcher and may have affected the study results.

- Instructional design theory suitable for developing clinicians' skills in pressure ulcer prevention, diagnosis, and treatment may not generalize to other types of clinical reasoning activity.
- Though clinical trainees were recruited to participate in the study from two distinct geographic areas: Fort Lauderdale, FL (with a focus on Nova

Southeastern University) and the Baltimore-Washington metropolitan area (with a focus on MedStar Health), the characteristics of the clinical practice environments in these areas may not generalize to other areas in the United States or abroad. Additionally, all learners who participated in the study were female.

- Diagnostic skills are built as a result of exposure to many and varied patient cases (Norman, 2005). VPs, as a technology, promise to increase clinician expertise by increasing case exposure. Because it focuses on the experience of single patient, the instance VP around which theory was built cannot demonstrate the effectiveness of VPs in improving pressure ulcer prevention, diagnosis, and management skills globally. It only demonstrates learner perception of the potential of the present instructional strategy.

Delimitations

The following constraints were imposed on the study to focus the scope of research.

- A single testing interaction was carried out on each module (Day 1 and Day 2) of the *Matt Lane* VP. Participants who complete Day 1 were invited to complete the second, Day 2 module.
- Only clinical trainees from the Baltimore-Washington, DC and the Fort Lauderdale, FL, metropolitan areas were recruited to interact with the VP. Purposive sampling was used to explore learner situationalites, for example, experience, education, and clinical domain, but only within the specified geographical constraint and educational programs operating within it.
- Participants were engaged in the study for single sessions of approximately 90 minutes. This delimitation was responsive to time constraints typically

experienced by clinical trainees and the negative impact these constraints impose on clinicians' motivation to participate in research.

Definition of Terms

The following are definitions of terms frequently used in this proposal.

Branching Logic (Design): One of the principal designs of screen-based, low-fidelity VP cases. In the branching logic design, learners choose (within the limits of the system) how they will interact with the virtual patient and can receive immediate feedback on the results of the path they choose (R. H. Ellaway, Poulton, Fors, McGee, & Albright, 2008). Branching logic designs stand in contrast to linear designs where the path of the learner through the intervention is pre-determined.

Clinical/Diagnostic Reasoning: These terms are used interchangeably throughout this proposal. Clinical or diagnostic reasoning is the process by which a clinician develops a hypothesis on what is wrong with a patient and how to treat the patient's problem. It involves both deductive and inductive, analytic and intuitive processes (Croskerry, 2009b), the effective interaction of which has been the subject of much debate (Banning, 2008; Norman, 2009; Norman & Eva, 2010). It is generally agreed that diagnostic skills are dependent on experience with many patient cases and corrective feedback (Norman, 2005).

Formative Research: A type of case study research. It is particularly useful for developing or improving instructional design theory (Reigeluth & Frick, 1999).

Game-based Technology/Learning: Multimedia, 3-D technologies developed for commercial video games. Their use in education has been primarily focused on motivating younger learners. Their appropriate use in adult learning is a current topic of inquiry (Connolly, 2009; Tang, Hanneghan, & El Rhalibi, 2009; Whitton, 2009)

Goal-based Scenarios (GBS): A theory of instructional design based in experiential learning theory (Schank et al., 1999) . GBS and Games-based Learning have many points in common.

Graduate Medical Education: Also known as residency, a period of intense, clinic-based, hands-on learning following medical school (American Medical Association, 2012).

Instructional Design Theory: A type of design theory, characterized as goal-oriented and normative. It works to elucidate preferability in instructional situations (Reigeluth & Carr-Chellman, 2009).

Mixed Methods Research: The use of both qualitative and quantitative methods in a single research study (Gay, Mills, & Airasian, 2009)

QUAL-quan: A technique used in exploratory where findings of an initial qualitative research study are followed up with a quantitative investigation to improve understanding of qualitative data (Gay et al., 2009).

Virtual Patient (VP): "an interactive computer simulation of real-life clinical scenarios for the purpose of healthcare and medical training, education, or assessment" (Ellaway, Candler, Greene, & Smothers, 2006 as cited by Ellaway & Masters, 2008, p. 463).

Chapter 1 Summary

Chapter 1 introduced diagnostic error and the serious problem it poses to the provision of quality health care. It identified pressure ulcer prevention as an area that cuts across medical specialties, offers significant benefits to patient health and well-being, and for which improved instructional methods are needed. Online, interactive VPs offer a promising strategy for increasing new clinicians' exposure to patient cases to help them build expertise. However, no instructional design theory exists to guide VP development to foster clinical reasoning generally or pressure ulcer prevention, diagnosis, and treatment skills specifically.

Chapter one proposed the goal of developing an instructional design theory of VPs in clinical education with diagnosis of pressure ulcer risk, prevention, assessment (if not prevented), and treatment as the content focus. The chapter advanced GBS theory as an appropriate framework for formative research. It proposed three research questions to guide a formative research study on an existing VP instance teaching pressure ulcer prevention, diagnosis, and treatment. The purpose of these questions were: to identify areas where the *Matt Lane* VP embodies GBS principles and where it diverges from them; to investigate what components of GBS work and don’t work with learners in the context of VPs and to recommend improvements to the GBS theory to tailor it to guide the design of VPs.

Chapter one described the relevance and significance of the proposed study in terms of both the impact of missed diagnosis and treatment of pressure ulcers and the interest of the medical education research community in the potential of VPs to extend the training benefits of face-to-face patient encounters. The chapter identified barriers and issues relevant to developing an instructional design theory of VPs and limitations and delimitations of the proposed study. It closed with a list of terms that would be used throughout the report and their definitions.

Chapter 2

Review of the Literature

Introduction

The following review of the literature is organized into four sections. The first section reviews the study of diagnostic skills by identifying the theories and models that describe how diagnostic and clinical reasoning skills develop and the differences between how experts and novices perform a diagnosis. The second section describes strategies that have been used in medical education to help new clinicians develop diagnostic skills. The third section focuses on the use of VPs in clinical instruction and assessment and the designs (e.g. linear, branching, game technology-based) in which VPs have been implemented. The final section examines instructional design theories that offer guidance on VP design.

Diagnostic Skills

The cognitive process by which a physician progresses from novice to expert in clinical reasoning and subsequent diagnosis and treatment of patients has been the subject of research for over 30 years (Schmidt & Rikers, 2007). Traditionally, basic medical science (e.g. anatomy, physiology, pharmacology, etc.) and its clinical application have been taught in separate and to a large extent, mutually isolated, parts of the curriculum. The transfer of didactic (basic science) knowledge to clinical practice was hypothesized to occur by a logico-deductive process and new clinicians' skill in diagnosis would correspond to their skill in this general, deliberate process. It followed, then, that the characteristics of an effective, expert diagnostic process could be defined and taught to medical learners across specialty areas (Norman, 2008a). On the contrary, researchers found that medical experts *encapsulated* basic medical science knowledge into schema or *illness scripts* that they had developed across numerous experiences of interaction with patients in their specific areas of practice (Charlin, Boshuizen, Custers, & Feltovich, 2007; Schmidt & Rikers, 2007). These illness scripts allowed experts to apply the aggregate of their formal and experiential knowledge of illness rapidly and make highly accurate diagnoses. Researchers found that expert diagnosticians differed from novices in how early in the problem-solving process they arrived at a correct diagnosis; early generation of a correct diagnosis also predicted a correct, final conclusion (Norman, 2005). Experts in a field also distinguished themselves from non-experts by recognition of *enabling conditions*, those circumstances surrounding illness (e.g., the fact that the patient had recently returned from travel) that, if recognized, helped a physician zero in on a correct diagnosis (Schmidt & Rikers, 2007). Despite the finding that non-deductive strategies characterize experts' approach to diagnosis, experts still retain the ability to retrieve encapsulated biomedical knowledge (Rikers, Schmidt, & Moulaert, 2005). The more difficult the patient case before them, the more likely experts are to explicitly incorporate logico-deductive reasoning from biomedical knowledge into diagnosis (Patel, Groen, & Arocha, 1990; Stolper et al., 2011). Likewise, though logico-deductive reasoning tends to characterize the diagnoses that new clinicians perform, experiments show that when novices apply the more inductive and intuitive methods of more seasoned clinicians they are not entirely unsuccessful (Ark, Brooks, & Eva, 2006, 2007; Eva, Hatala, LeBlanc, & Brooks, 2007) .

A critique of illness scripts is that the theory does not specifically account for bias that can introduce error into diagnostic thinking (Lubarsky, Charlin, Cook, Chalk, & van der Vleuten, 2011). This same critique may be applied to knowledge encapsulation theory. The subject of bias and heuristics in human decision making was dealt with extensively by Tversky and Kahneman who received a Nobel Prize for their efforts (Croskerry, 2009a). Both biases and heuristics are knowledge organization strategies human beings employ in decision making to manage cognitive overhead (Stolper et al., 2011). It has been noted that use of heuristics to reach a correct diagnosis is called *expertise* whereas the same application of heuristics that turns up an incorrect diagnosis is called *premature closure* (Coderre, Wright, & McLaughlin, 2010).

Using heuristics to form beliefs or make judgments is generally useful but can also lead to severe and systematic errors (Tversky & Kahneman, 1974). Certain biases, for example representativeness, the identification of phenomena with specific categories based on their characteristics but without regard to their underlying prevalence in the population, typify how human beings automate knowledge according to Tversky and Kaheneman, who provide the following, stereotype-driven, example. A man in a given community is characterized as shy and bookish. Is this man more likely to be a librarian or a farmer? According to what Tversky and Kaheneman perceive as widely held stereotypes, most people would say the man in question is more likely to be a librarian without regard to the fact that, in the community in which he lives, 99% of the population is engaged in farming. He is, therefore, much more likely to be a farmer, however well-suited he might otherwise be to working in a library. Attempts have been made to reduce the potential impact of bias in medical diagnosis through promotion of awareness and instruction in Bayesian logic (Fuks, Boudreau, & Cassell, 2009; Kurzenhäuser & Hoffrage, 2002; A. P. Round, 1999).

Dual Process Theory provides a framework for understanding the interplay of encapsulated and explicit biomedical knowledge in diagnosis (Croskerry, 2009a). As described by Croskerry, Dual Process Theory presents a dichotomous view of human cognition that traces its origins in Western thought back to Platonic-Aristotelian tradition. Human decision making takes place along a continuum from the intuitive to the analytical. Two systems of thought processes are associated with each end of the continuum. System 1 thinking is intuitive, employs a heuristic or associative reasoning style, and is characterized by speed, high automaticity, and minimal effort. Analytical or System 2 thinking, on the other hand, uses deductive or normative reasoning and is slow, deliberate, rule-based, and effortful. According to a Universal Model of Diagnostic Reasoning (Croskerry, 2009b) based in Dual Process Theory, the type of processes triggered in diagnosis depends on whether the physician recognizes a pattern in the patient case presentation. Recognition of a pattern allows System 1 processes to take effect. If no pattern is recognized, a physician activates System 2 processes to reach a diagnosis. Observations of reciprocal activation of different substrates of the brain under fMRI (functional magnetic resonance imaging) in response to tasks appropriate to System 1 or System 2 thinking tend to support Dual Process Theory (Lieberman, Jarcho, & Satpute, 2004).

Croskerry's Universal Model is designed to explain how diagnostic skills develop, optimally function, and how diagnostic errors occur (Croskerry, 2009a). The model describes, for example, how System 2 reasoning, practiced repeatedly, might become automated as a System 1 process (2009a, p. 30). Knowledge encapsulation and the formation of illness scripts, phenomena that appear to develop as physicians gain clinical experience, are consistent with such a pattern. Notably the Universal Model does not prefer one system of decision making to another; both diagnostic success and error can originate in either System 1 or System 2 processes and likewise be corrected by either type of process.

Consciously leveraging both types of processes has been shown to improve diagnostic performance in physicians at all levels of expertise

Research in the area of nursing diagnosis and clinical reasoning identifies multiple types of logico-deductive reasoning which it describes under the category of “hypothetico-deductive” (Banning, 2008). The types of reasoning identified in nursing diagnosis and critical thinking are differentiated by: whether the end result is a conclusion/decision (Theoretical Reasoning) or an action (Practical Reasoning); whether a problem is identified along with the factors influencing it and its likely solution (Problematic Reasoning); where reasoning identifies and differentiates among alternatives and viewpoints (Operational Reasoning); where reasoning moves from the specific to the general with generation of statements of purpose (Inductive Reasoning); and where reasoning is holistic (Dialectic Reasoning), where the whole is greater than its parts (p. 178).

According to Banning (2008) the nursing diagnostic thinking literature considers both cognition and metacognition: “thinking about thinking.” Both may be important to the clinical reasoning process as experienced in nursing practice. Citing previous work in the area of care planning (Fowler, 1997), Banning describes a tripartite process of clinical reasoning that incorporates the knowledge and perspectives (experience) of the decision maker, the known evidence relative to the current clinical situation, and the present clinical context into the clinical reasoning process. According to Banning’s research, these processes are theorized to be controlled by a central metacognitive process that mediates the various inputs and helps the nursing practitioner arrive at a clinical conclusion which, in turn, directs action (Pesut & Herman, 1992). This metacognitive step with respect to sense-making within an individual’s hypothetico-deductive (e.g. logico-deductive or System 2) processing has been considered as promising for the reduction of diagnostic error in medicine as well (Graber et al., 2012). Findings of a systematic review of the literature conducted by Graber and colleagues on cognitive interventions to reduce diagnostic error demonstrated that metacognition, in the form of "diagnostic timeout," has been associated with decreased diagnostic error. Graber and colleagues note, however, that the effects of metacognition per se are not distinguishable from the effects of simply having additional time to arrive at a diagnosis. The question (unknown) of how much time is needed initially (e.g. not on reflection) to process a clinical situation and arrive at a diagnosis/care plan is raised in the context of clinical reasoning in nursing as well (C. A. Thompson, Foster, Cole, & Dowding, 2005).

System 1 (automated) cognitive processes find their approximation in the nursing clinical reasoning literature under the term of *intuition*. Banning (2008) traces the origin of exploration of the role of intuition in nursing diagnosis to the early 1980's (Benner, 1984). As in the case of physician practice, intuitive processes characterize the thinking of experts in nursing practice as well (Banning, 2008). Heuristics as defined in the previously described work of Tversky and Kahnemann (1974) have been thought to figure specifically in nurses' "intuitive" reasoning (Simmons, Lanunza, Fonteyn, Hicks, & Holm, 2003).

In the specific content area of pressure ulcers, reasoning about prevention among registered nurses has been characterized by "routine thinking," defined as a lack of cause-effect assertions about patient and system factors influencing the risk of pressure ulcer development (Funkesson, Anbäcken, & Ek, 2007). In a study of clinical reasoning that included both nurses providing direct and continuous patient care and those providing consulting services, Funkesson and colleagues found that more patient contact over time increased the complexity of nurses' reasoning, with direct care nurses engaging in more holistic thinking about patient risk factors.

Whereas there are studies of clinical reasoning (instructional) interventions involving PAs, no specific work exists that examines patterns of thought specific to PA professionals. Notably, a reference work on clinical reasoning in the health professions, now in its third edition, continues to synthesize the cognitive process research for physicians, nurses, physical and occupational therapists, and speech-language pathologists but remains silent with respect to PAs (Higgs, Jones, Loftus, & Christensen, 2008).

Strategies for Teaching Diagnostic Skills

Approaches to teaching diagnostic skills in medicine have evolved along with understanding of the cognitive processes that underlie clinical reasoning. Until the latter half of the 20th century, basic medical science and its clinical application were taught sequentially in isolated phases of medical training. Classical teaching strategies focused principally on lectures and teaching rounds (A. P. Round, 1999). Educators made no explicit effort to help students apply their basic science knowledge to actual patient problems. As students advanced to the clinical stage of training (e.g., the latter years of medical school and continuing into residency) and became involved in direct patient care, training took on the characteristics of apprenticeship (Best, Seibel, & Lyon, 2009). Trainees' growing diagnostic skills were assessed by senior clinicians in the course of rounds on patient units, during attachments to outpatient practices, and by specific examination (Groves, Scott, & Alexander, 2002). No explicit effort was made to help new physicians organize the knowledge they acquired from books and in the laboratory and apply it to understanding their patients' conditions. As characterized by Groves and colleagues, the traditional approach to teaching clinical reasoning was haphazard and heavily dependent “on the nature of the clinical experience and the quality of supervision." (p. 507). Residents were deemed ready for independent practice after they had performed a requisite number of procedures, passed multiple choice written and open-ended oral examinations, and received the subjective appraisal of competence from their program directors (Best et al., 2009).

When nursing first began to emerge as a distinct profession/avocation in the 19th century, immediate access to inexpensive (female) labor to support the operation of hospital wards was a strong driver of approaches to training. Situated learning (Lave & Wenger, 1991), learning in the context of the actual clinical situations in which one provided services, was the norm for training nurses in those early days and devalued vis á vis formal instruction from which nurse trainees were largely barred (Egenes, 2009; Goss, 1990; Grindle & Dallat, 2000; McBride, 1999). Gaining the right to didactic (e.g. lecture-based versus on-the-job-training) instruction was a historically significant milestone in the advancement of the profession of nursing (Egenes, 2009). Further, the appropriate balance of didactic versus service learning in clinical rotations during remains an issue of inquiry into the second decade of the 21st century (Sanfey et al., 2011).

In the late 1960’s, in response to a growing sense of the inadequacy of traditional teaching methods, the School of Medicine at McMaster University (Hamilton, Ontario, Canada) radically modified its curriculum to put patient problems as the center of learning from the very first day of medical school (Butler, Inman, & Lobb, 2005). This approach to physician training became known as problem-based learning (PBL). As conceived and implemented in the program at McMaster, the defining feature of PBL was that problems formed the organizing focus and stimulus for learning and were the vehicle for the development of clinical problem-solving (e.g. reasoning) skills (Barrows, 1996). PBL is an educational philosophy (Butler et al., 2005) with roots in the work of theorists such as Piaget, Dewey, Rogers, Bruner, Ausubel, and Novak that has been widely embraced, though in varying degrees, in medical education over the past 40 years (Gijbels, Dochy, & Segers, 2005). Adoption of PBL curricula was promoted in the U.S. after release of the Report of the Panel on the General Professional Education of the Physician and College Preparation for Medicine, the GREP Report (Barrows, 1996).

Evidence on the effectiveness of instruction grounded in PBL philosophy has been mixed (Butler et al., 2005). A meta-analysis of the effects of problem-based learning showed that students in PBL medical curricula have higher assessment of skills and better retention of knowledge than do students in conventional curricula (Dochy, Segers, Van den Bossche, & Gijbels, 2003). A subsequent meta-analysis found that students in PBL curricula surpassed students in conventional curricula in their ability to understand principles linking concepts and also in their ability to link concepts and principles to conditions and procedures for their application (Gijbels et al., 2005). Both of these meta-analyses, however, have been criticized for not testing for bias toward the target intervention (e.g., PBL curriculum) in the studies examined (Colliver, Kucera, & Verhulst, 2008). Further, an earlier literature review had found that students in PBL curricula employed backward (deductive) reasoning techniques in contrast to the forward (inductive) techniques that characterize expert problem-solving (Albanese & Mitchell, 1993).

A study of student nurses before and after a PBL intervention (Tiwari et al., 2006) showed they had adopted an increasingly deep approach to learning, as measured by the revised two-factor Study Process Questionnaire (R-SPQ-2F) (Biggs, Kember, & Leung, 2001). As reported by Tiwari and colleagues, themes derived from students' focus group reflection on their PBL experience included: motivated to learn; self-direction in learning; active, interactive and student-centered learning; and enjoyment in learning – all supportive of a contention that PBL may support deep learning.

Findings after the first three years of a longitudinal study comparing outcomes of PBL and lecture-based learning (LBL) PA curricula showed no significant differences in standardized test scores in students who had participated in the PBL versus the LBL curriculum (Wardley, Applegate, & Van Rhee, 2006). According to investigators, student performance was measured before beginning either a PBL or LBL, at five, nine, 12, and 24 months into the curriculum and finally, on the Physician Assistant National Certifying Exam and no differences were found at any of these milestones.

Though problem-based learning focuses students' learning around clinical problems, it is not the same as problem-solving (Barrows, 1996). The goal of problem-solving is to find the correct solution; the goal of problem-based learning is to increase understanding (Butler et al., 2005). This distinction may explain the inconclusiveness of evidence for positive effect of PBL curricula on the development of clinical reasoning skills. It may also explain PBL's popularity and uptake in academic (e.g. theoretical vs. applied, professional training) environments outside of medicine despite the fact that medical education was where it originated (p. 175).

Medical educators describing their 20 years' experience in teaching clinical reasoning in the Faculty of Medicine at the University of Leuven, Belgium explicitly distinguish their small-group, problem-solving seminars from PBL (Dequeker & Jaspaert, 1998). The problem-solving seminars at Leuven worked to promote students growth in inductive reasoning skill by offering them holistic patient cases that unfolded as they would in actual clinical situations. The seminars took place in four stages. Students observed a case presentation on video. They formulated a synoptic clinical problem, differential diagnosis, and investigation list. Group members then discussed the case and arrived at a consensus diagnosis, which faculty subsequently confirmed or corrected. Students synthesized data from the presented case in contrast to being given the data already synthesized, as was usual practice in case-based curricula according to Dequeker and Jaspaert, writing from the perspective of the latter decades of the 20th century. In the course of the seminar, students practiced critical thinking and developed fact-finding strategies. They framed the patient problem in medical concepts, considered epidemiologic data and test reliability in making their diagnoses, and weighed risks and benefits in prescribing treatment.

Dequeker and Jaspaert (1998) did not present evidence for the effectiveness of their seminars but noted that student satisfaction was high. A later, similarly constructed, implementation of problem-solving seminars at Leuven, however, showed improvement in seminar participants' scores pre-seminar to post-seminar on the Diagnostic Thinking Inventory (Bordage, Grant, & Marsden, 1990), a validated test designed to measure degree of flexibility in thinking and degree of structuring of knowledge in memory (Beullens, Struyf, & Van Damme, 2006). Most of the components of the Leuven problem-solving seminars as related by Dequeker and Jaspaert have been subject of subsequent instructional investigation, notably, problem formulation and framing in medical concepts, methods for eliciting inductive reasoning, balancing inductive and deductive approaches, and application of Bayesian logic and awareness of sources of bias in diagnostic decision making.

Problem formulation is crucial to correct diagnosis. To formulate a problem, clinicians must recognize the raw evidence presented by patients before them and either fit that evidence into disease schemas they already possess or synthesize new ones (Auclair, 2007). When asked to develop a presentation of the problem from the raw data in a complex case of endocarditis, only 12 out of 32 third-year medical students studied by Auclair could correctly formulate the problem. However, when Auclair provided a second group of third-year students data from the same case already synthesized, 19 out of 25 were able to make a correct diagnosis.

Expert problem representation is characterized by use of semantic qualifiers (SQs), abstractions of raw data gathered in the course of interacting with a patient case (Nendaz & Bordage, 2002). Sixty, second-year medical students participated in eight months of training where they were explicitly taught how to translate findings from encounters with standardized patients (medical actors) into SQs and how to use these abstractions to compare diagnostic hypotheses (Nendaz & Bordage). The intervention increased students' use of SQs in case write-ups and helped them recall findings. Their ability to interpret data and the accuracy of their diagnoses were unaffected, however. Findings suggest that use of SQs may be a result of expertise but not a significant factor in its development.

A study of how residents communicated their clinical reasoning about patient cases to preceptors (clinical faculty) found all parties to the exercise in need of remediation (Papp & Wolpaw, 2010). Internal Medicine residents audio-taped the patient presentations they made to preceptors. Investigators rated participants' presentations using a three-point, *Learner Thinking-Behaviour Scale* to determine whether conversations were conducted 1) at the level of giving facts, 2) explaining assessment or decisions, or 3) exploring uncertainties or difficulties. Findings showed that 80% of presentation time was spent conveying facts and a third of all interactions dealt with facts alone. Preceptors, rated on a similar *Preceptor Thinking-Promotion Scale*, concerned themselves principally with clarifying facts regardless of whether the presenting resident was at the end of training or at the beginning. There was no difference between the mean scores of senior residents and interns (first-year residents) on the *Learner Thinking-Behaviour Scale*.

Dual Process Theory has inspired a series of studies (Ark et al., 2006, 2007; Eva et al., 2007) examining the effect of eliciting both System 1 and System 2 thinking from novices on the accuracy of their diagnoses. In all three experiments cited above, participants were undergraduate psychology students instructed in how to diagnose a variety of cardiac conditions through interpretation of electrocardiogram (ECG) tracings. Non-medical students were specifically recruited to control for the effect of prior knowledge.

In the first study (Ark et al., 2006), students were tested on their diagnostic skill under four conditions. In one condition, students were instructed to use a features first (e.g. logico-deductive, System 2) approach to diagnosis. In a second condition, investigators told students to consider a sense of familiarity (e.g. intuitive, System 1) as they made their diagnoses. The accuracy of diagnoses returned by both of these groups was comparable. A third group of students was implicitly instructed to use a combined (System 1 and System 2) approach to diagnosis and a forth group was given this instruction explicitly. These latter two groups were similar in the accuracy of the diagnoses they made but both outperformed the first two groups.

In a second study of novice ECG diagnosticians (Ark et al., 2007), investigators introduced a technique of instruction that focused on highlighting the contrasting features of otherwise similar ECG tracings. When tested, students instructed to use a blended approach to reasoning and those who had received instruction by contrast performed better than students left to devise their own approach to reasoning and those who had not experienced contrastive instruction. Students who received instruction by contrast did particularly well in diagnosing novel ECGs, ones they had not explicitly seen during prior encounters. They also demonstrated better retention of learning.

In the final study (Eva et al., 2007) distracters were introduced into testing to bias students toward either a correct or incorrect diagnosis. The students who received instruction to use a combined approach to reasoning outperformed those left to select their own approach and the diagnoses of those students who used a combined approach to reasoning were not affected by the biasing information.

Though studies of interpretation of ECGs by naïve diagnosticians (Ark et al., 2006, 2007; Eva et al., 2007) suggest that non-experts may improve the accuracy of their diagnoses by tapping into pattern recognition skills to augment the logico-deductive processes that typify novice clinicians' thinking, querying an initial diagnosis, a logico-deductive process, also appears to improve diagnostic accuracy in beginners (Coderre et al., 2010). First-year medical students were given eight common problems to diagnose and subsequently provided with additional data that was concordant or discordant with that originally presented. When presented with discordant data, students were more likely to change than maintain their initial diagnosis. When presented with concordant data, students typically kept their original evaluation of the case. There was, however, no difference in arriving at a final correct diagnosis between groups receiving subsequent concordant or discordant data. Though a correct and rapid initial diagnosis has been associated with a correct final diagnosis (Norman, 2005), Coderre and colleagues suggest that this relationship may not exist in the case of novice clinicians.

Explicit teaching of cognitive biases and Bayes Theorem to 4th year medical students in a traditional (non PBL) medical school curriculum (A. P. Round, 1999) improved their scores on the validated *Diagnostic Thinking Inventory* (Bordage et al., 1990). The intervention was composed of clinical scenarios illustrating several cognitive biases that may occur in medicine and the application of Bayes Theorem to demonstrate the errors they may cause. Round tested for a cohort effect and found that the difference between the scores of more senior students and more junior students was not significant.

A technique called the Background Knowledge Probe (BKP) was used to integrate statistical understanding into an evidence-based practice curriculum for first year PA students (Howlett & Phelps, 2006). BKP is a group participatory, classroom-based approach that involves presenting a case and eliciting students' assessment of probabilities based on their current understanding. As described by Howlett and Phelps, the technique iteratively uncovered the range of understanding possessed by the students' over the course of the one-year implementation as well as their errors and biases in critical thinking. Students showed improvement from the first to second semesters and positively appraised BKP as an approach to activating prior learning and promote engagement.

A unifying characteristic of the clinical reasoning interventions just described is that they are case-based and specific. According to Fuks et al. (2009), clinical reasoning has to be imparted with content otherwise it is not memorable: Medicine is "the art of individualizing, and natural science, the art of generalizing" (p. 108). Given that exemplar cases are essential to the process of developing clinical skills (Norman, 2008a), medical educators have long sought ways to increase trainees' exposure to a rich variety of patient cases (Satava, 2009; Tworek et al., 2010). Barrows (1996), writing in the context of PBL, suggested various strategies educators could use: written cases and case vignettes but also standardized patients, video, and computer simulation. Technological advances since the time of Barrows' writing, particularly the rise of the Internet, have made computer simulation of patient cases an increasingly more feasible and flexible option for enhancing student learning experiences and filling the gaps in medical (Bateman & Davies, 2011; Cook & Triola, 2009; K. Williams et al., 2011) and nursing (Brown, 2008; Cioffi, 2001) curricula.

An Agency for Healthcare Research and Quality-sponsored review of the literature between 2000 and 2009 (Graber et al., 2012; Singh et al., 2012) uncovered empirical studies of 42 cognitive interventions (Graber et al., 2012) that were aimed at reducing the likelihood of medical errors. Reviewers rated the level of impact of each reported intervention on reducing diagnostic error and on how well the evidence presented for each intervention supported conclusions. The best evidence was found for focused training in specific clinical content areas, radiology and psychology, in the studies reviewed. Interventions providing intensive, detailed and specific feedback also resulted in decreased diagnostic error in experimental cases in these disciplines. Authors noted that deliberate feedback is a technique widely used outside of medicine to improve both individual and team performance. Second opinion reviews, a similar technique that provides confirmation or correction of an original diagnosis, was likewise found effective in increasing diagnostic accuracy in radiology and, to a lesser extent, in pathology. Graber et al. did not find strong evidence that simulation lab interventions resulted in changes in diagnostic skill since outcome measures were participant perspective and non-objective.

Virtual Patients in Clinical Instruction and Assessment

A computer simulation of a patient case has come to be known as a "virtual patient." In more comprehensive terms, a virtual patient (VP) is "an interactive computer simulation of real-life clinical scenarios for the purpose of healthcare and medical training, education, or assessment" (Ellaway, Candler, Greene, & Smothers, 2006 as cited by Ellaway & Masters, 2008, p. 463). Through interacting with VPs, "learners emulate the roles of health care providers to obtain a history, conduct a physical exam, and make diagnostic and therapeutic decisions" (Colloquium on Educational Technology, 2007, p. 7). An important characteristic of VPs is that they are screen-based simulations that can be delivered wherever/whenever a learner has the appropriate computer connection. This characteristic distinguishes VPs from other simulations of patient interactions, such as standardized patients and mannequin simulators, which require learners to be present at a specific time and location to engage in learning/assessment with simulated patient cases. Though certain implementations may employ sophisticated interactive techniques such as haptic and natural language interfaces, these features are extraneous to the genre (Cook et al., 2010) and may, in fact, introduce *extraneous cognitive load* (Paas, Renkl, & Sweller, 2003), a factor in information processing that detracts from learning (Cook & Triola, 2009). Research in domains outside of medicine suggests that learner expertise and fidelity in multimedia representations of subject matter are inversely correlated: the more expert the learner, the less benefit s/he derives from highly realistic presentations of material to be learned (S. Kalyuga, Ayres, Chandler, & Chandler, 2003).

Contemporary VPs generally follow either linear or branching logic designs and may be used for both group and individual learning (R. H. Ellaway et al., 2008). In the linear design, learners interact with the virtual patient in a pre-determined sequence: They take a history, perform a physical exam, order tests, provide a diagnosis, and recommend treatment. In the branching logic design, learners choose (within the limits of the system) how they will interact with the virtual patient and can receive immediate feedback on the results of the path they choose (R. H. Ellaway et al., 2008). Though hypertext, technically, is used to create the learner path in all online applications the branching logic VP design has more in common with the hypertext literary genre (Wardrip-Fruin & Harrigan, 2004) largely because of its reliance on the quality of narrative (Decision Simulation, 2014) to create impact and enhance memorability.

VPs are one among many instructional techniques (computer-assisted and traditional) available to target clinicians' development across the range of clinical skills (Triola et al., 2012). Cook and Triola (2009) propose a continuum of competency development where, for example, small group and computer-assisted instruction target core knowledge, standardized patients (medical actors) help learners improve history-taking skills, and mannequin simulators allow safe practice of high-risk procedural skills.

Evidence from the cognitive science literature presented in the previous section of this review points to the importance of exposure to many and varied patient cases, practice, and timely expert feedback in the development of expertise in clinical reasoning and diagnostic skills. Taking this body of evidence into account, Cook and Triola (2009) hypothesized that virtual patients would be well-suited to developing competency in clinical reasoning skills. Despite the intuitiveness of this conclusion, the authors' subsequent systematic review and meta-analysis exploring the effect of virtual patients in health professions training was inconclusive (Cook et al., 2010). They recommended further theory-based comparison between different VP designs and rigorous qualitative studies.

Cook and colleagues analyzed studies from the 1960's, the earliest reports of VPs in the literature, through 2009 and found that VPs were associated with large positive effects in the area of knowledge outcomes, clinical reasoning, and other skills when compared with no intervention but that their effects were, on the average, small when compared to non-computer interventions. In keeping with the cognitive science literature, VP designs that accommodated repetition until demonstration of mastery, enhanced feedback, advance organizers (comparable to the effectiveness of explicit teaching of cognitive bias described by Round, 1999), and explicit contrast of cases were most effective (Cook et al., 2010).

Of the seven studies selected for review by Cook et al. (2010) that involved residents, only one dealt with clinical reasoning: a VP designed to teach lung cancer management to internal medicine residents (Garrett & Ashford, 1986). The system presented a scenario and then queried learners for next steps. Learners could pick from an option list with more than one right answer. Correctness was determined by concordance with subject matter experts. All but two residents showed improved clinical reasoning skills from pre- to posttest.

Two studies reviewed by Cook et al. (2010) focused on NP students (Sanders et al., 2007; Schleutermann, Holzemer, & Farrand, 1983) and two focused on PA students (Boyd et al., 2008; Kleinert, Fisher, Sanders, & Boyd, 2007). Three of the four VPs described in these studies dealt with the topic of developmental disabilities and used a linear VP design. One, an ambulatory medicine VP targeting NP students, employed branching logic. Knowledge, skills, and satisfaction with the learning intervention were outcomes measured by these VPs; none focused on clinical reasoning.

A criticism of Cook et al.'s 2010 review and analysis was that older interventions and those dating from more recent years are not really comparable since older VP implementations were hampered by limited or no Internet connectivity, lack of low-cost, clinician-friendly authoring systems, and lack of standards to promote sharing and re-use of VP cases (Bateman & Davies, 2011). Bateman and Davies echoed the call from Cook and colleagues, however, for theory-based research into design of VP interventions in the "new era." (p. 151).

The high development costs and long development timelines associated with VPs have been disincentives to their use (Huang, Reynolds, & Candler, 2007). Huang and colleagues surveyed U.S. and Canadian medical schools from February to September of 2005 and, of the 26 institutions using VP cases, 85% reported that their VPs cost more than $10,000 to produce and 26% reported costs exceeding $50,000. Of the VPs described to Huang and colleagues, 61% took more than six months to produce and the average production time reported was 16.6 months.

In the years that have elapsed since Huang and colleagues' survey (2005), the barriers of cost and time have abated considerably with the appearance of low-cost, integrated simulation development environments such as Unity3D (2013) and the development and dissemination of educator-friendly authoring tools such as Web-SP (Karolinska Institutet, 2011) and DecisionSim™ (Decision Simulation, 2014). In the present health and clinical education environment however, software products, such as Unity3D, that have grown out of the gaming entertainment industry are more often associated with "serious" games than with VPs. The term "game" is broad (Salen & Zimmerman, 2006; Sawyer & Smith, 2008; Tang et al., 2009) and the definition of a VP (Ellaway, Candler, Greene, & Smothers, 2006 as cited by Ellaway & Masters, 2008, p. 463), particularly given its “online” and “role playing” descriptors, fits well within it. However serious games and VPs have different literatures and may be seen, as least for the present, as different genres within health education. Game development platforms such as Unity3D, though their cost to license is small, still require considerable technical acumen, both in terms of programming and artistic skills, to use to create VP scenarios. The need to acquire these technical skill sets makes game technology-based VPs less accessible to clinical educators who might like to explore their capabilities. Products such as Web-SP and DecisionSim™, however, allow educators without programming or graphical design expertise to directly create VP cases and the licensing of these authoring systems is comparable to that of the more demanding game technology environments.

Though the cost of the development platform itself was not reported, implementation of a hybrid VP-paper case PBL learning module in a program to train physician assistants resulted in a 40% savings in faculty facilitator time with a projected potential savings of 92% were VPs to replace paper cases entirely (Maldonado, 2011). It is noteworthy, however, that when VP authoring presented a task that increased the time residency program faculty were involved in training, a VP that was highly rated by residents and took faculty as little as four hours to create was received with reservation (K. Williams et al., 2011). These findings may point to inherent differences in the expectations of undergraduate and graduate medical faculty for how they will be involved in teaching and design of instruction. As Poulton and Balasubramaniam (2011) point out, optimal integration of technology into clinical learning is likely to require skills that augment the subject matter and teaching expertise of the current faculty. The simplicity of a VP development platform, therefore, does not guarantee that it can be effectively leveraged by current clinical programs without reconsideration of instructional design roles and production workflow.

Comparison of Game Technology-based and Hypertext Branching Logic VPs

The learner experience of hypertext/branching logic VPs differs from that of game technology-based VPs principally in the explicitness of choices offered for caring for the patient and in the level of immersion, as well as freedom, the learner may feel in the clinical scenario. Decision Simulation characterizes its product as a purveyor of narrative learning and notes that the power of the experience it can deliver lies in the ability of the author to craft a good story.(Decision Simulation, 2014). This stance is consistent with the view that links hypertext strongly with authorship (Wardrip-Fruin & Harrigan, 2004) rather than with emergence (which embodies the notion of player freedom of movement) that is more characteristic of game environments (Jenkins, 1998).

Though hypertext VPs can incorporate a variety of media, including video and animations, branches (decisions) take the form of explicit, text-based alternatives. This explicitness contrasts a more implicit exposition of choices available in game technology-based clinical scenarios. For example, in a game technology-based patient scenario, the sight of a monitor at bedside might prompt the learner to check the patient's vital signs just as might occur in real life. A hypertext/branching logic VP imposes greater distance between the learner and the scenario by making him or her explicitly consider taking the patient's vitals by selecting that action from a list of options. This is not necessarily an inferior approach, however, since there may be learning value in the critical distance that hypertext/branching logic, as a narrative form, provides in contrast to the more immersive exposition of scenarios that game technology facilitates (Frasca, 2004). It has been noted in the context of examining the clinical reasoning process that using standardized, written or orally presented patient cases may artificially reduce task complexity because such case presentations remove the naturalistic influences of the senses, real time, and an actual clinical environment on information gathering and decision making (Funkesson et al., 2007). Similar limitations on case complexity, rooted in the same causes, would seemingly be lessened in online case scenarios, perhaps more so in game technology-based scenarios versus hypertext branching logic scenarios. The degree to which these factors impact VP design preferences is an anticipated finding of the proposed study.

Previously, lack of standardization of hypertext VPs was a barrier to sharing them across programs and fostering economies of reuse (R. H. Ellaway et al., 2008; Fors, Muntean, Botezatu, & Zary, 2009). The development of VP standards such as ANSI/MEDBIQ VP.10.1-2010 (MedBiquitous Consortium, 2011), a proposed *VP Commons* case library (Ellaway et al., 2008), and a recently completed project in the European Union (EU), e-ViP, has succeeded in standardizing hypertext VP cases produced by the various participating countries and making them available to EU medical educators (eViP, 2012).

Studies Following Cook et al.'s 2010 Landmark Review of VPs

A search of the literature since the publication of Cook et al.'s review and meta-analysis in 2010 turned up several empirical studies of the effectiveness of virtual patients in the development of clinical reasoning. Maldonado (2011) found that the clinical reasoning scores of 80 physician assistant trainees in a problem-based learning curriculum were 12% higher in a cohort that learned using commercial, multimedia clinical case scenario software (e.g. a VP created through DxR Clinician http://www.dxrgroup.com/clinician/) than were those of a cohort that learned using a text-based patient case. The validity of the scales used to measure diagnostic reasoning in DxR Clinician, the clinical reasoning score (CRS) and level of diagnostic performance (LDP), has been questioned, however (Jerant & Azari, 2004). Jerant and Azari found no strong correlation between the DxR Clinician measurements (as the product was marketed at the time of their study) and the validated *Diagnostic Thinking Inventory*, DTI (Bordage et al., 1990). The scores of trainees in the study reported by Maldonado (2011) were validated based on comparison to a written justification of diagnosis completed by both cohorts. However, Maldonado did not administer a validated instrument, such as the DTI, to provide further credibility to her trainees' DxR Clinician scores.

First clinical year (year 4 of 6) students in internal medicine studied hematology and cardiology randomized to cohorts using lectures, linear VP cases created in Web-SP, or combinations of both. (Botezatu et al., 2010). Investigators developed a scoring rubric to measure clinical reasoning in students' diagnostic and therapeutic decisions. The rubric was internally validated by the medical school's faculty through a study of inter-rater variability (e.g. inter-rater reliability) according to usual practice. The rubric, along with the test of knowledge customarily administered to students in cardiology and hematology, was administered to all treatment groups. During the first three of the four terms during which investigators conducted the study, students who learned with the VPs scored higher on both the clinical reasoning rubric and the knowledge test than did students who has not used the VPs. During the fourth term, investigators used a paired design where students served as their own controls. The scores of this cohort were similar to those of the control groups of the previous terms. Investigators cite the nature of paired design and administrative turnover at the medical school as a possible explanation for the lower-than-expected results.

Psychiatry residency program faculty created VP cases from the Web-SP Healthy Patient template (Karolinska Institutet, 2011) to address the ACGME competencies of medical knowledge, practice-based learning, and systems-based practice in psychiatry (K. Williams et al., 2011). Cases were independently reviewed for accuracy of the presumptive diagnosis. Ten residents in PGY1-4 (e.g., all four years of psychiatric residency) interacted with the VPs at the rate of one new case per week. They asked the VPs questions from a pre-defined question bank, ordered tests, provided a differential diagnosis, and prescribed treatment. Faculty reviewed the residents' interactions with the VPs, evaluated each resident's clinical reasoning individually, and provided feedback. Faculty found the tool efficient for assessing residents' knowledge as well as the quality of their diagnostic and treatment decision-making. Residents rated the VP useful for both learning and assessment.

Two narrative VPs were created as part of a multi-lingual e-learning course for European mental health nurses (Guise et al., 2012). Content aimed at teaching clinical decisions making based on non-coercive, ethical, and therapeutically effective approaches to dealing with patients with mental illness. The VPs and e-learning course were tested by 90 experts, experienced mental health nurses and nurse educators in six European countries, for content validity and usability. Revisions were made and the final VPs piloted with student nurses in the United Kingdom and Finland and positively received. The study is still in progress and final outcomes pending.

In summation, there is evidence that VPs, operationally defined as online, interactive, narrative patient cases for learning or assessment, can be effective tools for developing clinical reasoning (Botezatu et al., 2010; Cook et al., 2010; Maldonado, 2011; K. Williams et al., 2011). Cost and complexity of development have decreased significantly (Decision

Simulation, 2014; Karolinska Institutet, 2011; Unity, 2015), and standardization of hypertext-based products has opened the way to reuse of cases and sharing across institutions (MedBiquitous Consortium, 2011). However, the theory-driven studies of design and implementation in curricula called for in the literature (Cook et al., 2010; Cook & Triola, 2009; Triola et al., 2012) have not materialized.

Instructional Design Theory Guiding VP Design

The call for theory-based research on VP design and implementation echoes continually through the VP literature (Colloquium on Educational Technology, 2007; Cook et al., 2010; Cook & Triola, 2009; Triola et al., 2012). Among the themes identified across symposia conducted at the annual meetings of the American Association of Medical Colleges and the Association for Medical Education in Europe (AMEE) was the idea that computer-assisted instruction in medicine could benefit from application of educational theories originating both inside and outside of medical education (Triola et al., 2012). AMEE, further, has produced a guide to integrating theory and practice in medical education using a design-based research approach (Dolmans & Tigelaar, 2012). Though the general education literature has long identified research in instruction with the methods of design science (Lindsey & Berger, 2009), this perspective is novel in medical education.

An extensive systematic review and meta-analysis of the literature has provided recommendations for VP design based on relatively small effect sizes when compared to other interventions (Cook et al., 2010). Other authors have described development frameworks (Guise et al., 2012) and published heuristics for VP case authoring (R. H. Ellaway & Davies, 2011; Posel et al., 2009). No formal instructional design theory has been proposed, however, for developing VPs to optimize effectiveness in their identified best use: teaching clinical reasoning and diagnostic skills.

Among the theories recommended for exploration by Cook et al. (2010) are the theory of multimedia learning (Mayer, 2005), analytic and nonanalytic reasoning (Ark et al., 2006, 2007; Eva et al., 2007), deliberate practice (Ericsson, 2004), and formative feedback (van de Ridder, Stokking, McGaghie, & ten Cate, 2008). Each of these cognitive theories serves as a guide to aspects of the VP experience that are likely to result in positive learning outcomes. None, however, provides instructional design theory for creating VPs. Two defining characteristics of VPs are that they are problem-oriented (patient condition) and goal-based (diagnosis or treatment). The Goal-Based Scenarios (GBS) theory of instructional design (Schank et al., 1999), therefore, may be a more comprehensive choice for initiating research to develop a theory to optimize VP design for teaching clinical reasoning. GBS design theory is grounded in the descriptive theory of case-based reasoning (Schank et al., 1999). This orientation suggests GBS as a particularly suitable point of departure for developing a design theory for VPs which are, before all else, case instances. The GBS theoretical framework has seven essential components: goals, mission, cover story (background), role, scenario, resources, and feedback (Schank et al., 1999). These components correspond closely to those previously described as defining of VPs (Ellaway, Candler, Greene, & Smothers, 2006 as cited by Ellaway & Masters, 2008, p. 463; Colloquium on Educational Technology, 2007) or prescriptive for best practice in VP design (R. Ellaway & Masters, 2008; Posel et al., 2009). That GBS is likely to be a promising framework for VP is underscored by its identification of feedback as a core component. Studies have consistently pointed to feedback as essential to the effectiveness of learning through VPs (Cook et al., 2010; R. Ellaway & Masters, 2008; Elstein, 2009; Satava, 2009; van de Ridder et al., 2008; K. Williams et al., 2011; Zary et al., 2009).

Leaders in health sciences education have called for increased cross-disciplinary exploration of the usefulness of theory developed outside of medicine to enhance learning within the clinical sciences (Triola et al., 2012). GBS fits this description well. It is a generalized theory of instruction that originated not only outside of health sciences education but outside of human education entirely in the area of machine learning (Schank, 1999). GBS, further, has received little attention in its own right (Hsu & Moore, 2011). Though the VP has not yet been explicitly identified in the health sciences education literature as a type of goal-based scenario, Schank, the principal author of GBS theory, has explicitly described the GBS framework as being appropriate to the development of diagnostic skills, the educational niche so frequently prescribed for virtual patients (Schank, 2010). It is worth noting that the concept of “illness scripts,” the descriptive theory used to explain the cognitive process underlying the development of clinical expertise, also originated in the work of Schank (Schank & Abelson, 1977) and proved highly relevant to medical education researchers (Charlin et al., 2007) .

Chapter 2 Summary

Chapter 2 provided a review of the literature in four areas relevant to developing an instructional design theory of VPs for teaching diagnostic/clinical reasoning: the cognitive processes underlying clinical reasoning and development of diagnoses, current and historical approaches to teaching clinical reasoning in the health sciences, the types of VPs that have been developed and their effectiveness, and instructional design theory relevant to VP design. Researchers agree that clinical reasoning expertise develops through exposure to many and varied patient cases and draws on both deliberate (logico/hypothetico-deductive) and automated or intuitive processes and that the thinking of experts is characterized by a higher degree of automated thinking than is that of novices. This duality in the cognitive processes underlying diagnostic reasoning is mirrored in the approaches that have been taken to teach it. Problem or case-based learning, PBL, is a technique now well-established in health sciences education once dominated by the lecture approach to instruction. PBL is generally preferred by learners over traditional, didactic, lecture-based instruction, but measurement of its effect on learning outcomes has been challenging. Research that PBL is not *inferior* to traditional methods is persuasive.

VPs, as online, interactive patient cases, fit within the PBL approach to curriculum development. They promise to increase learners' exposure to a variety of patient cases and aid maturation of clinical reasoning skills. Increasing availability of user-friendly, low-cost authoring/development technology has made VPs increasingly feasible, particularly VPs of the hypertext narrative genre. Like other PBL interventions, the effect size of VPs on clinical reasoning skills acquisition is small. There is a need for theory-based research on VP instructional design. GBS is a promising theory for extension to VP design.

Chapter 3

Methodology

The goal of the study was to use formative research to extend GBS Theory to provide guidance on the design and use of VPs to develop clinical reasoning skills in novice practitioners. The section that follows describes the formative research process.

Introduction to Formative Research

Formative research is a case-based, design research method that works to create knowledge in three areas: how to improve a given instance of instruction, e.g. an instructional product; how to improve the instructional design theory that underlies the product, and how to refine the descriptive theories of learning that, in turn, inform that theory of instructional design (Reigeluth & An, 2009). Instructional theories prescribe specific methods for use in specific instructional situations, though at varying levels of precision. A theory may become more precise as research yields greater understanding as to how its various "parts" are best applied in instructional situations to bring about desired learning objectives (Lindsey & Berger, 2009).

Formative research is a methodology appropriate for generating knowledge on how to make instructional theories more precise (Reigeluth & Carr-Chellman, 2009) and hence was selected to tailor and elaborate GBS theory to guide VP design. As originally described by Reigeluth and Frick (1999) in the context of instructional design, the general method of conducting formative research involves identifying a theory, selecting or creating a case of instruction that uses the methods prescribed by that theory, and examining, through observations, documents, and interviews, the degree to which the methods of the theory and the instance match and the degree to which those methods work or don't work with learners. The expectation of using formative research to improve or create a design theory is that understanding how an instance of the theory can be improved will also demonstrate how the theory itself can be improved by adding refinements that are appropriate to specific learners and situations (Reigeluth & Carr-Chellman, 2009; Reigeluth & Frick, 1999).

The approach to conducting a formative research study differs depending on whether the goal of research is to improve an existing theory or to develop a new theory and whether the case around which the study will focus is an existing instance of instruction or an instance that has yet to be designed (Reigeluth & An, 2009; Reigeluth & Carr-Chellman, 2009; Reigeluth & Frick, 1999). The goal of the current study is to articulate an instructional design theory to guide the development of VPs. No such theory is formally defined and the lack impedes the most constructive use of VPs in clinical education (Colloquium on Educational Technology, 2007; Cook, et al., 2010; Cook & Triola, 2009; Triola, et al., 2012). Though VP development heuristics (R. H. Ellaway & Davies, 2011; Posel et al., 2009) do not acknowledge the influence of GBS theory (Schank, 2010; Schank et al., 1999) in their conceptual framework, they share many criteria of design in common with GBS. Most significant among these common criteria is the importance of learning through applying knowledge in true-to-life scenarios and providing the learner feedback on decisions he or she has made in the context of those scenarios. Therefore, the present study has taken as its focus extending and *improving* GBS theory as it specifically relates to VP cases modeled on clinical evidence and reflecting authentic experiences of providing (clinicians) and receiving (patients) care.

The instructional instance that was chosen for research on refinement of GBS theory to support VP case design was *Matt Lane*, *a Pressure Ulcer Prevention Virtual Patient*. Prior to receiving approval to conduct the current study, the researcher developed *Matt Lane* using the DecisionSim™ (Decision Simulation, 2014) hypertext/branching logic virtual patient authoring platform, applying industry design heuristics (Decision Simulation, 2014; Posel et al., 2009), and leveraging the rich video resources made available by a real patient that documented of his experiences as a patient in a rehabilitation hospital. Subsequent examination of the *Matt Lane* VP demonstrated that it broadly incorporated the methods prescribed by GBS theory. Given these circumstances, *in vivo naturalistic case* methods of formative research were appropriate for this study (Reigeluth & An, 2009). The three defining questions of naturalistic case formative research, as prescribed by Reigeluth and An (2009), provided the framework for the three research questions proposed in Chapter One to guide the tailoring of GBS theory to the requirements of VP design. Generally defined, these questions work to:

1. Examine the extent to which elements of the theory under investigation are actually present in the designed instance of instruction and which features of the instance are not accounted for in the theory;
2. Analyze what aspects of the instructional instance worked and didn't work with learners;
3. Propose refinements to the theory to extend its usefulness for design of instruction in the clinical context that was the subject of the VP studied and its target learners.

Application of Formative Research Methods in the Virtual Patient Study

Formative research, as a type of case study research, is a predominately *qualitative* method. Qualitative research tends to use the term “trustworthiness” where quantitative research uses the word “rigor” (Morse, Barrett, Mayan, Olson, & Spiers, 2002) in the evaluation of research design and outcomes. The terms are not unrelated; the rigor of the research process is essential to producing trustworthy findings in both qualitative and quantitative research (Krefting, 1991). However, the distinction is more than semantic. Because of the different philosophies and theoretical perspectives that underlie them, the criteria for assessing rigor, and hence trustworthiness, in qualitative and quantitative research designs are also different. The seminal framework for defining standards of rigor in qualitative research was developed by Guba in 1981 (Morse et al., 2002). Trustworthiness of research depends of four factors: truth value, applicability, consistency, and neutrality (Guba, 1981). How these factors are evaluated, however, depends on the differing goals and perspectives reflected in qualitative and quantitative research.

Table 1

Criteria for Establishing Trustworthiness in Qualitative versus Quantitative Research.
(Adapted from Krefting, 1991, p. 217)

Factors in Research Trustworthiness	**Quantitative Criteria**	**Qualitative Criteria**
Truth value	Internal validity	Credibility
Applicability	External validity	Transferability
Consistency	Reliability	Dependability
Neutrality	Objectivity	Confirmability

Table 1, adapted from Krefting’s exposition of the work of Guba, shows the difference in criteria by which rigor, trustworthiness, may be advanced in qualitative versus quantitative research designs. Reigeluth and Frick (1999) place particular emphasis on truth value, credibility, in formative research. The fundamental truth that must be established in doing formative research on an existing design theory is that the "theoretical construct," the set of methods that compose the theory, are correctly identified, without omission or inclusion of methods that are not part of the theory. Reigeluth and Frick (1999) advocate explicit disclosure of the researcher's own assumptions, biases, and theoretical perspectives throughout the formative research process. The researcher's disclosure is provided in Appendix A.

Reigeluth and Frick (1999) also advocated expert evaluation as a strategy to verify the accuracy of representation of methods of existing theories of instructional design. Expert evaluation finds no mention in his 2009 work with An, however. In this later work, the concept of "boundaries" comes to the fore: the explicit definition of which methods and situations are part of (or not part of) the theory under investigation. Reigeluth and An extend the step of defining boundaries to instructional design research generally, not only to formative research methods. The purpose of the first two research questions of the proposed study is to identify boundaries: which methods of GBS theory are part of or not part of the *Matt Lane* VP and which methods used in *Matt Lane* work and don't work with target learners.

Incorporating explicit verification practices into the research design to continually monitor how a study is addressing its research goals enhances trustworthiness and mitigates the risk of rejection of a study's findings (Morse et al., 2002). Qualitative methods employ an "emergent" approach, with data collection and analysis taking place concurrently and continuing until "saturation," no new information is revealed (Creswell, 2007; Reigeluth &

An, 2009; Reigeluth & Frick, 1999; Small, 2009). According to Morse et al. (2002), this iterative, “mutual interaction between what is known and what one needs to know” (p. 12) is one of the key determinants of validity and reliability[1] in qualitative research. Reigeluth and Frick (1999) associate it with thoroughness, a concept also related to both credibility and dependability. Because emergence is non-linear, Morse et al. advocate a specific aim (a term reminiscent of quantitative approaches) of “methodological coherence” in study designs. The function of methodological coherence is to continually bring the researcher back to the question or questions guiding the study and recognizing how the emerging data may require modification of collection methods or the questions themselves.

A QUAL-quan Approach

Formative research employs methods that are principally qualitative in character: inductive, sensitive to context, process-oriented, and focused on deep understanding of the topic of study (Fraenkel, Wallen, & Hyun, 2012). However objective data gathered by quantitative techniques may also be useful in describing the methods of an instructional design theory, particularly in terms of their effectiveness, efficiency, and appeal (Reigeluth & Frick, 1999). Further, a multi-method approach may improve the representativeness of the findings of research (M. Williams, 2000). Therefore to enhance rigor, a mixed methods, *QUAL-quan*, approach where quantitative data help interpret qualitative findings was chosen to support to process of developing a theory of VP design.

Observations of learners interacting with *Matt Lane* and semi-structured interviews with learners about their experiences with the VP provided the principal sources of

[1] Morse and colleagues, though appreciative of the Guba (1991) framework, disfavor abandoning the terms “validity” and “reliability” in qualitative research.

qualitative data in the study. Quantitative data, e.g. characteristics of learners captured through surveys, prior education and experience, VP technology acceptance as rated on a validated scale (Chin, Johnson, & Schwarz, 2008), and machine-captured data such as learner time-on-task in *Matt Lane* scenarios, helped the researcher interpret qualitative data. This QUAL-quan approach was appropriate to the exploratory (as opposed to confirmatory) objectives of the study (Gay et al., 2009).

Even though improving diagnostic/clinical reasoning is the putative niche of VP interventions (Cook et al., 2010; Cook & Triola, 2009), it was not expected that *Matt Lane* would have a measurable effect on participants' pre-/post reasoning skills. Therefore the extensive testing required to measure global diagnostic/clinical reasoning skills before and after learners interacted with the *Matt Lane* VP was not undertaken. Validated instruments that measure change in diagnostic/clinical reasoning, such as the Diagnostic Thinking Inventory (Bordage et al., 1990) or Clinical Reasoning (Groves et al., 2002), do so across long developmental timeframes: years of study or experience not as an outcome of a single instructional intervention. Diagnostic/clinical reasoning skills develop through experience with many and varied patient cases (Norman, 2005) and can be enhanced through deliberative metacognitive strategies, both logico/hypothetico-deductive (Croskerry, 2009a) as well as socio-interactive (Higgs et al., 2008). The focus of the study was to generate an initial theory of how VP technology should be used to create teaching cases that simulate, and provide an experiential learning benefit comparable to, actual patient cases. Theory may include methods that build metacognitive skills as well. Therefore learners' observed interaction with *Matt Lane* and their feedback on individual methods of the theory (GBS) that worked or didn't work to enhance the VP instance provided the primary qualifiers of the intervention's effectiveness, efficiency, and appeal. Individual differences among learners (e.g. education, clinical experience, level of comfort with technology) helped interpret the observational and reflective data.

Description of GBS Theory

The goal of GBS theory is "to foster skill development and the learning of factual material in the context of how it will be used" (Schank et al., 1999, p. 163). GBS was recommended by its principal author (Schank, 2010), as a suitable basis for developing medical diagnostic skills, of which pressure ulcer risk identification, the central learning theme of *Matt Lane*, is an example. However, to the knowledge of this researcher, no attempt has yet been made to test GBS theory in teaching clinical reasoning skills.

The GBS theory of instructional design is grounded in the descriptive theories of experiential (Kolb & Fry, 1975; Lindsey & Berger, 2009) and situated learning (Lave & Wenger, 1991; Reder, Anderson, & Simon, 1996). Descriptive theories look for "truth," why aspects of instruction are effective or ineffective. Design theories of instruction leverage descriptive theories but focus on the "preferability" of various aspects of instruction designed to provide the building blocks for learning as prescribed by descriptive theory (Reigeluth & Carr-Chellman, 2009). Therefore, the purpose of the methods prescribed by GBS is to assure that instruction is optimally designed to facilitate experiential learning: learning by doing. The preferability of those methods, according to Reigeluth and Frick (1999), is established by examining their effectiveness, efficiency, and appeal across the various instructional situations in which they are brought to bear.

The *Matt Lane* VP was examined as a naturalistic instance of GBS theory. The methods of GBS as expressed in *Matt Lane* are summarized in Table 2.

Table 2

Methods of GBS Theory Mapped to the Matt Lane Virtual Patient

<table>
<tr><th>GBS Method</th><th colspan="3">As Expressed in Matt Lane, a Pressure Ulcer Prevention Virtual Patient</th></tr>
<tr><td rowspan="2">The Learning Goals</td><td>Goal (in context)</td><td>Objectives (Explicit)</td><td>Outcomes (Implicit)</td></tr>
<tr><td>Learn, by doing, how to care for a patient at high risk for skin breakdown (pressure ulcers)</td><td>1. The learner will conduct a patient history and physical exam (including an exam of the patient's skin) that demonstrates awareness of the impact of physical disability on a patient's risk for getting a pressure ulcer during admission to the hospital.
2. The learner will correctly anticipate the patient's pressure ulcer risk according to the Braden Scale (Braden, 2012).
3. The learner will prescribe evidence-based pressure ulcer risk reduction techniques for: bed positioning and turning, seated pressure relief maneuvers and chair cushioning
4. The learner will recognize/identify the National Pressure Ulcer Advisory Panel (NPUAP) stage of a pressure ulcer and the need for further evaluation and management.
5. The learner will demonstrate correct handoff of the patient using ISBAR (Marshall, Harrison, & Flanagan, 2009; J. E. Thompson et al., 2011), a structured clinical communications protocol.</td><td>The learner will develop:
• Appreciation of the specific and general risks the hospital environment presents to people with mobility and sensory impairments;
• Empathy for people of living with a disability;
• Awareness of the ability and right of people with disabilities to direct their care;
• Appreciation of the teamwork required to provide excellent patient care;
• A preliminary model of patient-centered care.</td></tr>
<tr><td>The Mission</td><td colspan="3">Consistent with target learners' clinical role, provide evidence-based pressure ulcer prevention and management care to a patient with a physical disability (spinal cord injury) who is at high risk.</td></tr>
</table>

GBS Method	As Expressed in *Matt Lane, a Pressure Ulcer Prevention Virtual Patient*
The Cover Story	Learner, new to the rehabilitation unit of a major hospital, has been assigned to care for a newly admitted patient with spinal cord injury.
The Role	Junior clinical decision maker in an inpatient post-acute setting: resident physician, advanced practice nurse, physician assistant.
The Scenario Operations	Interact with patient, interact with other clinical staff, conduct histories and physical exams, use structured evaluation and communications processes, review clinical documentation, perform diagnoses, prescribe and carry out therapeutic interventions.
The Resources	Online aggregation of best-practice and evidence-based materials guiding pressure ulcer prevention, patient-specific documents and multimedia, open searching of the Internet
The Feedback	Learner experience of decision outcomes, detailed explanatory feedback from scenario characters at key junctures in patient care

Design Characteristics of *Matt Lane*

Most often, clinical decision making skills are domain-specific and not generalizable across medical practice as a whole (Norman, 2008a). Since this is the case, the clinical content chosen for VP instructional design theory building should be as cross-cutting as possible to maximize the utility of design recommendations and to encourage their uptake and continued experimentation by a wide range of clinical educators and instructional designers. Pressure ulcer prevention is such a content area. Immobility, a key concern in the evaluation of pressure ulcer risk, is also a factor in a wide range of clinical disorders (e.g. paralysis, unconsciousness, cognitive dysfunction preventing proper self-management), treatments (e.g. casting of fractured limbs, anesthesia) and environments (emergency, perioperative, acute, post-acute, and long-term care). Theory generated to guide instruction in pressure ulcer prevention, therefore, can be expected to have applicability to the training of clinical reasoning skills in a range of clinical domains.

The *Matt Lane* VP exposes learners to the care of a patient with spinal cord injury across the first two days of his hospital admission. The case, conceived in the course of conducting a systematic review of the literature on pressure ulcer prevention (Groah, Schladen, Pineda, & Hsieh, 2014), was designed in consultation with clinical experts and modeled on an actual patient case. The patient on whose case the story of Matt Lane was based worked with the researcher and a videographer to document parts of his hospital experience and released his medical record to provide an authentic basis for the case narrative. In the course of interacting with the VP, learners evaluate Matt Lane's risk for getting a pressure ulcer, apply best and evidence-based practices in a hospital environment, and observe the impact of the decisions they make on patient well-being.

The *Matt Lane* VP was iteratively tested and revised through several classes of medical students (Schladen, Pineda, & Castillo, 2014) prior to being selected as the VP instance for the current theory building study. As originally conceived, *Matt Lane* might have been used in both group and individual learning scenarios. The focus of the present study, however, was on individual learning: how well the VP worked for individual, autonomous, exploration and acquisition of knowledge.

Instructional design is bounded by *situationalities* (Reigeluth & Carr-Chellman, 2009). The content of instruction (e.g. diagnosis of pressure ulcer risk and prescription of preventive measures), the level of learners targeted (e.g. clinical novices), and individual versus group instructional applications are situationalities that have already been discussed. The technology underlying instruction is another situationality that must be taken into account in developing an instructional design theory (Reigeluth, 2012). The choice of technology for instantiating VPs for the express purpose of teaching diagnosis and clinical reasoning (as opposed to diagnostic visualization or clinical motor skills) is a subject of controversy (Tworek et al., 2010; Zielke, LeFlore, Dufour, & Hardee, 2010). Game technology-based VPs, such as the team-based learning intervention developed. in the

CliniSpace™ platform (Innovations in Learning Inc., 2015), leverage technology that is ubiquitous in the entertainment world and which consumers have come to expect. On the other hand, despite the affordability of modeling and interaction design tools such as 3-D Studio Max (Autodesk, 2015) and Unity (Unity, 2015), the learning curve is still steep and the time to develop a game technology-based VP is high. Further, given that a hospital or university-based instructional design department is likely to have no more than one or two developers on staff, it is not realistic to expect that a game technology-based educational product will equal the sophistication of those created for the mass-market by large teams of multidisciplinary developers (personal communication, Rob Hafey, Lead Developer, Simulation Training & Education Laboratory, October 18, 2012). Hypertext/branching logic-based authoring systems are much simpler tools to learn and easy to use for instructional designers working autonomously or in small teams with clinical educators (J. Round, Conradi, & Poulton, 2009). For this reason, *Matt Lane* was instantiated as a narrative (versus game technology-based) VP using DecisionSim™, (Decision Simulation, 2014) a hypertext/branching logic system that requires no programming skills.

Research Framework: Data Collection and Analysis

The process of making sense of qualitative data *as it emerges* is essential to the coherence of qualitative research (Morse et al., 2002; Reigeluth & Frick, 1999). The current study organized the collection and iterative parsing of data according to a framework (Miles & Huberman, 1994; Miles, Huberman, & Saldana, 2014) that defines three major phases of data analysis: data reduction, data display, and conclusion drawing and verification. These phases are briefly described below.

Data Reduction

Data reduction is the iterative process of selecting and focusing data from the various sources the researcher has amassed, qualitative and quantitative, objective and reflective, in relation to the research questions. Not all data collected are relevant to the goals of the study.

Data Display

Data display may be graphical or text-based, but its essence is organization and compression, characteristics that help the researcher see emerging themes and relationships. According to Berkowitz (1997), data display is a very useful technique for discovering what is working or not working in a process. This characteristic of data display makes it a highly appropriate approach to addressing the question of what worked and didn't work for learners in *Matt Lane*.

Conclusion Drawing and Verification

Conclusion drawing and verification is the culmination of the research process and the phase where the researcher interprets and ascribes meaning to the analyzed data. Like prior phases in the research process, conclusion drawing is iterative, addressing the confirmability of conclusions by revisiting the data.

The researcher implemented the essential Miles and Huberman (1994) framework using NVivo 10© (QSR International, 2014) qualitative analysis software to coordinate the various data types created in the course of the study and to structure and document their analysis. The software package accommodates the import, annotation, and coding of audio and video files in addition to such widely used text formats as Word (Microsoft Corporation, 2014c) and PDF (Adobe Systems Incorporated, 2014). NVivo 10© is also integrated with the online survey tool, SurveyMonkey® (SurveyMonkey, 2014), for the import of survey data for use in categorization and classification of participant responses. Multimedia field notes captured using Evernote (Evernote Corporation, 2014) likewise transfer easily to NVivo 10©. Centralization of both data and the analysis process in NVivo 10© was conceived in the spirit of Morse et al. (2002) who recommended treating the maintenance of coherence in a qualitative study (where iteration and emergence is the rule) as a specific management aim, apart from the knowledge aims of the study itself. The sections that follow describe the data gathered in the course of the study and the processes used to manage and analyze it. Table 3 provides a summary of these data types.

Data

Table 3

Types of Data Supporting VP Theory Development

Data Type	**Description**
Survey and Scale Data 1. Clinical Education, Experience, and Technology Use Survey 2. Technology Acceptance Scale	Two short quantitative instruments to: 1) help assess the impact of learners' prior experiences on their interaction with the VP, 2) provide an overall assessment of whether the VP worked or didn't work
DecisionSim™ Navigation Trace	System-generated, time-stamped trace of the learner's path through the VP and record of decisions made
Think Aloud Verbalizations	Comments made by participants in the course of working through the VP
Semi-Structured Interviews	Focused feedback from the learner relative to VP design
Screen Capture Video	Video trace of participants' screens as they worked through the VP. Available for approximately half of all interactions
Research Journal	Chronological, text-based repository for all field notes and researcher reflections and emerging hypotheses during VP testing and analysis
Transcripts	Text versions of audio data; descriptive summaries of video data

Survey and Scale Data

Learners completed two, brief quantitative instruments. The first was a survey to gather information about learners' clinical education and experience and their level of comfort with various applications of online technologies for clinical documentation, word processing, entertainment, and information finding (Appendix B). The purpose of gathering these learner data was to identify situationalities that might impact the appropriateness of the design of the VP for individuals with different levels of clinical knowledge and experience and comfort with various types of computing/online technologies.

Then, after interacting with *Matt Lane*, learners completed a validated technology acceptance scale (Chin et al., 2008) tailored to the specific instance of VPs (Appendix C). This very brief (and hence minimally intrusive) scale compares well with the longer technology acceptance scale in use since the latter part of the last century (F. D. Davis, 1989).

These short instruments, survey and scale, provided objective data, as recommended by Reigeluth and Frick (1999), to help describe the methods of an instructional design theory, in terms of their effectiveness, efficiency, and appeal. This multi-method approach was implemented to help improve the representativeness of research findings (M. Williams, 2000).

The Education, Experience, and Technology Use survey was housed and completed on SurveyMonkey®. Participants' free-text survey responses were imported into NVivo 10© where they were directly available for coding. Categorical survey data were downloaded from SurveyMonkey®, analyzed and graphed (e.g. displays created) using the spreadsheet program, Excel (Microsoft Corporation, 2014a). The displays were imported into and managed as part of the study NVivo 10© project file.

The VP Technology Acceptance Scale was completed within the DecisionSim™ platform immediately after the learner finished interacting with each VP module (e.g. *Matt Lane Day 1* or *Matt Lane Day 2*). The scale is dichotomous in nature, forcing learners to evaluate various aspects of interaction with the VP as "good/bad." Gathering learners' responses within the DecisionSim™ platform itself where each response was time-stamped made it possible to detect learner hesitation and identify more equivocal aspects of VP effectiveness where learners were less certain of their evaluation.

DecisionSim™ Navigation Trace

DecisionSim™ creates an objective, time-stamped, server-side log of the learner's navigation through a VP. The platform captures every choice and iteration the learner makes, as well as all free-text responses the learner enters into the system. The navigation trace served principally to help the researcher interpret learners' think-aloud comments (see below) that did not have an accompanying video screen capture artifact to provide clarification. Navigation traces were exported from DecisionSim™ as spreadsheet files and imported into the NVivo10© project file to be available for coding.

Think-Aloud Verbalizations

Learners were oriented to the critical technique prescribed by Reigeluth and Frick (1999) to reduce inhibitions they might feel about sharing their frank perceptions of the VP. The researcher instructed and continually encouraged learners to "think aloud" as they worked their way through *Matt Lane*. The think aloud process, though not sufficient unto itself, contributes to understanding of what aspects of an interactive technology product predispose a user to choose a particular path through the intervention (Nørgaard & Hornbæk, 2006; Ramey et al., 2006). These learner verbalizations were audio recorded, transcribed, and annotated in NVivo 10©.

Semi-Structured Interviews

Each learner participated in a semi-structured interview focused on the study research questions. The initial script for this interview can be found in Appendix D. As the study progressed, it became apparent that richer feedback could be captured if the researcher posed questions to the learner in the course of completing of the virtual patient as opposed to asking the learner to recall specific features after-the-fact. It became further apparent that even greater focus could be achieved if the researcher shared participants' computer screens as they worked through *Matt Lane* and the researcher asked questions about what participants was thinking as they made choices at different points in the intervention.

Screen Capture Video

Earlier interactions of participants with the VP were documented through audio recordings (WAV or WMA files) augmented by the researcher's handwritten field notes. Later interactions were in the form of synchronous (MP4 files) video screen capture and audio of learners' think-aloud comments and verbal interaction with the researcher as they worked through *Matt Lane*. All audio only interactions were conducted face-to-face with participating learners. Interactions involving a shared screen were conducted both face-to-face and at-a-distance. The screen share plug-in, join.me (LogmeIn, 2015), was used to enable sharing of the learner's screen over the Internet and the screen recorder, Screencast-O-Matic© (Screencast-O-Matic, 2015) was used to both audio and video record the shared interaction. Distance interactions used independent voice and Internet connections to mitigate the risk of data loss. Figure 1 shows the basic face-to-face and distance configurations for joint attention to *Matt Lane* by the researcher and learner.

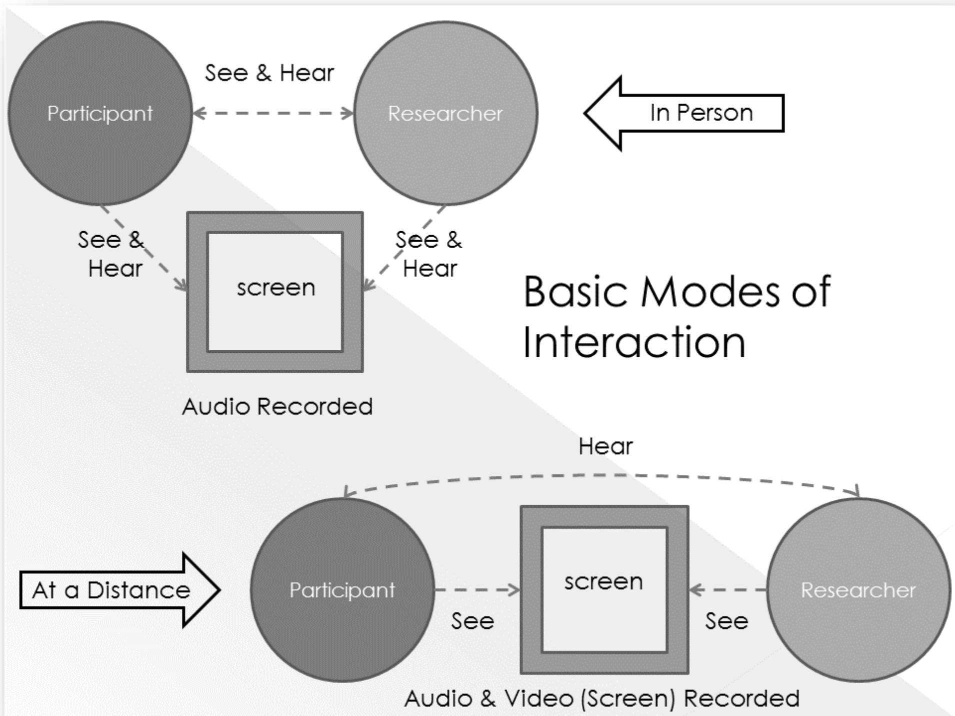

Figure 1. Positioning of participants and researcher during VP testing face-to-face and at-a-distance.

Transcripts

All audio and video files were transcribed by the researcher and an assistant with timecode links to the source media files which were managed as either internal or external files for iterative reference. The researcher’s handwritten, field notes were preserved as searchable text in Evernote, imported to NVivo 10© for management, and later transcribed for ease of coding and review. All transcripts were annotated at the time of transcription. The researcher reviewed the assistant’s transcripts and annotations against source media files and modified and expanded on them as necessary. In the case of video screen capture, annotations provided detailed descriptions of learners’ navigation of the virtual patient case.

Research Journal

The function of a research journal is to assure continuity and completeness of the research record, to guard against data loss, and to promote transparency of research process. It serves as a chronological log of all research activities performed and reflections on those activities.

NVivo 10© provided the structure for the study research journal, as well as serving as the repository for all study data: audio, video, and text. Early in the study during face-to-face observation and interviewing of learners interacting with the *Matt Lane* VP, the researcher made significant use of handwritten field notes and memos captured in a notebook that allowed for upload and text search on Evernote. Because Evernote is integrated with NVivo 10©, it was possible to pull all notes and their organizing folders created in the field in Evernote directly into an NVivo-based research journal. After field work was completed, the researcher used the memoing function of NVivo 10© to create on-going entries in the research journal during the later phases of transcription and analysis.

VP Methods Documentation

Categories for each of the GBS methods were created in NVivo 10© when the software project file was established. As each learner interaction was analyzed, passages of transcripts were coded against these categories. Sub-division, refinement of categories progressed iteratively as did expansion and addition of further codes to help describe the learner experience of the virtual patient. Iterative coding and memoing guided the progressive reduction of data to understand the nature of the instructional methods that were operational in *Matt Lane*, the degree to which those methods corresponded to GBS methods, and whether the methods identified worked or didn't work to enhance the effectiveness, efficiency, and appeal of the virtual patient intervention. Patterns observed in coding were distilled to display the study data. These displays, in turn, served as the guide for proposing refinements to GBS methods for the case of virtual patients.

Study Overview: Stages

The study was carried out in three stages: preparatory, data collection and analysis, and theory articulation/reporting. The tasks and activities associated with each stage are described below.

Stage I: Preparation

Activities of the preparatory stage focused on putting in place all processes and data tools that would be needed to support the research process. These activities included: establishing online accounts for the study in DecisionSim™; Evernote, SurveyMonkey®; OneDrive (Microsoft Corporation, 2015), for cloud back-up of all data; and NVivo 10©. Testing was planned to take place, by default, on the learner's own computer accessing the virtual patient modules and the Education, Experience, and Technology Use Survey over the learner's own network connection. As a backup configuration, a laptop with Internet access via mobile hotspot was designated for the study. (See Appendix E for the full inventory of resources used in the VP study.)

Permission to recruit students across the various campuses of Nova Southeastern University (NSU) that conduct physician assistant training programs was received from the NSU Institutional Review Board (IRB). Permission to recruit students training at MedStar National Rehabilitation Hospital in Washington, DC (which includes medical students from the Georgetown University School of Medicine that serves as MedStar's academic partner) was received from the MedStar IRB. (See Appendix F and Appendix G.)

Stage II: Data Collection and Analysis

Once IRB permission to conduct research was received, the researcher began collecting and analyzing data according to the framework, and using the data structures, described in the previous section. Details on participant recruitment, selection, and the VP testing process are provided in the following section, *Participant Recruitment and Testing*. Data collection and analysis proceeded in an iterative fashion until saturation, e.g. no new themes were emerging. Saturation occurred by the tenth learner. Eighteen interactions in all, across the two VP modules exposing Day 1 and Day 2 of Matt Lane's hospital admission, were conducted with the 10 learners recruited.

The data management structures initiated during the Preparatory Stage of research were used to reduce, organize, and display data to bring clarity to how the methods used in *Matt Lane* actually conformed to the methods prescribed by GBS theory and what worked and didn't work for learners interacting with the VP. Relationships among the data made clear through the reduction and display processes provided the basis for recommendations for improvements to GBS theory as applied to VPs.

Stage III: Theory Articulation and Reporting

The final stage of research drew on the knowledge synthesized during the previous stage in which the VP instance, *Matt Lane*, was tested and learner experiences analyzed. Chapter Four describes this process in detail, presents the results of the study, reports conclusions, and makes recommendations for improvements to GBS theory in the design of VPs. See **Error! Reference source not found.** for a graphical representation of the flow of data into the study and its reduction, and use for drawing conclusions.

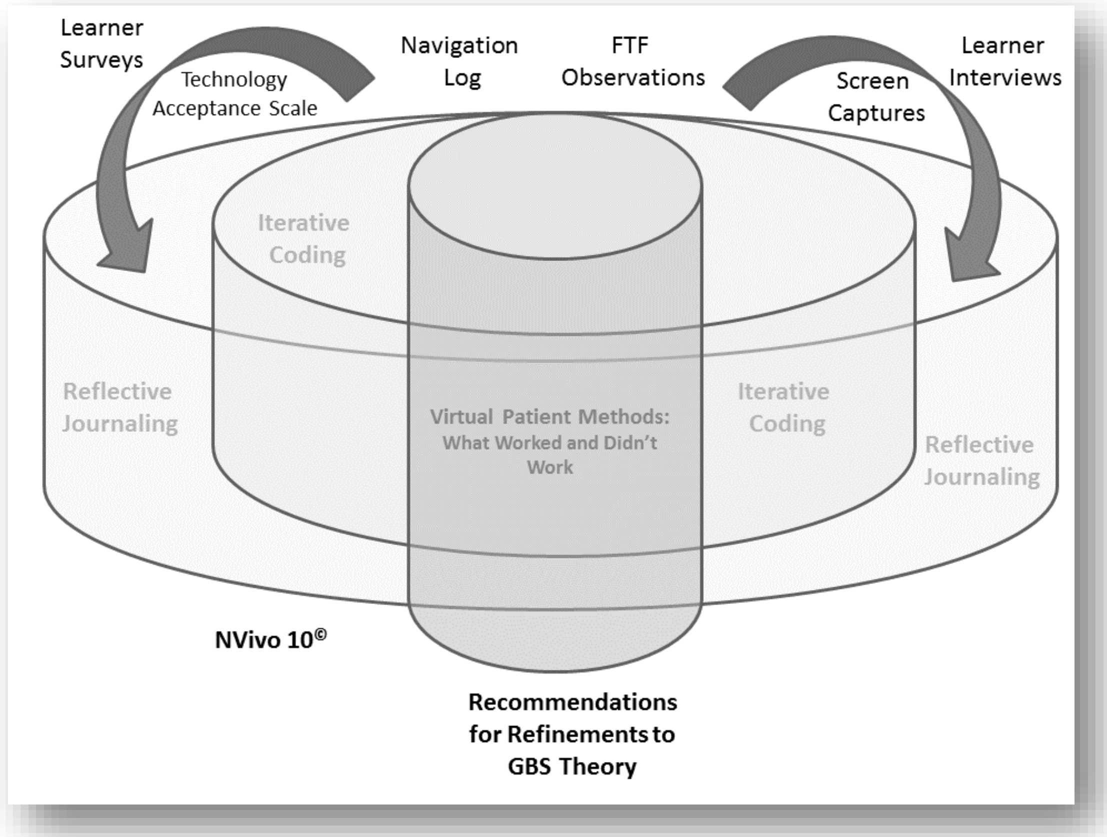

Figure 2. Original graphical representation of the data reduction process followed to implement the Miles and Huberman (1994) Framework.

Participant Recruitment and Testing

Inclusion and Exclusion Criteria

Individuals were eligible to participate in the study provided that they had, by self-report, an understanding of the basics of patient care: how to take a history and how to perform a physical exam. Table 4 lists participant inclusion and exclusion criteria.

Table 4

Participant Inclusion and Exclusion Criteria

Participant Types	**Inclusion Criteria**	**Exclusion Criteria**
Medical Residents Medical Students Nurse Practitioner Students Physician Assistant Students	Possess at least a basic understanding of how to perform a patient history and physical exam (per self-identification)	No reported understanding of how to take a patient history and perform a physical exam Wound care specialist designation

Sample Size and Recruitment

A study of nonprobabilistic sampling has shown that data saturation may occur within the first 12 cases involving intensive interviewing with all major themes being identified as early as case six (Guest, Bunce, & Johnson, 2006). Therefore the target number of participants for the current study was 12. Saturation of themes was perceived to have occurred by the ninth participant. The further testing of a tenth participant was confirmatory. *Matt Lane: New Patient on the Unit* and *Matt Lane: Day 2 on the Unit* were tested between February and April, 2014 with 10 clinical learners. Seven of the 10 participants completed and provided feedback on both modules. Two learners participated in a focus group to share and compare their experiences across both Day 1 and Day 2 of *Matt Lane*. Participants were medical trainees from the Georgetown University School of Medicine, and the Physical Medicine and Rehabilitation Residency Training Program at MedStar National Rehabilitation Hospital, both in Washington, DC, and from the Physician Assistant Program at Nova Southeastern University in Fort Lauderdale, Florida.

Selection of Participants

Learning needs in the development of clinical reasoning skills vary across experience levels (Posel et al., 2009). Therefore a range of “novice” clinicians (Table 4) were invited to interact with *Matt Lane* to attempt to accurately differentiate learner situationalities such as experience, clinical role, and perception of learning technologies in relation to VP design methods. As understanding of these learner factors developed, recruitment become increasingly purposive, i.e. intentionally sampling to test nascent theory (Yin, 2011). Purposive sampling promotes coherence and theoretical thinking (Morse et al., 2002). Of particular interest in the group of learners who participated were the effects of experience with actual patients and specific experience of the secondary medical problems common to people with physical disability (such as exemplified by the VP character, Matt Lane). Initially, learners of both genders and from both medical (e.g. physician and physician assistant trainees) and nursing practice traditions were sought. However, as lack of familiarity with the needs of individuals with physical disabilities emerged as a consistent theme, the researcher focused on recruiting participants who were differentiated from the earlier learners principally in their experience of disability.

Informed Consent

Once a potential participant indicated an interest in the study, the researcher described the study in detail at a time and place convenient to the prospective participant (or through e-mail) and gathered tentative informed “pre-consent.” During the pre-consent conversation, the researcher explained the purpose of the study and what participation would entail for the learner, most specifically, the time commitment. The researcher advised prospective participants that their participation was voluntary, their data would be kept confidential, no clinical faculty or supervisor would have knowledge of whether they participated in the study, and no part of the data collected in the study would have any impact whatsoever on their academic or program standing. Participants provided verbal or text informed pre-consent at the time of recruitment (by phone or e-mail). They provided formal, written consent as required by IRB at the time of interaction with *Matt Lane* and received copies of their consent documents.

VP Testing Sessions

It had been the experience of this researcher that clinical learners were difficult both to recruit and to retain in a study. To mitigate the risk of losing participants for follow-up, each participant was scheduled for a single study session of no more than 90 minutes in length. Prior to interacting with *Matt Lane*, learners completed, as previously described, a brief survey (Appendix B) of their education, patient-care experience, and use of technology. Subsequently, participants worked through one module of *Matt Lane* while the researcher observed and asked questions. (See Semi-Structured Interview Script, Appendix D.) At the end of each VP module, learners completed a dichotomous technology acceptance scale (Appendix C) reflecting their experience on the preceding module. Learners having completed the first module of *Matt Lane, New Patient on the Unit,* were invited to schedule a time to complete the follow-on module, *Day 2 on the Unit*, as well.

Initially, participants met with the researcher in person at school to test the VP modules and to respond to questions about their experiences face-to-face. They went online using their own or the study laptop and their university's wireless connection. Headphones were used as participants desired. Two audio recorders provided redundant recordings of participant think-aloud comments and responses to interview questions. Seven sessions testing *Matt Lane* proceeded in this manner. (See Table 5.)

As previously described in the section on study data, as testing progressed, recording learners' screens as well as their comments emerged as a preferred practice. Certain participants who tested in person used the study laptop. In these instances (two learners across three testing sessions), learners' computer screens, as well as their comments and responses to the researcher's questions, were shared and recorded. Screen sharing also made it possible for learners to test the virtual patient at a distance under observation of the researcher. Seven sessions were conducted at a distance with screen sharing and recorded (Table 5).

In all cases but one (noted in Table 5 with an asterisk) the researcher observed and audio recorded participants' think-aloud comments while they interacted with the virtual patient scenario and responded to interview questions about their experience with *Matt Lane*. In that single case, the learner completed the day-1 scenario autonomously and then participated in an interview 48 hours later. Screen navigation, along with audio think-aloud comments were captured for nine interactions. In three cases, the researcher was in the same room with the participant and was able to observe (and take field notes on) the participant while she interacted with the virtual patient in addition to capturing the participant's screen for later analysis. Seventeen of the eighteen interactions with participants were completed one-on-one. One interaction was a joint interview (focus group) with two participants reflecting on both virtual patient scenarios.

Table 5

Breakdown of Data Gathered During Testing of Two VP Modules with 10 Unique Participants Across 18 Interactions

Participant (pseudomized)	*Matt Lane: New Patient on the Unit*			*Matt Lane: Day 2 on the Unit*		
	Screen Capture	*Audio*	*Field Notes*	*Screen Capture*	*Audio*	*Field Notes*
Emily	Yes (distance)	(backup file)	Yes	-	-	-
Andie	Yes (distance)	(backup file)	Yes	Yes (distance)	Yes (distance)	Yes
Maria	Yes (observed)	(backup file)	Yes	Yes (observed)	Yes	Yes
Alyssa	Yes (distance)	(backup file)	Yes	-	-	-
Jess	Yes (distance)	(backup file)	Yes	-	-	-
Zoe	-	Yes*	Yes	-	Yes (observed)	Yes
Cathy	-	Yes	Yes	-	Yes	Yes
Dana	-	Yes	Yes	Yes (distance)	Yes	Yes
Stacey	-	Yes	Yes	-	Yes	Yes
Shari	-	Yes	Yes	Yes (observed)	Yes	Yes
Joint Interview - Zoe and Shari	-	Yes (observed)	Yes	-	Yes (observed)	Yes

Note. *Completed virtual patient unsupervised. Debriefed face-to-face within 48 hours.

A case comparison (Schladen & Snyder, 2015) of two participants, Shari and Emily (pseudonyms), who demonstrated similar readiness to think aloud while testing the VP showed that screen capture provided considerably more data about how the learner interacted with the intervention than did audio recording and field notes alone. In Shari's interaction with *Matt Lane, New Patient on the Unit* (e.g. the day-1 module) that was conducted in person with audio recording only and field notes, 40 references, covering 2.71% of the transcript, described how Shari was working through the VP. On the other hand, Emily's interaction that was conducted at a distance with both audio and screen recording had a total of 244 references to how she was navigating the case and these references covered 10.84% of the transcript. Characteristically, the granularity of data that derived from the screen capture description made consultation of the DecisionSim™ system log unnecessary for interpreting learner actions, and provided even more detailed data than did the log. For example, the log provided precise timing data to track when the participant moved between screens of the virtual patient. It did not provide information about the participant's manner of approach to working through the screen content. The video screen capture, on the other hand showed the participant's mouse movement and allowed for qualification of the participant's mouse actions. The screen capture allowed discernment of such aspects of the participant's interaction with the VP as hesitation, indecision, and skimming versus focused reading of text. See Figure 3.

In terms of discourse, there was no perceivable difference in how *responsive* the researcher was to the participant in the in-person versus the at-a-distance testing context. The researcher engaged in such activities as answering questions, engaging the learner in the intervention, offering appreciation, and providing instructions, 61 times during the face-to-face interaction with Shari and 62 times during the distance interaction with Emily. However, in the case of researcher-initiated questions of the learners about what they were experiencing, the researcher asked Emily (distance) 28 questions to the 14 she asked Shari (in person). This disparity suggests that subtle behaviors are more salient over screen share versus joint attention to a common screen while sitting side-by-side (Schladen & Snyder, 2015).

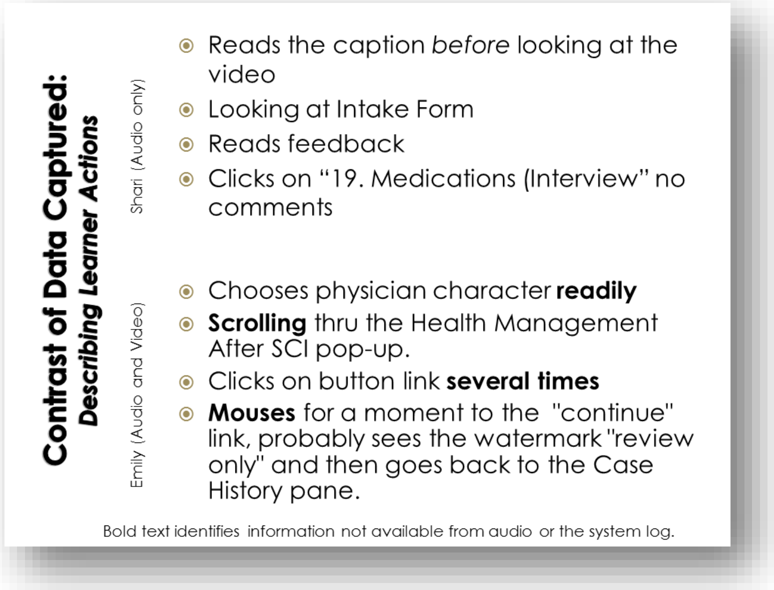

Figure 3. Contrast of data captured on how two learners, one whose session was annotated from recorded audio and the DecisionSim™ system log only and the other whose session was annotated from screen capture video in addition to audio.

Though grounded in an initial script, questions posed to learners during VP testing, like all aspects of participant interaction, were emergent and developed as issues came into focus. Reigeluth and Frick (1999) identify the interview as one of the most important tools for formative research and Krefting (1991) includes "interview technique" as a criterion of credibility in qualitative research. Krefting recommends that the interviewer be practiced in interviewing and advocates self-evaluation using audio and/or video recordings of oneself engaging participants in interviews. The researcher in the current study had several years' prior experience in conducting semi-structured interviews and had participated in audio and video self-evaluation. Additionally, she had previously piloted and revised the baseline interview questions found in Appendix D with medical students during testing of an earlier version of *Matt Lane*.

A criterion of interview quality is a high degree of internal consistency (Krefting, 1991). The interview script (Appendix D) provided a focused, point of departure for directing participants' attention towards the central topic of interest: the degree to which GBS methods, or methods not part of GBS, provided a positive virtual patient learning experience. Continual reflection on the VP testing process with each successive participant and consistent memoing provided direction and coherence to modifications to questions both in terms of content and timing during interaction with participants. As the researcher's experience with learners interacting with *Matt Lane* increased, the interview format evolved. Instead of asking the learner a block of questions upon completion of the VP, the researcher interjected probing questions at intervals during the course of the VP where they were relevant. See Table 6 for a summation of the various items that were part of the VP testing protocol and *Figure 4* for a graphical representation of participant interaction and how it evolved to better capture learner experience.

Table 6

Participation Protocol

Item	Description/Data	Estimated Minutes to Complete
Informed Consent	Pre-consent by phone or e-mail during recruitment	5*
	Review and signing of IRB approved document	5
Education, Experience, and Technology Use Survey (Appendix B)	Discipline, Program Year, Institution, Clinical Experience, Projected Career Path, Technology Use, Age, Gender	10
Matt Lane Virtual Patient Intervention Resource: Online aggregation of best-practice and evidence-based materials guiding pressure ulcer prevention, patient-specific documents and multimedia, open searching of the Internet	Learner path through the VP, think-aloud comments, Non-verbal communication (researcher field notes/screen capture), Use of resources	45
Technology Acceptance Scale (Appendix C)	Measures technology acceptance in terms of perceived usefulness and perceived ease of use	5
Semi-Structured Interview (Appendix D)	Guided reflection on VP experience	20

Note. *Outside of participant testing sessions

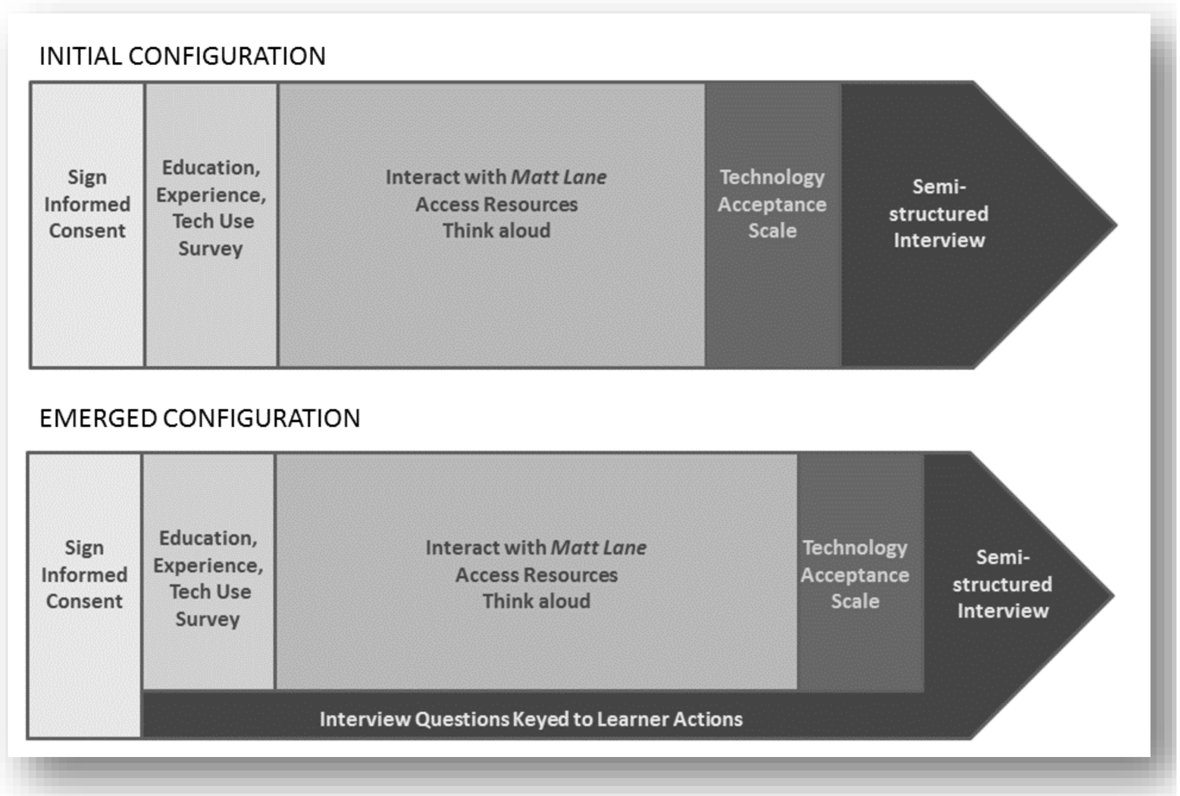

Figure 4. Comparison of the participant testing session flow in its initial configuration and emerged configuration at completion of participant testing.

Formats for Presenting Results

A case study based on experience with methods in the current study was presented at the 6th Annual Conference of The Qualitative Report, in January 2015, at Nova Southeastern University in Fort Lauderdale, FL. Abstracts describing the results of the current study will be submitted for presentation at educational research conferences and symposia. An abstract has been submitted to the Medbiquitous annual conference at the Johns Hopkins School of Medicine in Baltimore, MD. Medbiquitous is a highly appropriate venue as the organization is the promulgator of VP interoperability standards. Another appropriate venue is the annual Health Professions Educational Research Symposium (HPERS) at the Health Sciences Division of Nova Southeastern University in Fort Lauderdale, FL. The researcher has had preliminary VP work accepted for presentation at both Medquitous and HPERS, demonstrating the interest in the topic by the two organizations. Since online, case-based learning and development of reasoning skills have applicability beyond health care, the researcher will also submit abstracts to the annual Online Learning Consortium International Conference, the annual meeting of the American Educational Research Association (AERA), and the Association for Educational Communications and Technology (AECT) Convention.

Following the generation of this dissertation report, manuscripts will be produced and submitted to peer-reviewed medical and general education journals. High impact, medical education-focused journals, such as *Medical Education* and *Medical Teacher*, which publish qualitative and design research will be targeted. Also targeted will be journals that focus on education of PAs, such as the *Journal of Physician Assistant Education.* Manuscripts will also be submitted to journals focused specifically on instructional design and educational technology such as *Computers & Education*, *Educational Technology Research and Development (ETRD),* and the *British Journal of Educational Technology (BJET).*

Chapter 3 Summary

Chapter 3 described the methods used to develop an instructional design theory for VPs. The chapter detailed how formative research, a form of qualitative, case study research, was used to refine an existing instructional design theory, GBS, to develop a theory of VPs for the teaching of clinical reasoning. *An in vivo,* naturalistic case focused on a VP to teach pressure ulcer prevention, assessment, and treatment, *Matt Lane,* was examined as an instance of GBS. *Matt Lane* employs *a* narrative, branching logic/hypertext VP format. This format represents a mature technology. Two modules depicting two days in the hospitalization of the patient, Matt Lane, were examined for recommendations for modifications to GBS theory for the situationality of VPs.

Chapter 3 described the criteria employed in the study to assure the conduct of credible (rigorous) research that is principally qualitative in nature. A framework developed by Miles and Huberman (1994) that was used to guide the research process was described. The nature, structure, and management of data in the study to support the steps of data reduction, display, and conclusion drawing and verification defined by Miles and Huberman were detailed. The chapter also provided details about the VP testing session and how it evolved as testing progressed.

Chapter 4

Results

Participant Characteristics

Clinical Education and Experience

Ten medical trainees from the Georgetown University School of Medicine, and the Physical Medicine and Rehabilitation Residency Training Program at MedStar National Rehabilitation Hospital, both in Washington, DC, and from the Physician Assistant Program at Nova Southeastern University in Fort Lauderdale, FL volunteered to take part in the study. Students engaged in both clinical and pre-clinical segments of training in their respective programs participated. All were female. The number of years of clinical experience represented by the participants ranged from less-than-one to six and the number of medical domains they had sampled ranged from one to 16. The *Matt Lane* VP focused on caring for a patient with spinal cord injury on an inpatient rehabilitation unit. Three participants came to the intervention with specific experience in rehabilitation and two had specific experience with patients with spinal cord injury. Table 7 sets forth the level of training and prior clinical experience for each participant. Because individuals may have worked in health care *prior* to matriculation into their health science programs, level of training and years of clinical experience may not appear to directly correlate.

Table 7

Participants' Education and Experience

Participant *(Pseudonyms)*	Level of Training (*All participants were at the end of the year of training indicated.)*	Prior Clinical Experience			
		Years	Number of Clinical Areas Experienced	Inpatient Rehabilitation?	Spinal Cord Injury?
Maria	PGY-2[2] *Medical resident*	5-6	11	Yes	Yes
Emily	M-4[3] *Medical student*	2-3	16	Yes	Yes
Andie	M-1[4] *Medical student*	3-4	5	No	No
Alyssa	PA-2[5] *Physician Assistant Student*	1-2	6	No	No
Jess	PA-1[6] *Physician Assistant Student*	<1	1	No	No
Zoe	PA-1 *Physician Assistant Student*	<1	4	No	No
Cathy	PA-1 *Physician Assistant Student*	3-4	3	No	No
Dana	PA-1 *Physician Assistant Student*	5-6	1	No	No
Stacey	PA-1 *Physician Assistant Student*	2-3	1	Yes (*Outpatient)*	No
Shari	PA-1 *Physician Assistant Student*	2	2	No	No

Use of Computing Technology

As a group, participants were habitual and versatile computer users. Nine out of ten participants stated that they used a computer daily to find information or do

[2] PGY-2 means post-graduate year 2. PGY-2 is the first year of a typical Physical Medicine and Rehabilitation residency. These trainees will have completed an internship, PGY-1, generally in internal medicine. PGY-2's are still considered novice clinicians.

[3] M-4 is the last year of the typical 4-year medical school curriculum. Emily had just graduated when she tested *Matt Lane*. She had not yet begun her internship year, PGY-1.

[4] M-1 and M-2, the first two years of the medical school curriculum, focus on basic science. Clinical rotations typically begin in year 3.

[5] PA-2's are advanced physician assistant students who are mostly engaged in clinical rotations.

[6] PA-1's are pre-clinical physician assistant students. All PA-1's testing Matt Lane were near the end of their pre-clinical studies. All had previous experience with DXR Clinician, an early virtual patient intervention that received positive evaluation for both depth and efficiency of learning (Maldonado, 2011).

research. Six of the ten rarely or never used a computer for *interactive* entertainment, such as video games, but eight participants said they used a computer for *passive* entertainment, such as watching movies, daily or weekly. Eight said they used a computer in clinical or academic writing daily or weekly. Four participants used a computer daily for clinical documentation. The remaining six participants stated they did so monthly, rarely, or never. Figure 5 shows the distribution of participants' computer use responses.

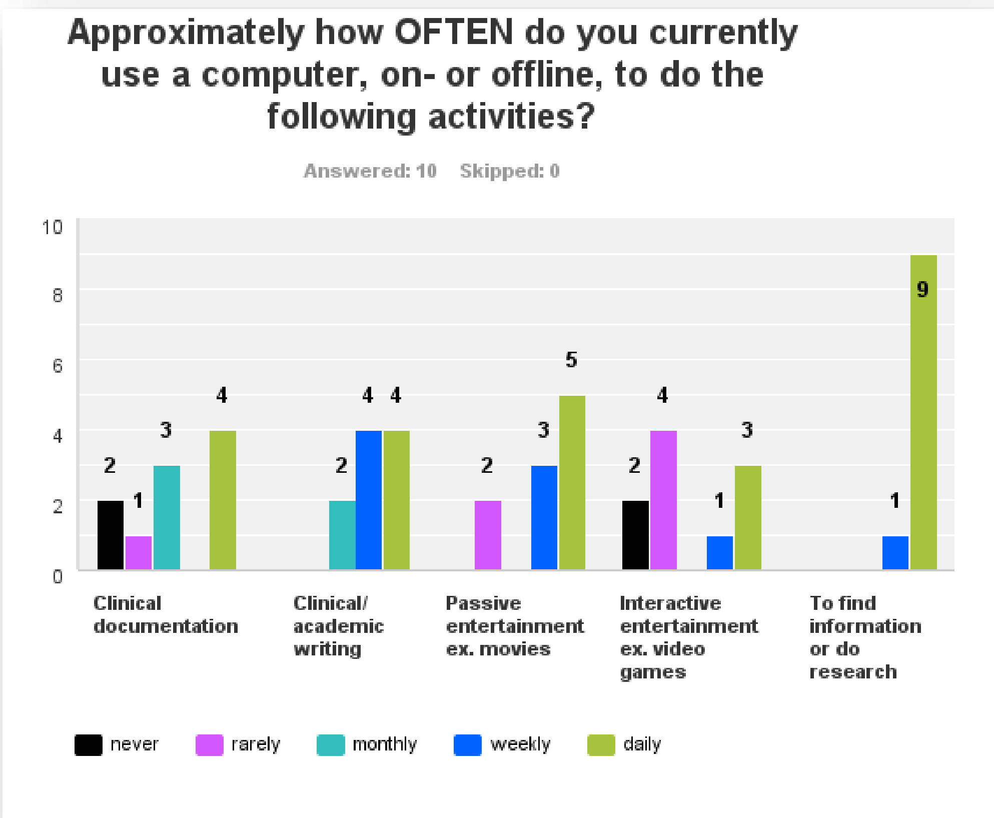

Figure 5. Distribution of participants' responses to frequency of use of a computer for work, study, and entertainment purposes.

Learner Situationalities and Testing Circumstances

Participants who tested the *Matt Lane* VP were all similar in that they were all training to be health care providers, had a basic understanding of such routine clinical procedure as taking a patient history and performing a physical exam, and did not have specific expertise in pressure ulcer prevention and management. Some had prior experience with VP applications. The Physician Assistant Program at Nova Southeastern University uses a VP application in training and several PA participants used this application as a benchmark in evaluation the *Matt Lane* VP. The participating PGY-2 medical resident also related prior VP experience (with a different application from the one used by the PA students) to her experience of *Matt Lane*.

Participants differed with respect to prior clinical experiences and current (i.e., at the time of interaction with *Matt Lane*) educational programs. Participants also differed in ways that did not exclude them from the study (See Table 4, Inclusion and Exclusion Criteria) but that might reasonably be expected to impact their interaction with an online, interactive, multimedia virtual patient instance such as Matt Lane. Examples of such potentially significant differences are practices surrounding the use of a computer for gaming and/or narrative, multimedia entertainment (e.g. watching movies). Other factors impacting responsiveness to *Matt Lane* and questions from the researcher about experiences with the VP include such constraints as time available to interact with the intervention, beliefs around expectations for participation in the *Matt Lane* study, and level of comfort during the testing interaction (predicated by many factors including location of testing). Table 8 maps potentially significant situationalities and testing circumstances to the 10 *Matt Lane* participants across their interactions with the VP. This breakdown will be referenced again as the description of data analysis proceeds.

Table 8

Learner Situationalities and Testing Circumstances with Potential Impact on Participation and Responses

Situationalities[7] & Circumstances[8]	**Learners Testing *Matt Lane***									
	Emily	**Andie**	**Maria**	**Alyssa**	**Jess**	**Zoe**	**Cathy**	**Dana**	**Stacey**	**Shari**
Professional Goal	MD	MD	MD	PA	PA	PA	PA	PA	PA	PA
Engaged in Course Work	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Engaged in Clinical Rotations	No	No	Yes	Yes	No	No	No	No	No	No
Frequency, Clinical Documentation	Daily	Monthly	Daily	Daily	Daily	Never	Rarely	Never	Monthly	Monthly
Video Game Play	Weekly	Rarely	Daily	Daily	Never	Never	Rarely	Rarely	Rarely	Daily
Movie Watching	Daily	Weekly	Daily	Daily	Weekly	Daily	Rarely	Weekly	Rarely	Daily
Prior VP Experience	Unk	Unk	Type1[9]	Type2[10]	Type2[10]	Type2[10]	Type2[10]	Type2[10]	Type2[10]	Type2[10]
Testing Condition	Distance	Distance	FTF[11]	Distance	FTF	FTF	FTF	FTF & Distance	FTF & Distance	FTF
Testing Location	Home	Home	Work - Hospital	Home	Home	Home & School	School	School & Home	School & Home	School
Referral Mechanism	Clinical Peer	Journal[12] Club	Clinical Mentor	PA Program	PA Program	PA Program	PA Program	PA Program	PA Program	PA Program
VP Day 1 Time Budget	Free	Free	Free	Free	Free	Free	Free	Limited	Limited	Limited
VP Day 2 Time Budget	NA	Free	Free	NA	NA	Free	Free	Free	Free	Free

[7] From Education, Experience, and Technology Use Survey.
[8] Based on learner report and memoed to the Research Journal.
[9] Multimedia, simulation-based VP
[10] Text-based VP
[11] FTF = Face to Face.
[12] Participant's School of Medicine has a Medical Education Research track that sponsors a Journal Club for track and other interested students.

Analysis

All data generated during testing of *Matt Lane* with learners were centralized in NVivo 10© for analysis. The bulk of these data took the form of audio and, in later interactions, video files of participants' think aloud interactions with the VP, interviews with the researcher focused on the methods exposed in the VP, and all field notes and reflective memos (the research journal) created by the researcher. Audio interactions were transcribed by the researcher and an assistant and learners' actions discerned from video screen capture were reduced to text descriptions by the researcher and incorporated as annotations into the transcript of audio interactions. Transcripts were validated during subsequent coding through a practice of simultaneous listening and coding of transcribed text.

Since the goal of the study was to refine an instructional design theory of virtual patients, the researcher created three, theory-driven, thematic code sets (DeCuir-Gunby, Marshall, & McCulloch, 2011), "nodes" in NVivo 10© usage, at project outset. Codes function to assign and label the significance of blocks of data gathered within a study (Miles et al., 2014). These theory-driven codes, or nodes, formed the basis of the initial "codebook" for the project. Maintaining a codebook is a qualitative research best practice (Fereday & Muir-Cochrane, 2006). It is a method for maintaining coherence and uniformity of understanding of what exactly is meant by individual codes assigned to data. The study codebook is available in Appendix H.

These theory-based nodes represented: 1) each GBS method; 2) each logical unit of the VP intervention; and 3) each participating, clinical learner. DecisionSim™ also uses the term "node" to describe a virtual patient logical unit. To avoid confusion of the terminology, from this point forward, “node” will refer to a thematic category in NVivo 10© and “DS-node” will refer to a logical unit of the *Matt Lane* VP.

Two of the foundational, theory-based node sets, Participants and DS-nodes, were assigned attributes within classification schemata to allow exploration of questions about the interaction of specific classes of learners and specific classes of DS-nodes. One such question might be: How did participants with more years of clinical experience versus those with fewer years’ experience appreciate the use of video versus narrative to carry forward the story in *Matt Lane*? Table 9 shows the classification/attribute schemata for Participants and DS-nodes.

Table 9

Attributes of Foundational, Theory-Based Node Sets: Participants and DS-Nodes

Node Set	**Classification Schemata**	
Participants (10)	*Attribute*	*Description*
	Participant ID	Unique identifier of individual learners (masked)
	Survey Date	Date participants completed education, experience and computer use survey
	Program[a]	Physician, physician assistant, medical resident training
	Program Year[a]	Learner's year in training program
	Years of Clinical Experience[a]	Health care experience both before and during current training program
	Clinical Domain Experience[a]	The types of clinical environments and patients the participant had experienced
	Technology Use[b]	How the learner used technology for work, learning, and entertainment
	Gender	Female, male. Optional response
	Testing Information[c]	VP modules completed and testing scenarios for each
DS-Nodes (144)	*Attribute*	*Description*
	Node ID	DS-node identifier
	Node Type • Branching • Free Text • Inquiry • MCQ[d] • Narrative	DecisionSim™ provides a framework for five basic types of learner interaction. Each is described in detail, along the GBS methods it supported in the exposition of *Matt Lane*, in later sections of Chapter 4.
	Hyperlink	T/F – Does the DS-node link to outside resources?
	Video	T/F – Does the DS-node use video?

Note.
a. See Table 7 for a detailed breakdown of participants' programs and clinical experience.
b. See Figure 5 for participants; technology use
c. See Table 5 for a detailed description of participant testing conditions.
d. MCQ is a DecisionSim™ and common-usage acronym for "multiple choice question."

Learner attributes were imported to the Participant classification from the Education, Experience and Technology Use Survey (Appendix B) that learners completed on Surveymonkey® and VP testing attributes were added to the classification individually as they became available. DS-nodes were classified, and audited for accuracy, as participants' interactions were reviewed and analyzed.

The DecisionSim™ server-side trace of learners' paths through the VP was exported from the virtual patient platform and imported to NVivo 10© as a spreadsheet. The navigation trace served as a tool for disambiguating participant comments and actions. Because the researcher interrupted participants as they interacted with *Matt Lane* to ask them questions about what they were doing or feeling, timing data from the DecisionSim™ navigation trace was not useful for drawing conclusions about the design methods underlying the VP.

The general approach to analysis involved appraisal of the audio and video artifacts of each participant's testing session. Verbal data were transcribed verbatim where germane to the research questions and "gisted" where it digressed, for example, discussions relative to informed consent or scheduling. Observational data of testing sessions that involved screen capture were recorded as field notes within the transcript of verbal interactions. Annotation and memoing took place concurrent with transcription activity for interactions transcribed by the researcher and on transcript proofing for interactions transcribed by the assistant.

Transcripts were then coded to the three, theory-driven, foundational node sets. New, open, codes, "data-driven" (DeCuir-Gunby et al., 2011) were created to address themes that emerged during the learner's active engagement with the VP. An important new node set that coalesced at this juncture was Methods – Not GBS. This node set served as the repository for methods discovered in the VP that were significant to learners' appreciation of the intervention but were not accounted for among the methods of GBS Theory. Further annotations and memos were added to the project file as coding proceeded. As new codes emerged, the codebook was revised to reflect new ideas, as well as super- and subordination of existing schemata.

Once all transcripts had been coded to the DS-nodes, these nodes were revisited and "coded on" (QSR International, n.d.) to the GBS Methods node set. Adjustments were made to the data-driven nodes and additional memos were created as needed. The data-driven nodes and memos were traversed and explored for patterns using the various tools available within NVivo 10© as well as externally with other software products, such as Microsoft Office (Microsoft Corporation, 2014b), as well as manually with paper and pencil. Data displays were developed to expose what worked and didn't work for participants testing *Matt Lane* and to frame that experience in terms of methods that were part of and were not part of those prescribed by GBS Theory. See Figure 6 for a graphical representation of the flow of the analytic process.

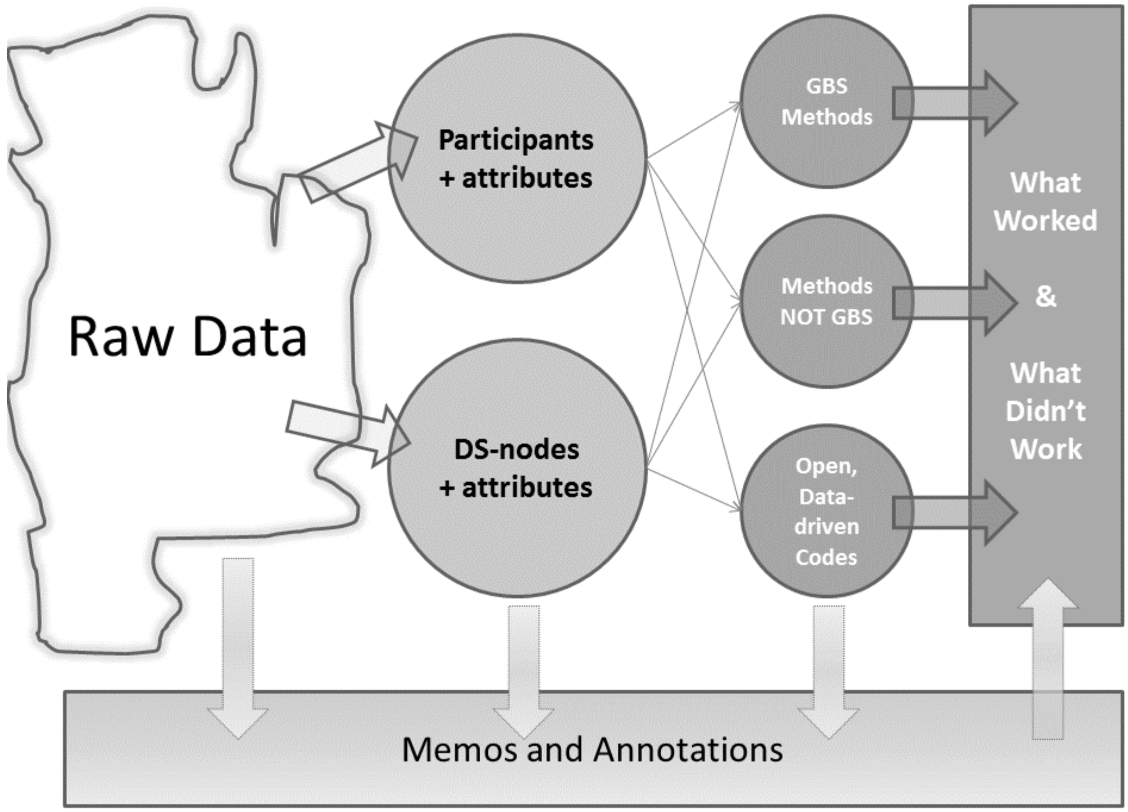

Figure 6. The analytic process of coding raw data (think-aloud verbalizations, screen captures, DecisionSim™ system log information, field notes) against Participants (those acting) and DS-nodes (the context for action), through GBS Methods, Non-GBS methods, and open codes driven by the data, to find what worked and didn't work in the Matt Lane VP.

Goal-Based Scenario Methods and Learners' Experience of *Matt Lane*

Method 1: The Learning Goals

The criteria for articulating learning *objectives* in teaching and learning are widely disseminated at conferences (Osters & Tiu, 2003), through university faculty development programs (University of Washington eProject, 2003), and general online, commercially sponsored teacher support (Teaching Today, n.d.). Learning *goals*, the term Schank et al. (1999) use to label the first method of GBS, has received less attention. *Diffen*, an online tool and forum for making semantic comparisons, distinguishes goals and objectives in terms of time frame for execution, attributes, and effect ("Goal vs. Objective," n.d.). A goal is a desired outcome whereas an objective is a specific action supporting the associated goal. An objective is measurable and achieved in the short- or mid-term. A goal is mid- long-term and may or may not be measurable. Schank et al. (1999) frame GBS Theory in terms of such outcome-oriented, longer-term goals that are reached by practice, by “doing” in scenario. Learning through “expectation failure” (e.g. learning through one’s mistakes) is integral to the process envisioned by GBS.

The *Matt Lane* VP was developed around explicit learning *objectives*, per standard protocol (Table 10, column 3). The *goals* that mediated the intervention and the outcomes anticipated were less well articulated during development, but present, nonetheless. Rehabilitation, as a discipline, is torn between a desire to implement a medical framework within rehabilitation while, at the same time affirming and facilitating empowerment of persons with disabilities to be active players in their own care (Gzil et al., 2007). Both themes are discernible in *Matt Lane*.

The learning objectives for *Matt Lane* were created with reference to a VP development template (McGee, 2012) provided by Decision Simulation to authors using the DecisionSim™ platform. The template guided authors to think about three to six desired learning outcomes or objectives: “What new knowledge and skills will your learners acquire or be able to do better” (p. 1)? Authors were additionally advised to articulate concepts they wanted to communicate or reinforce. “You do not need to specify these formally in the case, but they can help ensure that the case remains focused” (p. 2).

The desired outcomes of learning with the VP, as recommended by Decision Simulation, appear in the last column of Table 10. Neither learning objectives nor outcomes were explicitly communicated to learners in the *Matt Lane* VP. Learning goals were conveyed to learners in the context of the unfolding story, through the device of handoff communications.

Table 10

Goals and Objectives in Matt Lane

GBS Method	Method as Exposed in *Matt Lane, A Pressure Ulcer Prevention Virtual Patient*		
The Learning Goals	*Learning Goal (in context)*	*Learning Objectives (Explicit)*	*Learning Outcomes (Implicit)*
	Learn, by doing, how to care for a patient at high risk for skin breakdown (pressure ulcers)	1. The learner will conduct a patient history and physical exam (including an exam of the patient's skin) that demonstrates awareness of the impact of physical disability on a patient's risk for getting a pressure ulcer during admission to the hospital. 2. The learner will correctly anticipate the patient's pressure ulcer risk according to the Braden Scale (Braden, 2012). 3. The learner will prescribe evidence-based pressure ulcer risk reduction techniques for: bed positioning and turning, seated pressure relief maneuvers and chair cushioning 4. The learner will recognize/identify the National Pressure Ulcer Advisory Panel (NPUAP) stage of a pressure ulcer and the need for further evaluation and management. 5. The learner will demonstrate correct handoff of the patient using ISBAR (Marshall et al., 2009; J. E. Thompson et al., 2011), a structured clinical communications protocol.	The learner will develop: • Appreciation of the specific and general risks the hospital environment presents to people with mobility and sensory impairments; • Empathy for people of living with a disability; • Awareness of the ability and right of people with disabilities to direct their care; • Appreciation of the teamwork required to provide excellent patient care; • A preliminary model of patient-centered care.

The "handoff" is a structured, clinical communication protocol through which the care of a patient is safely entrusted by one clinician to another. In *Matt Lane*, the handoff (Figure 7) embodied a learning objective. It also served as the means for conveying the goal of interacting with the VP to learners as well as the means for directing them toward the scenario operations (e.g. take a history, complete a physical exam, write appropriate orders) that would immerse them in activities directed toward achieving the remaining four learning objectives: "So you'll need to do an H&P and write orders, and remember he is tetraplegic[13] and at higher risk for a number of secondary conditions[14] as a result."

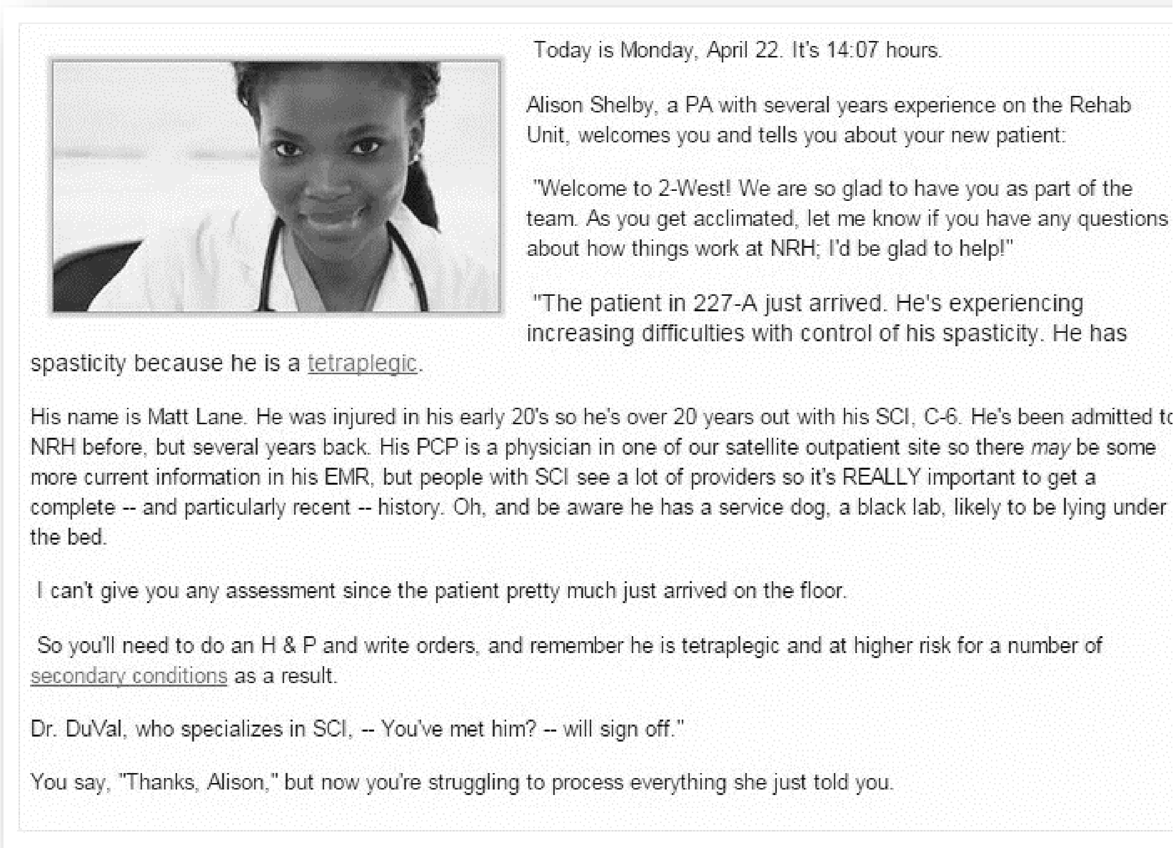

Figure 7. Introductory screen from *Matt Lane, New Patient on the Unit* (Day 1) introducing the learner to a structured communications protocol through narrative means.

In the description of GBS Theory (Schank et al., 1999), the remaining six methods (e.g. The Mission, The Cover Story, The Role, The Scenario Operations, The Resources, and

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[13] A prior hyperlink provides the learner resources for understanding tetraplegia.
[14] "Secondary conditions" is hyperlinked to an evidence-based, explanatory resource.

The Feedback) serve as the means for conveying the first method: The Learning Goals. This approach maintains the conventions of a story and seemed appropriate for a virtual patient case. A *narrative* virtual patient, of which *Matt Lane* is an example, is called that for a reason. It tells a story and learning, theoretically, occurs in the experience of the story and interaction with its components. The author of a novel doesn't want to give away the plot; such an act would deprive the reader of the impact of the storyline. In similar fashion, since a virtual patient is also a story, disclosure of both learning goals and objectives is merely alluded to, just as the disclosure of what a novel is about on the dust jacket is designed to interest readers and draw then in without giving away the whole story. Once engaged, the author works to create new openness in the reader and deliver his/her message through that portal. So in the case of *Matt Lane*, the learner was told that the case was about pressure ulcer prevention (overarching learning goal). The details of how that learning would unfold across the story of days 1 and 2 of Matt Lane's hospital admission were not revealed.

For Cathy, a PA-1 participant, the narrative approach worked to promote learning at all levels (See Table 11). She focused particularly on the exposure immersion in the scenario provider her:

> Because seeing ... just like the videos ... exposure to that ... when you're in class they say these words and I didn't have *any idea* of what any of that looked like, so that was really cool. I learned more from this, than other things, honestly.

Table 11

Transfer of Learning Goals and Objectives, Signs of Desired Learning Outcomes

<u>Cathy's Experience</u>
About Cathy: PA-1, no prior experience of rehabilitation or spinal cord injury patients, 3-4 years of prior clinical experience *in the area of developmental disabilities, home care, and working in a skilled nursing facility.*

Take-away from *Matt Lane*	**Goals/Objectives/Outcomes**
"I feel like there were some specific medical principles that were really clear … Things that it seemed to emphasize … was checking on his well-being *constantly*. … on the second day when it was the ulcers,...you know in class we're learning about a diagnosis?	Pressure Ulcer Risk Awareness, Pressure Ulcer Grading and Staging (Learning Objectives)
And there [are] other *serious* things that come up, so I feel like this really emphasized that you have to be constantly checking and I should have been looking at the *whole* medical record on the second day!"	"How to" provide care (Learning Goal)
"Because seeing ... just like the videos ... exposure to that ... when you're in class they say these words and I didn't have *any idea* of what any of that looked [like], so that was really cool. I learned more from this, than other things, honestly."	Empathy, The experience of care for a person with spinal cord injury (Learning Outcomes)
"The patient education thing, really stuck in my head. I should not assume that just because he's had this [spinal cord injury] forever that he knows everything."	Write appropriate orders to assure patient competencies (Learning Objective)
"… because he was so normal, he was such a normal person! It will help me be more comfortable going into the room with someone."	Empathy (Learning Outcome)

Other learners' responses, however, suggested that they were unprepared for the goal of transferring an appreciation of patient-centered care and empowerment, the principles of which have been shown to be complex, but nevertheless taken for granted in the culture of rehabilitation (Gzil et al., 2007). Stacey and Dana, both PA-1 participants, affirm the patient's engagement in his own care, but also show that they are uncomfortable with an implied discarding of the medical model of care.

Table 12 shows the reluctance of Dana and Stacey (despite her outpatient rehabilitation experience) to take away the patient-centered message. The relaxed reaction of Maria, a PGY-2 rehabilitation “cultural insider,” is provided to demonstrate counterpoint.

Table 12

Less-Than-Successful Transfer of Patient-Centered Care Model in Matt Lane

Discomfort with the Patient-Centered Care Model	
Researcher: This [video of Matt Lane ticking off the medications he takes] is trying to simulate talking to the patient. Is that valuable or ..? *Dana:* Yeah, because it's one thing if it's written out in the chart versus another of what he actually takes. I also would probably have to go check and go see if this is what he's ... he said this is what he's taking, it's not necessarily what he's prescribed. … So I don't know if he's SUPPOSED to be taking, I don't know, 5 valium a day at night. I'd have to check that and compare it with the actual dosages.	*About Dana:* PA-1, no prior experience of rehabilitation or spinal cord injury patients, 5-6 years of prior clinical experience in the area of mental health.
Researcher: Is this interesting to you? How he directs his transfer? *Stacey:* “Yeah, it is. It shows he is involved with his own care. He [tried] to direct what the professionals were doing. … It incorporated his involvement with their expertise, without stepping on his toes. It is good when patients are involved in their care, but not blinding the professionals from doing what they know is right.”	*About Stacy:* PA-1, no experience with spinal cord injury patients, 2-3 years previous experience in (outpatient) rehabilitation.

“At Home” with the Patient-Centered Care Model	
Researcher: [Discussing a vignette in *Matt Lane*] The intention was to show people who don't have any idea about what it means to have C5/6 spinal cord injury [i.e. at the level of the $5^{th}/6^{th}$ vertebrae], what it means to turn and.. then to hear him direct his care. *Maria:* Yeah, that's oh, I was like in my mind, “Oh HE’s pretty good at telling them how to position himself! … It's so funny, he's like *VERY* good, telling them, alright!”	*About Maria:* PGY-2, less than 1 year of experience in rehabilitation, completed spinal cord injury rotation.

Other learners did not feel that the *Matt Lane* learning goals and objectives were always clear and, particularly, that they were less clear in the Day 2 module than they were in the Day 1 module. Zoe, a PA-1 with some clinical experience (six months to one year) but no prior experience with rehabilitation or spinal cord injury, shared:

> I thought the first day was a lot clearer. I felt directed. I felt like I knew what the purpose was. It was to get a history; do the physical exam. It was *kind of the order we were taught:*[15] See the patient, take a history, you do the physical exam, you order tests. It all was very fluid; it made sense to me. So I'd say the objective for the first day was to see the patient and go through the case as if it were a real patient, as if you were there."

Much of Day 2, on the other hand, bore no resemblance to anything the PA-1's had been taught. It did not proceed in such a way that learners could apply patterns that they had previously learned to a new patient case.

As in the Day 1 module, Day 2 goals were framed with the patient handoff procedure (Figure 8) terminating with the recommendation to review the medical record closely. Note that on Day 2, handoff was framed explicitly according to the ISBAR[16] clinical communications protocol that was taught in the Day 1 module. Learners were free to review the medical record in any order they chose and then go see the patient. The medical record contained details for the care Matt Lane had received since the learners had seen him the previous day. The initial task was to find the gaps in care and address the risks those gaps presented with respect to preventing pressure ulcers. Once the ulcer was discovered, the task was to stage it according to NPUAP guidelines.

The medical record was modeled on an actual patient record and the errors and omissions embedded in it, representing two days of an inpatient admission, were real. Maria, PGY-2 with a recent rotation on the spinal cord injury unit under her belt, remarked, "Here,

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[15] Researcher's emphasis.
[16] ISBAR is an acronym for identification, situation, background, assessment, and recommendations.

it's kinda harder … like it's harder to think about it, ‘cause it's so... *so many* things you can think about.”

Zoe, as was the case for all the other PA-1 participants, had little prior experience with medical records. She reflected on Day 2 of the *Matt Lane* VP: “So you really want everyone to get *to* the pressure ulcers. That's the main goal.”

Shari, a PA-1 with no spinal cord injury or rehabilitation experience but with 3-4 years of clinical experience in developmental disabilities and emergency medicine, amplified, “The pressure ulcers were the best part. I think because it was in *that structure*, following along.”

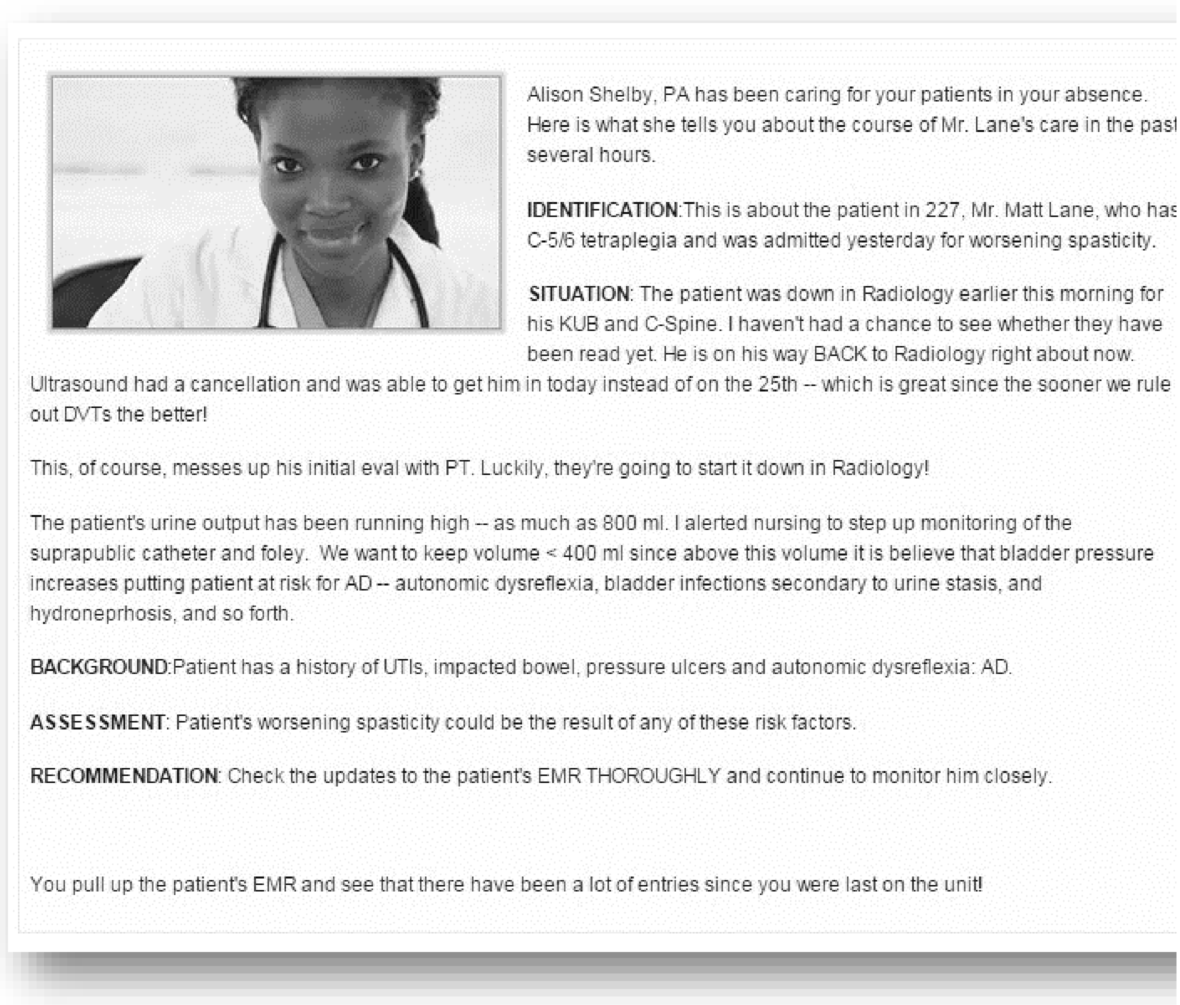


Figure 8. Handoff Screen, *Matt Lane Day 2 on the Unit*, framed explicitly according to the ISBAR structured clinical communications protocol.

> "I'm actually kind of confused. Do I want to see more of this stuff? I'm pretty sure I should look at all of it.. Ahm, I don't know."

Figure 9. Shari's think-aloud.

The sequence Zoe described on finding and grading Matt Lane's pressure ulcer was the only truly linear component of Day 2 in contrast to Day 1, which, as she previously noted, was largely linear and directed. Shari, based on the confusion (think-aloud inset, Figure 9) she felt during *Matt Lane*, Day 2, advocated a conventional, explicit communication of learning objectives to the learner:

> Part of the curriculum here [in her academic program] for all of our lectures is there's objectives listed at the beginning of every PowerPoint. It's supposed to give you an idea of what you're supposed to be learning. So I'm thinking like that would be helpful, to have a list of objectives. Like ok, you're going to see this patient and by the end of this case, you will have learned how to evaluate lab values, perform [a] skin exam -- so maybe give a little bit of direction, like, "Oh, ok. Now I know what to do, what I'm supposed to be learning."

In summary, The Learning Goals Method of GBS Theory was present in *Matt Lane* and it was implemented within the virtual patient's story. This technique worked for some learners, but not for others. Where it did work, access to real patient and clinical experiences were pivotal. Learner descriptions of a need for directedness, preparation, and simplification were key factors identified with goals that didn't work.

Method 2: The Mission

Table 13

The Mission in *Matt Lane*

GBS Method	**Method as Exposed in *Matt Lane*, *A Pressure Ulcer Prevention Virtual Patient***
The Mission	Consistent with target learners' clinical role, provide evidence-based pressure ulcer prevention and management care to a patient with a physical disability (spinal cord injury) who is at high risk.

The GBS instructional design theory (Schank et al., 1999) is built on the learning theory of Case-based Reasoning (p. 166). Reasoning from cases, according to Schank and colleagues, applies both within and across contexts. It has also been widely cited as the way experts arrive at diagnostic decisions (See Chapter 2 Summary, Chapter 2 of this report, *Review of the Literature*). Learners in the current study also appreciated the value of case-based reasoning in their learning. Shari made the following observation:

> This is really what we struggle with now in class, is the fine details, and we ask, "When do you order this besides this? When do you order besides that?" And the answer's always, "It depends." So it's interesting to see it in terms of a patient. So you say, "Ok, this patient, I'm just going to order BMP and CBC, but since I am worried about a UTI, I'm going to order a culture and sensitivity on the urine." So it's nice to have that feedback. You don't really get that in a classroom, 'cause you CAN'T. You have to do it on *a case-by-case basis*.

A key mediator of Case-based Reasoning is that the chosen case be intrinsically motivating to the learner (Schank et al., 1999). The mission, or performance goals (versus instructional goals) of the case must motivate the learner to engage. Shari, again, informs, this time on the importance of motivation in pursuing case-based learning:

> *Shari:* I wouldn't know enough about a baclofen pump to know if he's missing a big thing. Umm, so I'd have to research to know, 'cause I don't have any like background information on that.
> *Researcher:* You could X out and look it up. You could read up on baclofen pumps or, just submit it and get your feedback.
> *Shari:* If I was doing this in real life, because this isn't necessarily -- this is going to sound bad: This isn't a topic that interests me -- I wouldn't be inclined to do my own research. But if it *was* a topic I was really interested in, I think I *would* do my own research. So I guess it depends on, ahm, what the topic was.

Though participants were informed of the topic of *Matt Lane* at the time of recruitment, they were not screened specifically for interest in pressure ulcer prevention, rehabilitation, or spinal cord injury. The process of testing *Matt Lane* was influenced by learner motivation that, reasonably, is not the same as the motivation experienced by the learner interacting optionally and autonomously with the intervention. Many factors mediate the amount of time a participant stays engaged in a learning intervention in a testing context: other pre-existing obligations, rapport or lack thereof with the researcher, technology troubleshooting, and personal style, to name a few (See Table 6, *Learner Situationalities and Testing Circumstances with Potential Impact on Participation and Responses*). However, when the amount of time learners spent on the *Matt Lane* VP was examined, individuals with specific interest in spinal cord injury, rehabilitation, and research generally speaking trended (with one significant outlier) toward spending longer amounts of time engaged in the intervention (Table 14).

Table 14

Learner Time Engaged with Matt Lane and Learner Areas of Interest

Learner	Max time on a *Matt Lane* Module *(hrs:mins:secs)*	Stated Interest In:		
		Research	Rehabilitation	Spinal Cord Injury
Emily	01:52:50	-	yes	yes
Maria	01:43:28	yes	yes	yes
Shari	01:26:10[17]	-	no	no
Andie[18]	01:14:04	yes	-	-
Alyssa	01:09:54	-	-	-
Stacey	01:04:09	-	yes[19]	-
Jess	01:01:47	-	-	-
Dana	00:59:30	-	-	-
Zoe	00:43:18[17]	yes	-	-
Cathy	00:41:05	-	-	-

This observation suggests, though certainly does not prove, the correctness of the contention of Schank et al. (1999) that *intrinsic* interest in a case in motivating and an important underpinning of The Mission Method in GBS Theory. This impression is significant given that theory building in the current study targets the situationality of VPs for autonomous, study. If a case does not appeal to learners in free, self-directed learning situations, they will likely not engage with it. However, even if a particular patient case is

[17] The focus group discussion (Shari and Zoe), which took place after completion of both Day and Day 2 modules of *Matt Lane*, was excluded from the time-on-VP calculation.

[18] Interest presumed, participant recruited from School of Medicine Medical Education Research Journal Club, participation in which is elective

[19] This learner stated she found the VP interesting because of her rehabilitation background. She did not specify rehab as a future career goal, however.

not intrinsically interesting to a learner, the care process, performance of activities supportive of patient care generally, may still be. Experience with *Matt Lane* participants suggests that only two of the learners (Maria and Emily) would have picked a VP such as *Matt Lane* from a library of cases outside of the current design study. Nevertheless, as the task level, it was clear that some aspects of the care process were motivating and engaging than others. Details of what was motivating and not motivating at the task level is proper to and dealt with in the analysis of The Scenario Operations GBS Method below.

Method 3: The Cover Story

Table 15

The Cover Story in Matt Lane

GBS Method	**Method as Exposed in *Matt Lane, A Pressure Ulcer Prevention Virtual Patient***
The Cover Story	Learner, new to the rehabilitation unit of a major hospital, has been assigned to care for a newly admitted patient with spinal cord injury.

The Cover Story Method of GBS is the means by which the learner is linked to the mission of the learning scenario (Schank et al., 1999). “The cover story is the background story line that creates the need for the mission to be accomplished” (p. 174).

In *Matt Lane*, the cover story (Table 15) is established on the introductory screen (Figure 10) of the Day 1 module. (Completion of Day 1 was a prerequisite for testing the Day 2 story, so all learners were exposed to the VP Cover Story.) The learner is a new staff member on the rehab unit of Northeastern Regional Hospital. Fresh from new employee orientation, the learner is about to begin her first shift and receive responsibility for her first patients. This background provides the context for the mission of providing patient care.

Figure 10. Introductory screen to *Matt Lane, New Patient on The Unit*, providing the Cover Story for the virtual patient. The cover story provides the context in which the mission is played out by the clinical role the learner assumes in the VP scenario.

The Cover Story Method works together with The Mission and The Role to provide the rationale and context for the learner's engagement in the learning scenario. In the *Matt Lane* VP, The Cover Story is closely associated with the place where the learner will carry out the mission: inpatient rehab services at a regional hospital. Real-life clinicians provide health care services some*where*, e.g. in specific physical places. Matt Lane, the patient, may be virtual, but the care he is provided necessarily simulates in-person, location-based interactions.

Though PA's are envisioned as an increasingly more important part of the inpatient health care delivery team (Duffy, 2003), the inpatient setting and inpatient routines disconcerted, even if they did not actually displease, the PA participants testing *Matt Lane*. Table 16 exposes the discomfort PA students had with various clinical processes they were called to engage during the VP scenarios. Shari, PA-1, posed the question, "What would a PA actually be expected to *do* with a person with SCI?" and Zoe offered, "It might also be interesting, if you could do an *outpatient* module on this, for more minor injuries, in an outpatient setting."

Table 16

Dissonance for PA Students Relative to the Inpatient Setting and Care Processes

	PA Students' Feedback	
Electronic Medical Records	*Stacey:* We haven't had, umm, training in electronic medical records yet. *Researcher:* They're all different, unfortunately every system you go to will be different Is this helpful or is it too much? Stacey: I find it helpful.	
Dispensing Medications	*Stacey:* I liked how it went through. Ahm so you get, I guess I realized it, that you would do all of these different orders in a hospital setting. Like drugs, tests, labs -- and I know from personal experience that, like when you go to the hospital, you can't bring your own medicines, even though you have them. The hospital has to dispense them. Um, but maybe some people wouldn't know that and they wouldn't order any of *Researcher:* He brought them in his bag [laughing]. *Stacey:* Yeah [laughing]. You're not supposed to, I don't think. When I was in the hospital, they wouldn't let you take any medication that you had. *Researcher*: He brought it. It was show and tell. And they ordered it all again. *Stacey:* I did like that 'cause it kind of takes you through the whole process. Whereas when we practice, it's mostly outpatient. Or when we do our practicals, someone comes in with this complaint, we figure it out.	
The Physical Exam	*Jess:* It might be better to list type of exam, and give feedback and what you should do. *Researcher:* wouldn't you do all of these? *Jess:* I don't think I would have done ENT. I think I would have been more focused. *Researcher:* I am wondering what you do, outpatient versus inpatient. *Jess:* it doesn't have on here, reflexes. *Researcher:* because he is a tetraplegic, he won't have any. Perhaps we should put reflexes, balance and movement on here, and have it be wrong, because you can't measure it.	*About Jess*: PA-1, 6 months – 1 year of experience in Obstetrics and Gynecology clinical research.
Nursing Evaluations	*Zoe:* I'm kind of just generally unsure how to read some of the labs, just because we have a lack of exposure to hospital. So for where it says pain, and then time, and then skill, it says score 0-10. I have no idea what that means. Like I don't know if this was results, of if it just wasn't plain done. I'm not sure.	
Inpatient Therapy	*Cathy:* This one on occupational therapy, I am not sure. I would think he would already have that. *Researcher:* Ah that's for *IN* the hospital.	

Realism was a significant "hook" for engaging the learner, as demonstrated by Emily, a newly graduated MD at the time of testing *Matt Lane* who planned to apply to a Physical Medicine and Rehabilitation Residency Program:2

> I felt it was engaging because it … was true to life. That's what, 'cause I rotated at the rehab hospital for my, ah elective medicine, my medical school elective, and that's what it's like there. Someone comes in, and they say, this is the patient, we don't know a lot about it. And we go like, all right, and you go in and get all the information.

Zoe, PA-1, appreciated the window on the human, non-objective side of medicine *Matt Lane* presented.

> I liked that there was emotion coming or even frustration, 'cause that's real. Patients *do* get frustrated. They *do* feel ignored. And that's an important component also. It's often difficult to convey – Yeah, to be receptive to their feelings, to pick up on that. "Oh, he's feeling neglected, he's feeling like" -- you know. I like that there [were] feelings involved.

If the context isn't familiar, the realism may not be able to have its full force. Stacey, PA-1, related conversations she had had with other PA students relative to the inpatient focus of *Matt* Lane: "I was talking to my friends about it, and we agreed we have been mostly exposed to outpatient things. So I've never seen an inpatient chart. I'm probably naïve to all the forms and record keeping involved."

In summary, The GBS method, The Cover Story, was present in the *Matt Lane* VP. The method was expressed through the setting, inpatient, for providing patient care. The inpatient context of care provision, and hence the Cover Story method, worked for learners who envisioned themselves ultimately assuming responsibilities in an inpatient setting. It did not work as well for learners, PA students, who didn't envision, or hadn't previously considered, that they *might* ultimately provide health care to patients in a hospital as well as in outpatient settings. Despite the fact that the handoff clinician on both Day 1 and Day 2 of the VP case was cast as a PA, the "alien" inpatient setting interfered with PA students' projecting themselves into the role of care providers in the scenarios.

Method 4: The Role

Table 17

The Role in Matt Lane

GBS Method	Method as Exposed in *Matt Lane, A Pressure Ulcer Prevention Virtual Patient*
The Role	Junior clinical decision maker in an inpatient post-acute setting: resident physician, advanced practice nurse, physician assistant.

The Role Method (Table 17) is tightly bound to The Cover Story. Whereas the latter identifies the context for action, the former identifies the "actor." At the start of each "day" of *Matt Lane* and directly following the "cover story" situating narrative, the learner was asked to choose a care provider role: nurse practitioner, physician, or physician assistant (Figure 11). The question was intentionally framed to be suggestive of choosing a role in a video game in keeping with the intensive use of video media in the VP.

Figure 11. Provider role selection question in *Matt Lane, New Patient on the Unit* (Day 1)

Subsequent screens of the VP would then reference and address the learner appropriately, according to the role chosen. The care provision activities learners engaged in, however, were identical regardless of provider domain role and clinical tradition selected.

Not to blur the many real distinctions among the various care providers who practice in hospital settings, in terms of basic, first-line patient care, resident physicians, physician assistants, and nurse practitioners all perform the same, essential tasks in looking after their patients. Therefore, each role has a different "wrapper," but the same actual clinical content requiring the same application of clinical reasoning and best-practice decision-making.

According to Schank et al. (1999), the significance of the Role Method lies in its power to provide a compelling context for action and be truly motivating to the student (p. 175). Students preparing for a specific health care profession would be motivated to participate in a clinical scenario where they would be called on to act out the role they aimed to fulfill upon completion of training. In fact, each of the 10 students who interacted with *Matt Lane* chose to do so as the type of clinician they were hoping to become. The rationale they provided for their selections was variable, however.

Stacey, PA-1, who indicated on her Education and Experience Survey that she rarely played video games, related that she hadn't really understood she was picking a role to play in the VP scenario when she clicked on the choice, physician assistant. This misunderstanding is consistent with experience during the pilot of *Matt Lane* with medical students selecting the nurse practitioner option simply because it came first in the list (Schladen et al., 2014). Stacey related that she chose the physician assistant option because she was in a physician assistant training program and thought that was the option she should chose to derive benefit from the exercise. She explained, "I didn't understand what it was asking. … But in terms of using this as a training tool, I would want to pick it from the perspective of the PA for the job that I was going [to fulfill]."

Alyssa, PA-2 and daily video gamer, was unsure about how to approach role choice.

> *Alyssa:* Ok. So, I'm not sure what I'll be doing exactly. I'm reading about his history and?
> *Researcher:* Yeah, you're gonna [stumbling] you're gonna play a role and you're gonna go in and provide CARE, to this patient.
> *Alyssa:* Ok.
> *Researcher:* The format kinda walks you through it. It asks you for some stuff and it gives you some stuff. Ahm. We'll see as we go along.
> *Alyssa:* Alright. … I just want to know what I'm doing. So that's ok.
> *Researcher:* It doesn't bite. So don't worry.
> *Alyssa*: Haha [laughing], Ok. So I'll be the Physician's Assistant, ok.

True role playing seemed to be more resonant with the physician trainees. Andie, M-1, recognized the choice when she selected the physician option, commenting, "I want to do -- physician."

Emily, M-4 and a weekly gamer, read the directions aloud and moved her cursor without hesitation to the physician role option. Maria, PGY-2 and a daily video gamer, also recognized she was selecting a role. "I guess I'll be the physician here," she commented as she made her choice.

Participants who provided a rationale for their choice of the familiar role, the one for which they were in training, explained that they didn't know how to perform in the other provider options.

> *Researcher:* Would you be curious about playing another practitioner?
> *Maria*: Yeah. The problem is I don't know how comfortable I'd be in that role. They would be doing different orders, right? It's like, if they were going to tell me, 'How am I going to transfer this patient?' I think I'd be like, 'Ahh, I'm gonna get the call gal.' It'ould be interesting, though.

In the course of their focus group interaction, PA-1 students Shari and Zoe denied the appeal of projecting themselves into their ultimate professional roles as practicing PA's, which they perceived as threatening as opposed to motivating. The excerpt below is follow-on to conversation about guidance and support in making decisions in the VP.

> *Researcher:* Part of this theory [GBS] is that role is really important, and I saw both of you click PA, but now I'm wondering if that's really what role means. Role is what you're doing, not necessarily your professional image?
> *Zoe:* Really we're like PA *students* so maybe it would be better if it's seen as if we are on rotation, and we always have a preceptor there to ask questions. This is kind of throwing us in, as if you are a PA and you're on your own and you have no help. Which is like, maybe a step further. Because our next step is to go on rotation with a preceptor.
> *Researcher:* I conceptualized it differently, like this is what your objective is, so you're projecting yourself into the role you're training to be. That it's probably too much in your first year? We could project you into being in year 2?
> *Zoe:* Yeah.
> *Researcher:* That would be better?
> *Shari:* That's probably why I was more comfortable with the doctor giving me immediate feedback [one of the strategies fielded in the VP scenarios], 'cause we're used to that, and he gave me more guidance versus, "I'm not sure if I'm doing this right or wrong."

Picking to enter the VP scenario in the role one was training for also enhanced the realism, a quality often noted with appreciation, of the experience. Cathy, PA-1, share this reflection after completing both Day 1 and Day 2 *Matt Lane* modules.

> *Researcher:* So part of this [e.g. learning through VP scenarios] is playing a certain role, you choose to play a PA— Did that help you? It's part of the theory.
> *Cathy:* [Pauses to think for a minute] It made it more real for me, it felt like a *real* thing.

In summation, no participant claimed to be motivated by projecting herself forward into the position toward which she was working and taking satisfaction from realization of that professional goal. Some participants' demeanor/diction suggested that they recognized the role-play motif from gaming. A sense of uncertainty, of being testing and wanting to meet expectations, may have inhibited confiding satisfaction, if any, in an environment simulating the learners' expected professional future. See Table 8 for situationalities and testing circumstances applicable to different learners that may have impacted their report of any enjoyment of sense of achievement in acting out their target professional roles.

As has already been described, PA-1 learners, for the most part, did not see themselves, ultimately, as working in inpatient care settings and hence, they may not have been motivated to project themselves into the role of care provider for Matt Lane during his inpatient stay. Fulfilling a role was appreciated commensurate to the opportunity it provided to practice what had been learned in didactics. Learners seemed to be reading “exercise” for “role.” *Relevance* of exercises, such as VPs, to training was of paramount concern. As will be further described in the following section on the scenario operations method, the “doing” aspect of role was motivating to learners but the impact of the “being” aspect was equivocal.

Method 5: The Scenario Operations

Table 18

The Scenario Operations in Matt Lane

GBS Method	Method as Exposed in *Matt Lane, A Pressure Ulcer Prevention Virtual Patient*
The Scenario Operations	Interact with patient, interact with other clinical staff, conduct histories and physical exams, use structured evaluation and communications processes, review clinical documentation, perform diagnoses, prescribe and carry out therapeutic interventions.

Just as GBS Theory methods two through four: The Mission, The Cover Story, and The Role, form an interrelated and complementary group, so do the final three methods of GBS. The first of those methods, The Scenario Operations, comprises "all the activities the student does in order to work toward the mission goal" (Schank et al., 1999, p. 175). The subordination of *mission* to *goal* in the phrasing used by Schank et al. is mirrored in the scenario operations method as implemented in the *Matt Lane* VP (Table 18). In *Matt Lane*, as prescribed by GBS Theory, learners are directed toward a series of activities that structure their performance of The Mission. These activities simulate standard clinical tasks: taking a patient history and performing a physical exam (the "H&P"), developing a differential diagnosis, writing orders, reviewing test results and patient progress, and communicating effectively within the care team, particularly during transitioning responsibility for the patient ("handoff" communications).

The *Matt Lane* VP scenario operations leveraged audio, extended by both video and still images, to provide learners opportunities to hear, observe, and interact with authentic patient and clinical team members in clinical activities (mission) that are part of the care provision process (goal). Narrative text with still images and illustrations was also used to bridge multimedia and to provide variety. Learners also had the opportunity to examine authentic clinical documentation artifacts, adapted to the *Matt Lane* storyline. Such medical record items available for inspection and use in clinical decision making included: laboratory results; radiologic images and reports; patient care, hospital flow sheets (shift by shift); interdisciplinary assessments; the Braden Scale assessment (captures pressure ulcer risk and templates a mitigation plan); and the Falls Risk assessment (captures risk and templates mitigation, similar to the Braden Scale).

The multimedia artifacts, narrative, and other learning resources were organized into clinical activities learners to engage in through the DecisionSim™ VP authoring system. DecisionSim™ templates (screens, called "nodes" within the DecisionSim™ platform and referred to in this report as DS-nodes to differentiate them from coding nodes in NVivo 10©, and logical groupings of DS-nodes) provided the means for structuring content into the clinical activities that constituted the scenario operations of the *Matt Lane* VP. As set forth previously in Table 9, the 144 DS-nodes that presented the two days of an inpatient admission in the *Matt Lane* VP each used one of the five basic templates, DS-node types, to support learner interaction. The different types of clinical activities spanned multiple DS-nodes and multiple types of DS-nodes were used to simulate the various clinical activities proper to providing patient care on an inpatient rehabilitation unit.

Table 19 displays the different types of DS-nodes used across the clinical activities modeled. All DS-node types accommodated insertion of multimedia and hyperlinks to resources stored outside the system.

Table 19

DS-node Types Used to Simulate Clinical Activities in the Matt Lane VP

Clinical Activities	**DS-node Types Used**				
	Narrative	**Branching Logic**	**Free Text**	**Inquiry**	**MCQ**
Handoff Communications	X		X		
Taking a Patient History	X	X	X	X	
Conducting a Physical Exam	X				X
Grading Pressure Ulcers	X				X
Writing Orders	X			X	
Reviewing Clinical Documentation	X	X	X	X	
Identifying and Addressing Risk (Differential Diagnosis)	X	X		X	

The DecisionSim™ authoring platform also provided the ability to examine various conditions of learners' paths and decision histories as they worked through the VP to provide customized next steps and feedback. See Appendices I-O for examples of each DS-node type and incorporated media as used in *Matt Lane*. Figure 12 is provided as a graphical summation of the process of translating authentic clinical media and documentation artifacts to online, interactive VP modules.

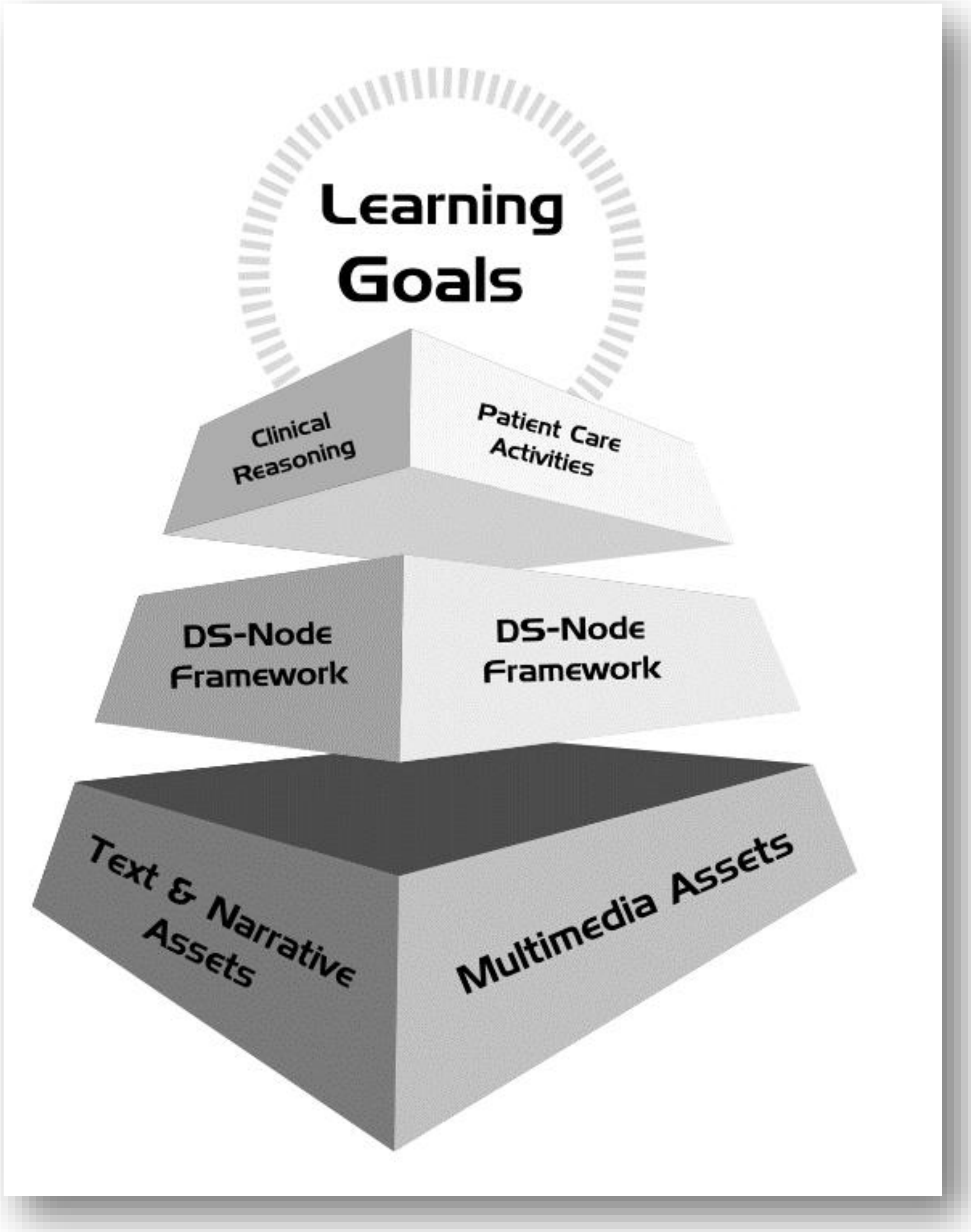


Figure 12. Translation of authentic multimedia, text, and narrative assets through the DecisionSim™ authoring framework to model patient care activities and opportunities to apply clinical reasoning to attain the learning goals of *Matt Lane, A Pressure Ulcer Prevention Virtual Patient.* Illustration by Cathleen L. Roskind.

The flow and connectivity of DS-nodes differed from Day 1 to Day 2 scenarios in the *Matt Lane* VP following the shape of patient care activities that predominated on each of those days. Day 1 proceeded in a principally linear fashion according to the standard clinical sequence of doing a history, examining the patient, and writing orders (See Figure 13). Day 2 conversely, built on Day 1 and focused on activities that did not tend to follow a prescribed or standard order: reviewing the patient record, developing a differential diagnosis, and, ultimately, grading (evaluating) the patient's pressure ulcer (See Figure 14).

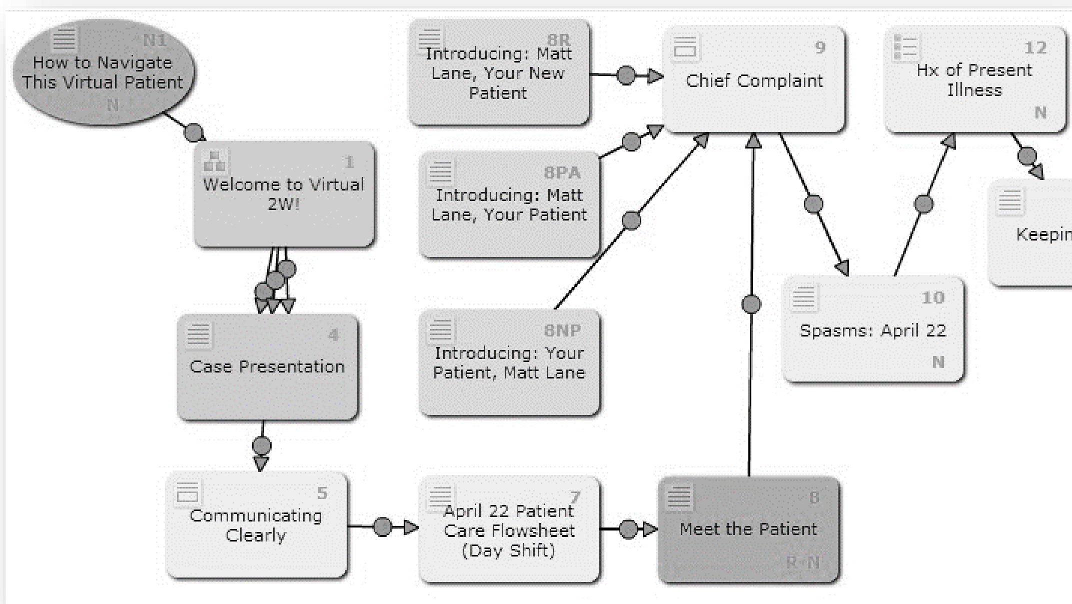


Figure 13. DecisionSim™ case map for segment of Day 1, *Matt Lane, New Patient on the Unit*, showing linear flow of DS-nodes and patient care activities

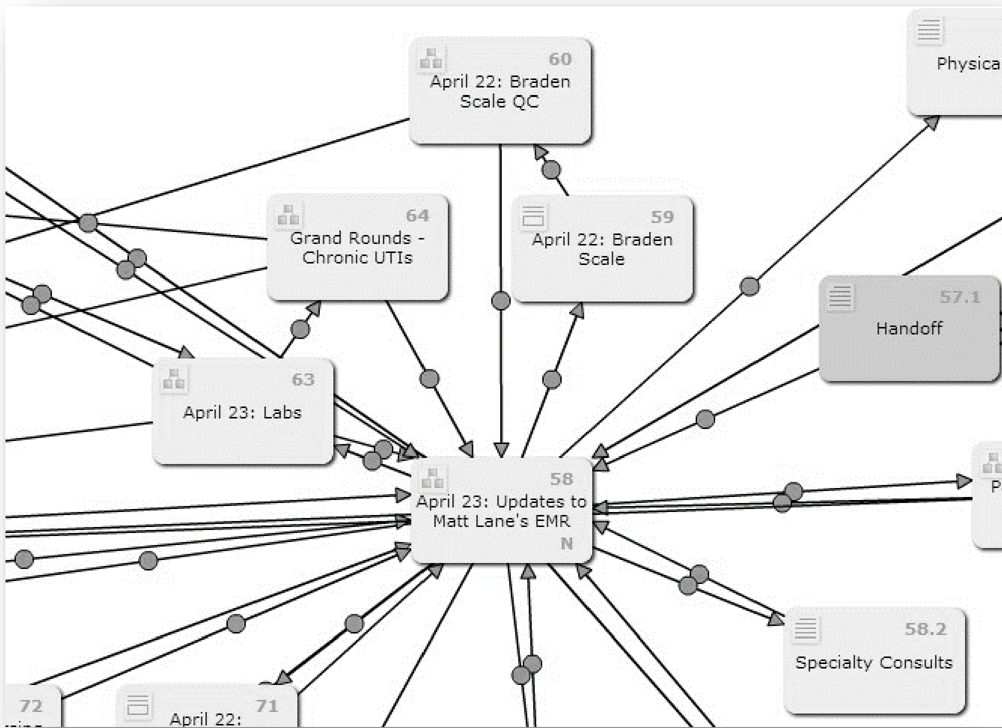


Figure 14. DecisionSim™ case map snapshot for clinical documentation review segment of Day 2, *Matt Lane, Day 2 on the Unit*, showing non-linear flow of DS-nodes.

As has already been revealed, learners preferred Day 1 to Day 2 commenting on its more readily intelligible organization. The sections that follow trace what worked and didn't work to enhance learning for each of the clinical activities presented for learner engagement in the *Matt Lane* VP.

Handoff Communications

"Handoff" refers to the transfer of responsibility of patient care from one clinician to another, particularly (but not exclusively) at shift change. Since patient safety depends on clear and accurate communication of patient status to the person assuming care, implementation of succinct communication protocols is increasingly perceived as a best practice in health care (Marshall et al., 2009). Protocols are often adopted from the military, as is the case with the ISBAR (i.e. Identification, Situation, Background, Assessment, and Recommendations) protocol (J. E. Thompson et al., 2011) modeled in *Matt Lane*.

A narrative and free text DS-node grouping was used to engage learners with ISBAR. This process also served to clarify the scenario mission for the learner. The scenario virtual PA, Alison, models ISBAR for the learner (Figure 7) and in the course of the handoff informs the learner that she needs to "do an H & P and write orders, and remember he is tetraplegic and at higher risk for a number of secondary conditions as a result." The learner then reflects back to Alison (by typing in a text box) what she has understood, using the ISBAR format, to provide verification of accurate communication. Learners click "submit" and receive a model communication, with elaboration on its important characteristics, against which to compare their own efforts at handoff. See Appendix I, for illustration of practicing (learner) and modeling (faculty) handoff communications using a free text DS-node. Figure 15 shows the linear connection of narrative to free text DS-node.

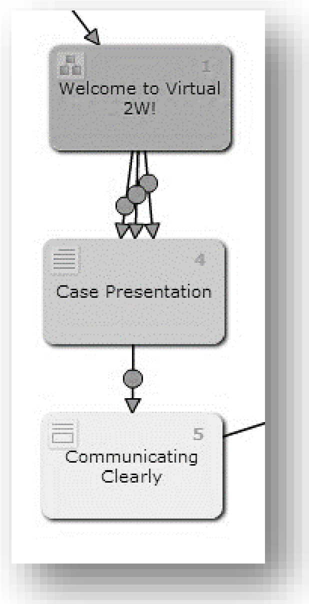


Figure 15. Narrative node (4) directs to free text node (5).

Only one learner, Andie, M-1, had previously heard of the ISBAR protocol or structured clinical communications. No participant provided a properly structured communication, but exposure to the concept was valued by all. Emily, M-4, shared on viewing the model handoff provided as feedback: "Ok, that's good. I mean I didn't, I never *heard* of the ISBAR protocol. I didn't think of it in that way, so yeah that's good. It helps you reflect on different [standards for transfer of responsibility of care]."

Alyssa, PA-2, commented enthusiastically, "I do like that ISBAR model, to learn how to communicate!"

Alyssa also noted, however, that the exercise would have been more productive if the concept of structured communications and the ISBAR acronym had been presented *first*, with practice constructing one's own communication to follow.

Emily, M-4, appreciated the strategy of framing one's own answer and then receiving a model to critique oneself against, commenting that it worked well with her learning style.

> *Researcher*: Was it good to think about it first, write it down and then get the immediate feedback?
> *Emily*: Yes. Yeah, I like getting immediate feedback. Like writing it down...I learn through my mistakes and so if I get it back immediately, then I'll fix it immediately. Do you know what I mean?

Dana, PA-1, reflected that the free text entry followed by return of model response was what she would expect by way of instruction when she began her clinical rotations the following semester.

> *Researcher*: How do you feel about that kind of feedback?
> *Dana:* This?
> *Researcher:* You type in what you think and then get the supposedly complete answer.
> *Dana:* No, I mean, that's the right way to do it. I don't really know what to do, so I need guidance in this situation. It doesn't bother me. I assume that's what I'd get in real life.

Zoe, however, was disconcerted by the fact that the model didn't explicitly acknowledge her own efforts. "It doesn't matter so much to see what I've typed. It's kind of like the feedback was explaining what I should have typed, and I DID type that."

In non-experimental conditions, instructors authoring free text DS-nodes would typically direct the learner's response to be e-mailed back to them for non-synchronous evaluation and feedback to the learner. That component was lacking during testing of *Matt Lane* and the learning experience diminished for Zoe as a result.

Taking the Patient's History

Learners interacted with the scenario character, Matt Lane, and took his history across 18 DS-nodes where they: played authentic media of the *real* Matt Lane describing his symptoms and concerns; chose more appropriate versus less appropriate ways to question Matt Lane, a patient with acute symptoms secondary to a long-term, chronic condition, spinal cord injury; and documented what they learned from the patient for his record.

Free text DS-nodes were used for presenting Matt Lane's descriptions of his condition, medications he was taking, and his concerns about increasing spasticity (involuntary contraction and shaking in the lower extremities), the reason for his hospital admission. The learner could play and replay patient audio descriptions before documenting what the patient related and getting model feedback through the mechanism of the free text DS-node, which has been previously described. Video of the patient actually experiencing spasticity, and interacting with nursing and therapy staff around the problem, was presented in the course of the unfolding narrative. Watching the shear force spasticity placed on the patient's body during a spasm provided tacit, visual demonstration of the nature of the to the pressure ulcer risk he was experiencing. All multimedia used in the *Matt Lane* VP was stored on the character's YouTube channel but played within DS-nodes that referenced it. See Appendix J for links to all multimedia artifacts used in *Matt Lane*.

Figure 16. Free text, DS-node with video wherein the learner is prompted to listen to, understand, and document the patient’s concerns about an anticipated treatment his problem with spasticity, a baclofen pump implant.

Figure 16 shows the presentation of a free text DS-node that guided the learner in documenting the patient’s concerns, presented through clips created from the interactions of the real Matt Lane with his health care providers, about his spasticity and possible treatment. A similar approach was used to capture the patient’s chief complaint and current medications. This information is a key part of the standard patient history.

Table 20

Taking a Patient History: What Worked (Media-Enhanced Free Text DS-Node Interaction)

Positive	**Experiences**
Facilitated really listening to the patient (Patient-centered care)	*Maria:* It's a good exercise to make sure you understand what the patient's thinking about. ‘Cause he was talking about [a] pump and you basically need to listen to him, and then you need to address what are his concerns. Especially like, I didn't think about this last part. [The patient raised an issue the clinician had not thought of independently.] *Andie:* Good point! [response to same statement remarked on by Maria] I didn't even think about that, muscles.
Facilitated practice of observational skills	*Researcher:* Are you getting an impression of this patient? *Emily:* … He seems to be in pretty good spirits well adjusted. *Researcher:* And you wouldn't know that without the video? *Emily:* Exactly, yeah. … The tone of voice, even the way he looks, like he's a little overweight, ahm, you know that's not good, but like ... you would get that from a picture, I guess, but you *wouldn't* get his tone of voice and his affect or anything like that. Because depression is also something you want to look out for. He's taking valium, it's a mood stabilizer … But you want to have an idea also of a patient's mood and everything.
Provided a context for exploration	*Dana:* I didn't know if you could see what I'm doing on the program or not. *Researcher:* Kind of .. *Dana*: Like I'm looking this up on Google to find out what the baclofen pump does and the risks online -- and I looked up FES because I didn't know what that was.

Table 48 in Appendix J provides an overview of aspects of the presentation of patient media with free text responses and model feedback worked to enhance learner experience of taking a patient's history. Both Maria and Andie were impressed by the fact that the patient ventured a concern about getting a baclofen pump to manage his spasticity they had not considered. The exchange was successful in underscoring the importance of listening carefully to patients and engaging them as partners in their own care.

Emily reflected on the importance of learning to identify a patient's mental state. She noted that she picked up on the patient's affect largely from his verbal expression in the course of the history interview. Dana was motivated to seek out information on baclofen pumps and functional electrical stimulation (FES) to address Matt Lane's concerns in scenario.

Table 21 points out some of the negative aspects of the media-plus-free text DS-node strategy for simulating taking a patient history. Unlike Dana, Cathy and Stacey experienced being faced with questions from the patient about things that were not familiar to them negatively. Andie thought that providing the learner more cues as to what was at issue, for example that FES was a treatment, not a side effect, would have improved her experience of trying to address Matt Lane's concerns. In addition to hesitating over unfamiliar medical issues in the scenario, Stacey also hesitated over the unfamiliar, patient-centered, clinical approach to interactions modeled by *Matt Lane*.

Dana, who had, in fact, gone out to the Internet to look up information she lacked in interacting with the patient, pointed out that doing so actually interfered with the realism of the VP experience as a clinician would likely *not* look up things while taking a patient history in real life. Similarly, Maria pointed out that the free text strategy prematurely curtailed her interaction with the patient as it did not provide a way for her to return questions to the patient, to authentically engage in dialog. Shari noted that listening to the patient to record his meds only partially modeled an authentic interaction as she would adopt an exercise-focused strategy to succeed at the task versus the patient-focused strategy she would employ in a real clinical encounter.

Finally, the field quality of the audio track caused learners some difficulty in understanding, at times, what Matt Lane was telling them. It is perhaps notable that Maria, a PGY-2 medical resident who was actually familiar with all the terms the patient was using to express his ambivalence over his spasms, had to play his video multiple times to be sure she understood him.

Table 21

Taking a Patient History: What Didn't Work (media-enhanced free text DS-node interaction)

Negative	**Experiences**
Premature curtailment of interaction	*Maria:* There are A LOT [of issues] actually that I want to talk to him about … I want to know if he knows what it *is* [a baclofen pump] how it actually works, how it's placed, what are the evaluations prior to him being able to get a pump placed, ahm, what are the risks of getting it placed. It's a surgical procedure! He can have infections, the pump can move, ahm, he may not respond to it -- and addressing issues that he's already told me about. So there are still a lot of factors that are still absent.
Lack of quality of field-captured audio	*Maria:* It's a bit hard to hear certain words, so I'm just gonna replay it [replays video]. I still can't hear some of the words he said, but I think what he said was that I still have pretty good tone and is it going to go away with the baclofen. I'm just going to play it one more time and increase the volume. [plays video a third time] Yeah, I think that's it.
Not faithful to authentic clinical process	*Dana*: A lot of what I'm doing I couldn't do with a live patient. I couldn't just Google something in the middle of my history with him I wouldn't most likely. It depends on the situation I guess…. I'd leave the room and go do it but I wouldn't do it in between "his concerns."
Non-authentic interactivity	*Shari:* In truth, I'd probably just cheat. Like in real life [e.g. if not in a research situation], I'd listen and type at the same time.
Uncertainty, Medical Knowledge	*Cathy*: I don't know if he is missing anything in his thinking, because I don't know enough about baclofen. *Stacey:* I don't really understand what this is, spasticity. *Andie:* Ok, I misunderstood it, what he was saying. I didn't know he was saying it as another intervention. I thought he meant that that was like some sort of disease he could get. Or some other side effect. So it might be, as a clue, maybe treatment, or something like that. Instead of just "FES."
Uncertainty, Clinical Approach	*Stacey:* So he just said the concerns? *Researcher:* So if you were actually doing a history on the patient, you would have a place where you would put -- patient's current complaint -- so you would summarize that there, based on what he told you. *Stacey:* Based on his *concerns*? *Researcher:* umhum

A second approach to simulating the process of capturing the patient's history was through narrative, with and without multimedia. Narrative, DS-nodes were used for this purpose. All DS-nodes are able to incorporate multimedia and text narrative, but the narrative node is specialized to that function in a linear fashion. Appendix K provides examples of narrative DS-nodes used for both video and text-based storytelling. They were purposely alternated in the *Matt Lane* VP to provide variety for the learner.

One of the adjectives learners frequently used to describe their positive experience of video in *Matt Lane* was "real." *Seeing* the patient may have supported learners' confidence that the assessment they were forming during the patient history was correct. See Table 22 for characteristic experiences of realism and truth value in the video exposition of the patient's story.

In one notable instance, the strength of observation led two learners to vigorously dispute the model response provided about whether a line of questioning of the patient was "leading" or not. The model response contended that asking the patient whether stimulation triggered his spasms *was* leading because it was the nurse in the documenting video who suggested this was the case. Emily pointed out, "… but you can *observe* it when they're taking off the, when they're touching the legs if it's happening."

Maria, likewise, would not deny the evidence of her own eyes. "… the nurse was, like, just trying to position his legs and it *was* actually stimulating the spasms."

Table 22

Experience of Video Exposition

Like "real life"	*Alyssa*: I liked it [video]! It made me feel like it was more real. *Zoe*: There's feelings involved … There's dialog in there that sounded like it was something he's actually say. Maybe it was. *Cathy:* Because seeing ... just like the videos ... exposure to that ... when you're in class they say these words and I didn't have *any idea* of what any of that looked , so that was really cool. I learned more from this, than other things, honestly. *Emily:* The scene with the videos was good. Also it was true to life. … I rotated at the rehab hospital for my elective medicine, my medical school elective, and that's what it's like there. *Maria:* I like this [video] better. 'Cause I think this is more real. Versus the other one, like you're reading and you lose concentration. Here I think, you have to have more concentration but this is more real life. *Stacey:* I do like the, I wish there was more that you could *do* with, the videos -- but I don't know what you'd do. It does make it a little bit more realistic.
Truth value in *seeing* the patient	*Andie:* [visceral response to Matt Lane's episode of spasms] Oh. POOR guy! *Researcher:* Is this interesting to you? How he directs his transfer? *Stacey:* Yeah, it is … It *shows* he is involved with his own care. *Shari:* I would think he's in the bed, he's stuck in bed. [But] I *saw* him moving around in bed, so it seemed like appropriate, but I just didn't really know enough [e.g. relative to implications for mobility of a C-5/6 spinal lesion]. *Is asking Matt Lane if stimulation increases his spasms is a leading question?* *Emily:* It's a leading question I suppose. But also another way to ask it would be, what makes it worse? And then you can specifically ask different things. 'Cause sometimes the patients don't think about it, necessarily, but you can *observe* it when they're taking off the, when they're touching the legs if it's happening. *Maria:* Because I noticed that the stimulation really aggravated the spasms, I'm just gonna go on that one first. [picking an option; the system says it's wrong] *Researcher:* So you noticed it, so you don't feel it's just that the nurses suggested it? *Maria:* Um hum. 'Cause the nurse was, like, just trying to position his legs and it *was* actually stimulating the spasms.

Table 23 highlights learners' characteristic experience of text-based narrative. Cathy enjoyed the story-like ambiance facilitated by the narratives. Where narrative text was the vehicle for having the patient provide information about his history, Emily and Shari appreciated it for its ability to expand understanding of the patient. Dana noted that reading is faster than gathering information from multimedia. Alyssa shared that she became impatient with too much use of video. She saw this as a function of the fixed pace of video versus the learner-centered pace of reading. Maria perceived lengthy passages of text as undesirable, requiring more focus than listening to the patient. As in the case video, Emily appreciated the voice of the patient coming through text-based narratives for its likeness to that of a real patient.

Shari's experience brought into focus the clarity of video versus text-based descriptions of the patient. In affirmation of the personhood of a person with physical disability, the text-based narrative describes him as shaking hands with the clinician. Shari was surprised that an individual with C-5/6 tetraplegia could shake hands. Later, when she observed Matt Lane working in conjunction with nursing staff to turn on his side for his skin examination, she understood clearly what his upper body function was and remodeled her concept of what it meant to shake hands. See the final entry in Table 23 for details of Shari's experience.

Table 23

Experiences of Text-based Narrative

Story value	*Cathy:* I really liked the narrative. It was a story. I felt like I was in it, you know what I mean? I really, really liked that. It was like the quotes, and then like the dog's wagging his tail. It wasn't boring at all.
Expanding on basic information	*Emily and Shari's comments reference the rather lengthy narrative of the Social History node (See* Figure 37, Appendix K*)* *Emily:* Yeah, it was ok. It was casual. It was more realistic so you can pick out the important points, like cigarettes, drinking casually, level of education, and then you can build rapport with the patient, saying, "Ah that's great, the work you do," and then he shows you the picture. It's nice to have a bit of dialog. And it's true to life too, so I think it's good. *Shari*: I like that 'cause it helps to get to know him, and also since I know his education level, I would eventually grill him about the smoking 'cause it's not like ignorance is an excuse. I know that I can talk to him about it. I know that he has a master's, so I'm gonna speak to him in a certain way, as opposed to a patient with a different education level.
Learner control - text versus audio	*Alyssa:* sometimes when there's too much video, I get a bit antsy. I can't, like I can't, focus and pay attention, but when there's reading, you can read at your own pace. *Dana:[whether it might be good to convert the text to audio]* …[I]t would take longer for me to listen to him speak it than it would for me to just read it so on a time, it's less efficient but it just might change it up a bit.
Text, focus, & interactivity	*Maria*: This is kinda long. This part, I would say, maybe, interactive might be better. Because people just lose focus. Especially when they're reading such a long thing, versus when you're listening.
Inaccurate image formation	*Shari:* I'm already a little confused. My conception of a quadriplegic is that he wouldn't be able to move, so the fact that he was able to shake my hand [text description], I'm thinking that he's not really a quadriplegic. *Researcher:* Did the turning video help at all with that? You saw he could wave his arm, but he can't really get it there himself. That sort of how he shakes hands too. He puts it up and *you* shake it. *Shari:* I was thinking about it, so that confirmed like I wasn't thinking the right thing because I didn't have the right information for it.

Table 24

Placing the Learner in the Narrative, using 2nd Person Address to Model Interview Technique – Differing Perspectives

Dana's Perspective
Dana: I like the little, "the patient smiles" or "you smile, and nod." It's kind of gives a feeling of like the subjectivity that you don't have it written, like how the patient's responding to you -- if they're getting agitated with you or if they're resistant, you know. If they're smiling and joking with you, it's, you kind of get a better feel for how the interview's going. I like that it's in conversational mode, not just giving me the facts. It's making me like pretend I'm actually having the interview. 'Cause I've done other ones where they just tell you in basic medical terms the facts of the history.
Shari's (Different) Perspective
Shari: It's interesting that this is kind of giving me a personality by the answers. It kind of goes along with my own personality, but I can see how it might not with others. I like that the person that I am is like friendly and sympathetic, but it also kind of takes me out of it because it's assigning me a personality, if that makes sense…. I kind of relate to it: I would want to ask these things, but it kind of takes me out of me interacting because I'm reading what I did, as opposed to doing it. Ahm. but I want all that information. …So maybe it could be, if I can't interact with the patient, which I know is the goal, if it can't be an interactive meeting, maybe I could … ask him certain things … if you had it like "Which questions of these do you want to ask?" … I do like that there is a personality component to this ahm, maybe if, I guess we don't have a video of him. If I picked family history and I just saw him talking so I could just see the patient and it's more just the patient's reaction not my interaction with the patient?

Text-based narrative to facilitate learners' history taking activity was constructed as a dialog between the patient and the learner-as-care-provider. While the patient's contribution to discourse was constructed from the real Matt Lane's medical record and various conversations he had with clinical staff during his video-recorded inpatient stay, the clinician's contribution was cast in the 2nd person ("you") and modeled on clinical discourse best practices for passive learning. Learners were divided as to whether this approach worked or didn't work to promote learning. Dana felt it drew her into the scenario and Shari, conversely, felt it took her out. The two women's related perceptions are detailed in

Table 24. Shari's preference for a bank of questions serves as entrée to the description of the final approach used to facilitate the history-taking activity in *Matt Lane*: DS inquiry node questioning.

The DS inquiry node provides a template for structured questioning. See Appendix L for its appearance to the learner. The DS inquiry node was used to help learners focus their questions to the spinal cord injury patient for both the history of present illness and history of past illness activities, as well as for other clinical activities, such as writing orders and developing a differential diagnosis.

The DS inquiry node template provides a pane for insertion of text or other media. The principal pane accommodates entry of items by the author which, when clicked by the learner, provide an informative response. In the specific case of the history-taking activity, each item took the form of a clinical question, some more, some less appropriate to ask of the patient. The questions embodied standard, clinical interviewing best practices such as "asking permission" (e.g. respecting patients' right to respond or not to what can be very personal questions about their health and function) and open-ended phraseology. In *Matt Lane*, the history questions were also used to inform the learner, through narrative, about various aspects of disability health and well-being.

Each DS inquiry node item was framed as a question to ask the patient to get necessary health history information. When clicked, the patient's response to the question was provided, along with bracketed feedback, noting briefly why the question was fully successful or not. See Figure 17 for an exploded item view.

In the case of *Matt Lane*, responses were scored and the scoring process used as incentive to the learner to approach the exercise thoughtfully. Though scoring is nowhere mentioned in GBS Theory, piloting of *Matt Lane* with medical students prior to the present study suggested that clinical learners both expect and enjoy the process of working to maximize their scores during learning (Schladen et al., 2014). This impression was borne out in the current study. Learners uniformly focused intently on the process of choosing questions to ask the patient.

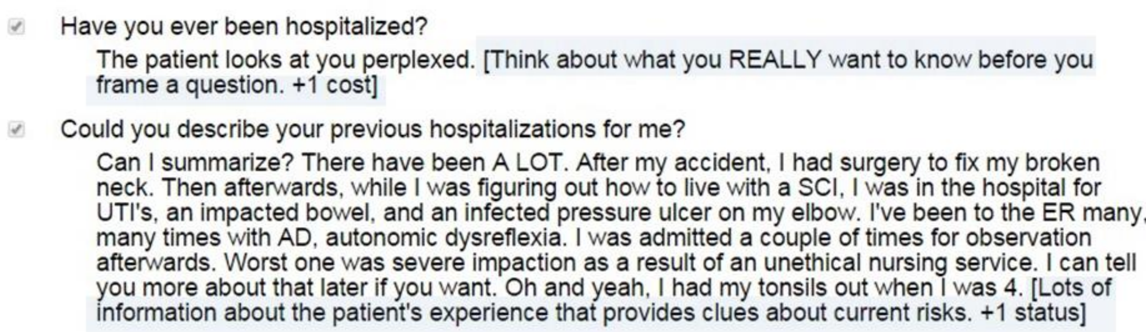


Figure 17. Successive, exploded DS inquiry node items used as questions to ask the patient in taking his past medical history. The learner clicks to select the question, noted by a checked box. Then, the patient’s response appears, followed by bracketed, instructor commentary, highlighted, here, in blue.

To complete Matt Lane’s past medical history, learners selected from 14 possible questions to ask him. Of these questions, eight were correct, meaning they captured essential information in an efficient and respectful manner and enhanced the care provided. This variable was framed (hard coded) by the DS inquiry node template as improving “patient status.” Five questions increased cost, meaning they wasted both the patient’s and the clinician’s time: in health care, time is money. Three questions decreased patient status in that they were likely to cause distress or lead to misinformation. The goal in taking Matt Lane’s past medical history was maximize patient status and minimize system cost. Participants’ scores on this activity are displayed in Table 25.

Table 25

Participant Scores on Patient's Past Medical History

Participant	Program/Year	Status Score	Cost Score	Game Play
Maria	PGY-2	8	0	Daily
Emily	M-4	7	2	Weekly
Andie	M-1	7	1	Rarely
Alyssa	PA-2	5	2	Daily
Jess	PA-1	3	2	Never
Zoe	PA-1	5	1	Never
Cathy	PA-1	6	3	Rarely
Dana	PA-1	6	2	Rarely
Stacey	PA-1	7	1	Rarely
Shari	PA-1	8	0	Daily

Two learners navigated the exercise without error. These learners, Maria, PGY-2 and Shari, PA-1, represented the two ends of the spectrum of participants' experience with patients with physical disabilities. Learners' engagement in gaming was added to Table 25 to explore a possible relationship between engagement (and success) in DS inquiry node activities and gaming. Time-on-task data from the DecisionSim™ system log is not indicative of engagement because of the researcher's variable questioning interposed during the activity.

Maria and Shari employed a similar approach to deciding which questions were and were not appropriate to ask Matt Lane. They evaluated the entire field of questions, identified the least equivocal options, selected and read the feedback from each, reevaluating their planned next choice based on what they learned. "…You want to make sure that everything is good," Maria explained.

Subsequently, Maria and Shari each proceeded to the next round of evaluation.

> Shari: So I have to pick another 3.
> Maria: I see ok. I need [checking items already selected] 1, 2, 3, 4, 5, 6. So I need 2 more.

They continued in the same manner until they completed the activity. Table 26 maps Shari's trajectory in taking the patient's past medical history and Table 27 charts the course Maria took. They each made seven passes through the 14 questions in reasoning through their choices. The other eight participants approached the problem in the same iterative manner as Maria and Shari did, with similar focus and apparent enjoyment, albeit somewhat less success.

> *Emily*: Yeah, it was cool. ‘Cause a lot of the questions I would ask, but you don't need to or you shouldn't ask. You shouldn't assume that just ‘cause someone's chronic, that they would know all these acronyms. So I liked that.

A linear as opposed to iterative approach was anticipated in the design of the past medical history question choices and a logical inconsistency was uncovered by the perfect-scoring participants as a result. Where order of choice is not constrained, the feedback provided for any given item must not influence the learner's choice of any other item.

> Researcher: I anticipated you'd pick top to bottom. But people don't do that. I've discovered people don't do that.
> Maria: Nooo.
> Researcher: They look at them all, because they want to pick the 8 [correctly].
> Maria: Right!

Table 26

Errorless Navigation of a DS Inquiry Node to Query Matt Lane About His Previous Medical History by Shari, PA-1

Questions	**Pass 1→**	**Pass 2→**	**Pass 3→**	**Pass 4→**	**Pass 5→**	**Pass 6→**	**Pass 7**
Comments in		"So many of these things, I don't know what they are."	"So I have to pick another 3."				Researcher guides to last choice. Discloses design flaw.
Q1. ASIA exam?	1-"What is an ASIA exam?"	1-"So I wouldn't pick that one."		1-"Have you ever had an ASA…?"	1-"Q1-3 , I don't know his mechanism of injury. I would LIKE to know it!"	4. "I don't know what an ASIA exam is."	
Q2. Level of injury?	reads					3-"The level, I know it's C6."	1-**Clicks**. "To me, that just reads as insensitive, if I know what his level of injury is and then just ask him what it is."
Q3. Swimming pool?	reads					1-"I feel like this is too specific. I want a question like how did it happen?"	
Q4. Ever hospitalized?	reads					2-"Obviously he's been hospitalized I would think."	
Q5. Previous hospitalizations?	reads		1-**Clicks**. "Unethical nursing service? Oh, my gosh!"				
Q6. Injury, (in) complete?	reads					5-"Complete or incomplete, I feel like I would ask??"	
Q7. More history on spasms?	reads	4-**Clicks**. Gives away Ashworth Score					
Q8. Ashworth Score?	reads	2-"So I wouldn't pick that one."				6-"He just told me he hasn't had an Ashworth score so I wouldn't ask that."	
Q9. Bowel function?	reads	5-**Clicks**.					
Q10. Bladder function?	reads	6-**Clicks**.					
Q11. Neurogenic bowel/bladder?	reads	3-"So I wouldn't pick that one."				7-"Neurogenic bowel or bladder, I don't know."	
Q12. Stabilization surgery?	reads	7-"I want the surgery." **Clicks**.					
Q13. How to enhance your care?	reads		2-"I want to know this." *Clicks*.				
Q14. SCI feeling, mobility?	reads	8-**Clicks**. "Oh! He's not controlling it. He can't feel it. It's just happening."					
Comments out	"I need figure out which 8 are the best."		"1,2,3,4,5,6,7, and then, there's one more."			"I'd rather just like not pick another one, if I had the option not to."	

Note. Read table by column, left to right, following numerical row entries to trace learner logic through the DS-node. Correct choices are in highlighted rows. Selections are bolded "clicks." See Table 28 for the full question text.

Table 27

Errorless Navigation of a DS Inquiry Node to Query Matt Lane About His Previous Medical History by Maria, PGY-2

Questions	Pass 1→	Pass 2→	Pass 3 (Note pad*)→	Pass 4→	Pass 5→	Pass 6→	Pass 7
Comments in				"You want to make sure that everything is good."			2-" I see ok. I need 1, 2, 3,4, 5, 6. So I need 2 more." 3-Researcher guides to Q2.
Q1. ASIA exam?	reads				1-"With the ASIA exam, I'm not too sure I need it."	2- "I think the questions is meant to be like -- you guys want open-ended questions and you want something that the patient would be able to answer in their own way. Like an ASIA exam, they might not know what it is but they would definitely know what level."	
Q2. Level of injury?	reads				3-"Can you tell me about your level of injury? It's already been answered at the bottom."		1-Researcher discloses design flaw. 4-C**licks**.
Q3. Swimming pool?	1-"Swimming pool – I'm not going to ask that."				4. "Were you injured in a swimming pool? I definitely don't need that!"		
Q4. Ever hospitalized?	reads	1-Moves cursor here. "So basically, I just want to choose my 8, right? But if I do something, it's gonna take away my score, I've got to be careful."			5. "Have you ever been hospitalized - He HAS."		5-"Have you ever been hospitalized."
Q5. Previous hospitalizations?	reads				6-"Could you describe your previous hospitalizations to me? I'm not too sure if I want to know that or if it's pertinent."	1-"Actually, it might be helpful." **Clicks.** "Yes. There you go!" 3. Reads the feedback. "Unethical nursing service -- oh wow. Ok. so how many? I'm missing 2?"	
Q6. Injury, (in) complete?	reads				7-"Do you know whether your injury is complete or "Incomplete? It's already been answered at the bottom."		
Q7. More history on spasms?	reads		4-"History of spasms – [counts] ok, 1,2,3,4"	2-**Clicks.**			
Q8. Ashworth Score?	reads						

Questions	Pass 1→	Pass 2→	Pass 3 (Note pad*)→	Pass 4→	Pass 5→	Pass 6→	Pass 7
Q9. Bowel function?	reads		1-"Bowel"	3-**Clicks**.			
Q10. Bladder function?	reads		2-"Bladder"	4-**Clicks.** "That one." [reads, assesses] "So I have 1,2,3,4."			
Q11. Neurogenic bowel/bladder?	reads						
Q12. Stabilization surgery?	reads		3-"Do we need details?"		1-"Do I really want to ask the neck fracture? Does it help?"		6- I would go more for "Can you tell me more of the details of the surgery". **Clicks** There ya go!"
Q13. How to enhance your care?	reads			5-**Clicks**. "Can you think of anything else?"			
Q14. SCI feeling, mobility?	reads		5-"Can tell me about your SCI?"	1-**Clicks**. Reads affirmatory responses before moving on.			
Comments out	"Hmm mm. Ok."						

Note. Read table by column, left to right, following numerical row entries to trace learner logic through DS-node. Correct choices are in highlighted rows. Selections are bolded "clicks." See Table 28 for full text of questions.
*Learner used a document in a separate window to keep track of likely "correct" questions. She subsequently transferred them, one by one, back into the DecisionSim ™platform.

Table 28

Question Battery (Full Text) for Taking Matt Lane's Previous Medical History

Question	Scoring Impact
Q1. Have you ever had an ASIA exam, Mr. Lane?	+$
Q2. Can you tell me your level of injury?	+status
Q3. Were you injured in a swimming pool?	+$, -status
Q4. Have you ever been hospitalized?	+$
Q5. Could you describe your previous hospitalizations for me?	+status
Q6. Do you know whether your injury is complete or incomplete?	-status
Q7. Is there anything about the history of your spasms you want to add that we haven't already talked about? For instance, has their intensity ever been measured?	+status
Q8. Has anyone ever given you an Ashworth Score for the intensity of your spasms?	+$
Q9. How do you manage your bowel function? Has this changed over time?	+status
Q10. And your bladder function: How do you manage it and have there been changes?	+status
Q11. Do you have a neurogenic bowel and bladder?	+$, -status
Q12. Can you tell me more about the details of the surgery you had to stabilize your neck fracture after your injury? Do you remember when it was done, what was done?	+status
Q13. Can you think of anything else we should know to enhance your care?	+status
Q14. Can you tell me about your SCI? Do you have any feeling in your lower body, any ability to move your lower body?	+status

Note. +$ = increases cost; +status = supports patient well-being; -status = detracts from patient well-being

In summary, two distinct approaches, free text DS-nodes and DS inquiry nodes, were employed to construct scenario operations to develop the history-taking clinical activity in *Matt Lane*. Providing patient information through video observations, audio dialog and text-based narrative dialog with the patient took place both independent of, in dedicated DS narrative nodes, and overlapping with, the free text DS node method.

Media-enhanced DS-nodes worked to help learners really listen to the patient and to practice and hone their skills of observation. Since learners could pause and briefly research issues and terminology the patient presented with which they were unfamiliar, the free text structure provided an impetus for exploration of the medical knowledge the VP was conceived to teach.

On the negative side, the same structure that allowed learners to research unknown topics detracted from their immersion in scenario. Since questioning was one-way, patient to clinician, learners experienced a dissonance in curtailment of a more typical clinical dialog where the clinician could, in turn, ask questions of the patient. The DS inquiry node structure provided this functionality. The process of deciding which questions to ask of the patient in taking his history engaged learners intently and they appraised it positively.

The realistic, true-to-life feel of the VP scenario, communicated both through multimedia and text, was highly appreciated by learners. The ability to see the patient and his clinical environment that video made possible enhanced the truth value of what was being presented in the VP story. Learners were of differing opinion about what constituted the right mix of video and text-based narrative in a VP scenario and also about whether their interactions with the patient should be modeled in dialog.

Performing a Physical Exam

Only the observational and procedural tasks involved in performing a physical exam were considered in *Matt Lane* and these focused on skin assessment since pressure ulcer prevention was the central theme of the VP. The DecisionSim™ MCQ (multiple choice question) node was used to create opportunities for learners to assess the integrity of the patient's skin and stage pressure ulcers when they were observed. The DS MCQ node incorporates a media pane, like the other specialized DS-nodes: the free text and inquiry nodes. Pressure ulcer images were displayed here. A list of the stages of skin breakdown appeared below the ulcer images in the media pane and the learner was tasked with selecting the stage that corresponded to the image. Once a choice was made, the learner received a text description of what an ulcer at the chosen stage looks like and was informed whether the choice was right or wrong. Appendix M shows the learner view of a DS MCQ node before and after a question is answered.

For normal skin, once the learner made a selection, all the other staging options displayed. The identification of "normal" was to provide the learner a baseline for recognizing a change in the patient later in the scenario. If the image actually depicted skin breakdown, as was the case on Day 2 of *Matt Lane*, the learner was given multiple tries at choosing the correct stage of the wound depicted. In this case, there was learning value in comparing the text description with the image of a pressure ulcer that might not quite correspond to the criteria for the selected stage.

A "pressure ulcer prevention virtual patient" suggests that success means NOT finding a pressure ulcer to stage. Learners, however, were very eager to engage in this part of

Matt Lane, though it was a very minor focus. “The pressure ulcers were the best part!” Shari informed about her Day 2 experience caring for Matt Lane.

Grading pressure ulcers is a complex skill. There was, in fact, disagreement among consulting experts about the proper grading of the wounds used in the *Matt Lane* scenarios.

> *Zoe:* Ok, I'm trying to stage his right heel. Ahm, confused. I judged it as Stage 2 and the description says that a Stage 2 would be an open ulcer, and it's not open. I Changed it to Stage 1, which is also not it. So I'm just going to click again. [Clicks “Unstageable” -- incorrect] Suspected deep tissue injury. [Clicks -- correct!]

Table 29 provides perspective on the fine distinctions and qualifications Zoe needed to apply to the task of grading Matt Lane’s pressure ulcer. She and Shari were the two students who formed a small focus group and shared some of their impressions of the VP. Both felt the pressure ulcer activity was the highlight of *Matt Lane, Day 2*, which they found otherwise unsatisfyingly unstructured. Having some familiarity with the task and feeling guided in practicing it were central themes in their reflections.

Shari: I didn't like it as much [Day 2]. … then, once I got to the pressure ulcers, is was so guided! … I could tell, ok, I'm supposed to be doing this! … I don't even think I clicked on the Braden Scale.[20] I didn't know what it was and I wanna see the patient already! … But I like the idea of, like, I could handle those ulcers -- like oh, ok, I know these.

Zoe: I started to feel good when I found the UTI and the ulcers. I was staging it and going forward, I really enjoyed that part. Once I saw that I'm supposed to look at the ulcers, I felt really confident in tackling the ulcers.

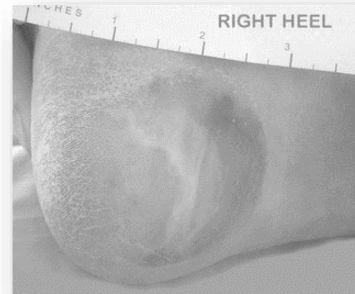
Shari: and I became, like, engaged ‘cause it went with what I knew …

Zoe: So like pressure ulcers was the main goal there, so have it like only like three options to look at and one of them is going to lead you to think, oh pressure ulcers.

[20] The Braden Scale is a pressure ulcer risk assessment.

Table 29

Zoe's Experience Staging Matt Lane's Pressure Ulcer



Normal Comparator **Abnormal Tissue**

Characteristics	**Stage**	**Zoe's choices**
Intact; Blanchable; No blistering; Similar to adjacent areas.	Normal	
Intact skin;Non-blanchable redness in a localized area; Typically seen over a bony prominence; Areas may be painful, firm, soft, warmer or cooler than adjacent areas; Darkly pigments skin may not have visible blanching, color, however, may differ from surrounding area. Stage I may be difficult to detect in individuals with dark skin tones.	Stage 1	SECOND
Partial loss of dermal thickness; Wound appears as a shallow, shiny or dry, open ulcer; Wound bed is red-pink; No slough; No bruising; May also present as a blister – open/ruptured serum-filled or sero-sanginous; NOT tears, tape burn, incontinence-associated dermatitis, maceration, or excoriation.	Stage 2	FIRST
Full thickness dermal loss; Subcutaneous fat may be visible but NOT bone, tendon, or muscle; If slough present, does not obscure depth of tissue loss; May include undermining and tunneling; Depth varies by anatomical location – bridge of nose, ear, occiput, and malleolus ulcers may be shallow but areas of extreme adiposity can be very deep.	Stage 3	
Full thickness dermal loss; Exposed bone, tendon, or muscle; Slough or eschar may be present; Often includes undermining and tunneling; Depth varies by anatomical location – bridge of nose, ear, occiput, and malleolus ulcers may be shallow but areas of extreme adiposity can be very deep; May extend into muscle and/or supporting structures such as fascia, tendon or joint capsule; Osteomyelitis or osteitis likely to occur; Exposed bone or muscle visible or directly palpable.	Stage 4	
Full thickness dermal loss with actual depth completely obscured by slough and or eschar; When enough slough/eschar removed to expose wound base and determine true wound depth, wound will be either Stage III or IV. Stable (dry, adherent, intact without erythema or fluctuance) eschar on the heels is "the body's natural (biological) cover" and should not be removed.	Unstageable	THIRD
* Suspected Deep Tissue Injury. Skin intact; Purple/maroon localized discoloration or blood-filled blister; May be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler compared to adjacent skin; May be difficult to detect in dark skin. Evolution: May include a thin blister over a dark wound bed; May become covered by thin eschar; May rapidly expose additional layers of tissue despite optimal treatment.	SDTI*	FOURTH (correct!)

In summary, though only a small portion of the *Matt Lane* VP actually invoked a skin evaluation activity (seven DS MCQ nodes all together: four for normal skin comparisons; three involving staging of pressure ulcers) it constituted the climax of the 2-day patient scenario. Learners appreciated the structure and guided nature of the activity of performing a skin evaluation and staging pressure ulcers, despite the subtlety of the latter process. Learners also appreciated that this was not an unfamiliar clinical activity, even if a difficult one to master.

Writing Orders

Writing admission orders for Matt Lane culminated the history and physical exam activities on Day 1. A design developed by DecisionSim™ known as an "analysis node" provided the framework for the order-writing activity. The analysis node is essentially an enhanced DS inquiry node that addresses what can be a significant shortcoming of the inquiry node approach that was described with activities supporting taking a patient history.

In the preface to the past medical history activity (structured using the DS inquiry node framework), learners were told in advance how many correct questions lay among the incorrect ones. If learners chose incorrect questions, they got corrective feedback. If they did not have the stated number of correct questions selected, they could continue the activity until they did. However, if learners chose to exit the node, they would not receive exposure to the unexplored, correct responses. The risk that learners may do this is real. Shari, PA-1, as she was about to complete Matt Lane's past medical history without error, expressed her desire to exit prematurely, "I'd rather just like not pick another one, if I had the option not to."

The DS analysis node functions to mitigate the risk of not picking a correct answer (and thereby losing full benefit of the activity) and to diminish tension by introducing a human face, a just-in-time mentor to support the learner. This function is in keeping with a GBS technique for providing feedback advocated by Schank et al. (1999, p. 178) and will be discussed in more detail in Method 7: The Feedback.

Shari described how she would like to interact with an item selection exercise, and her description was very close to how the analysis node functioned for learners in practice.

> *Shari:* What I would do -- is click the ones that I knew were right and I wouldn't click ones that I thought were wrong. I would fast forward and just see if I missed it.
>
> *Researcher:* So the way this kind of works is that if you get something wrong, you find out immediately because it tells you it's wrong. If you fail to order something that's indicated, then "Dr. DuVal" tells you.
>
> *Shari:* Ok, makes sense.

Learners worked through a standard, inpatient rehabilitation order set for Matt Lane. This order set began with defining the admission diagnosis and included orders for: precautions, nursing, nursing respiratory care, occupational therapy, physical therapy, consults, labs, radiology, and medications. Learners were informed that Dr. DuVal, the spinal cord injury attending (expert physician) on 2W, Matt Lane's unit, would help them with their orders and "sign off" when they were completed.

Learners entered each order group and selected from a comprehensive list of (billable) items that would be appropriate to order for Matt Lane. The items were replicated from the forms that appeared in the chart the real Matt Lane had released for developing the pressure ulcer prevention VP story. As learners selected items, they received feedback about whether their orders were appropriate or not, as they had received, mediated by the DS inquiry node structure, when they took Matt Lane's past medical history.

When learners were satisfied that they had ordered all necessary items, they chose to move to the next order grouping. At this point, they received mentoring on their omissions from their spinal cord injury attending, Dr. DuVal. The mentoring doctor's face, sporting a variety of expressions, appeared in a separate narrative frame (DS-node) for each item that should have been ordered by learners but was not. Dr. DuVal also provided a summary of all correct orders for each group before inviting learners to move to the next order grouping.

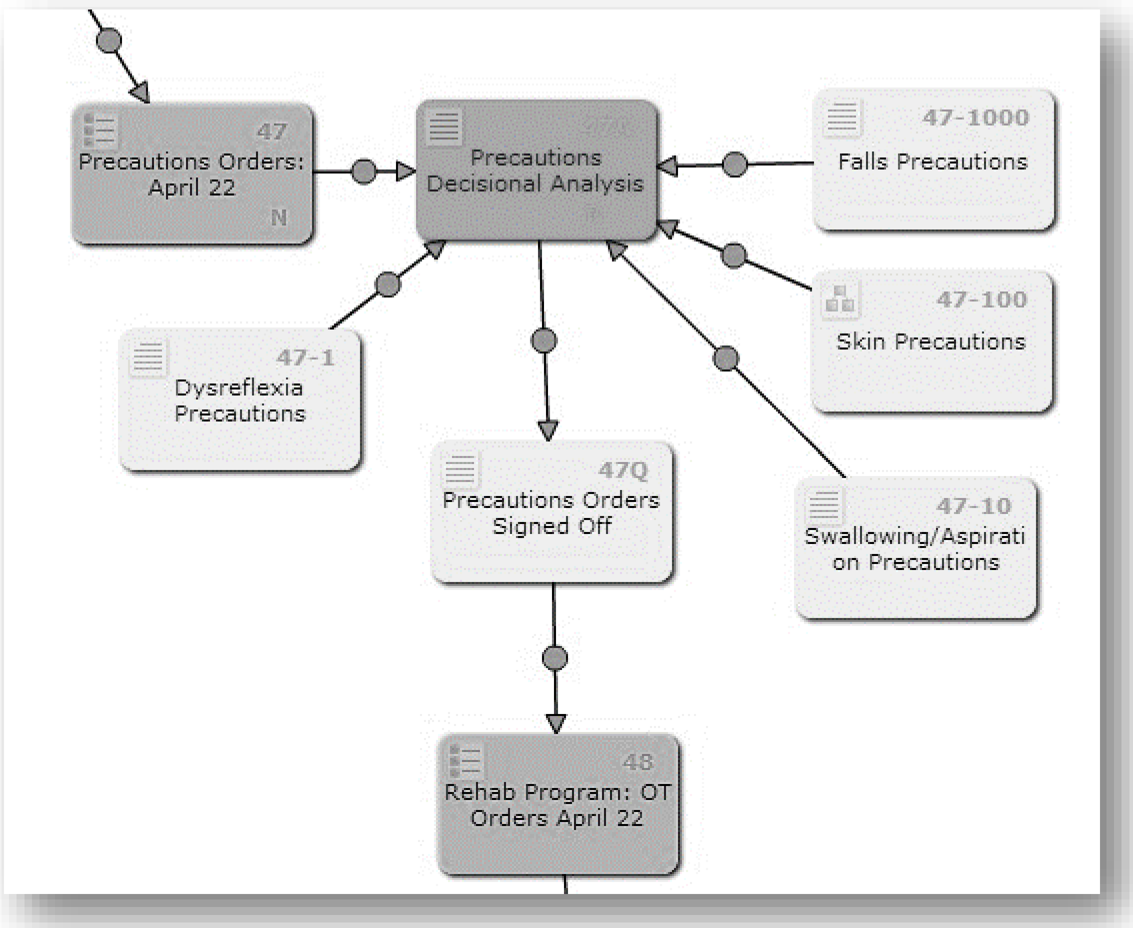


Figure 18. Analysis node 47A in the DecisionSim™ case map for precautions orders. Yellow node 47 is a DS inquiry node that lists each of the options represented by the blue nodes within it. Node 47 keeps track of which of the options learners fail to select and sends that information to the analysis node which, in turn, sends learners to each of the blue node items they have omitted to order. There, Dr. DuVal provides them just-in-time feedback on what should have been ordered and why. When all orders are correct, learners are transferred

to the sign-off node, 47Q, and on to the next yellow node to perform the next group of orders.

Figure 18 shows the DS analysis node and supporting narrative nodes in the case map view. Figure 19 shows the learner's view of an order grouping and Figure 20 demonstrates just-in-time mentoring from the attending physician on 2W.

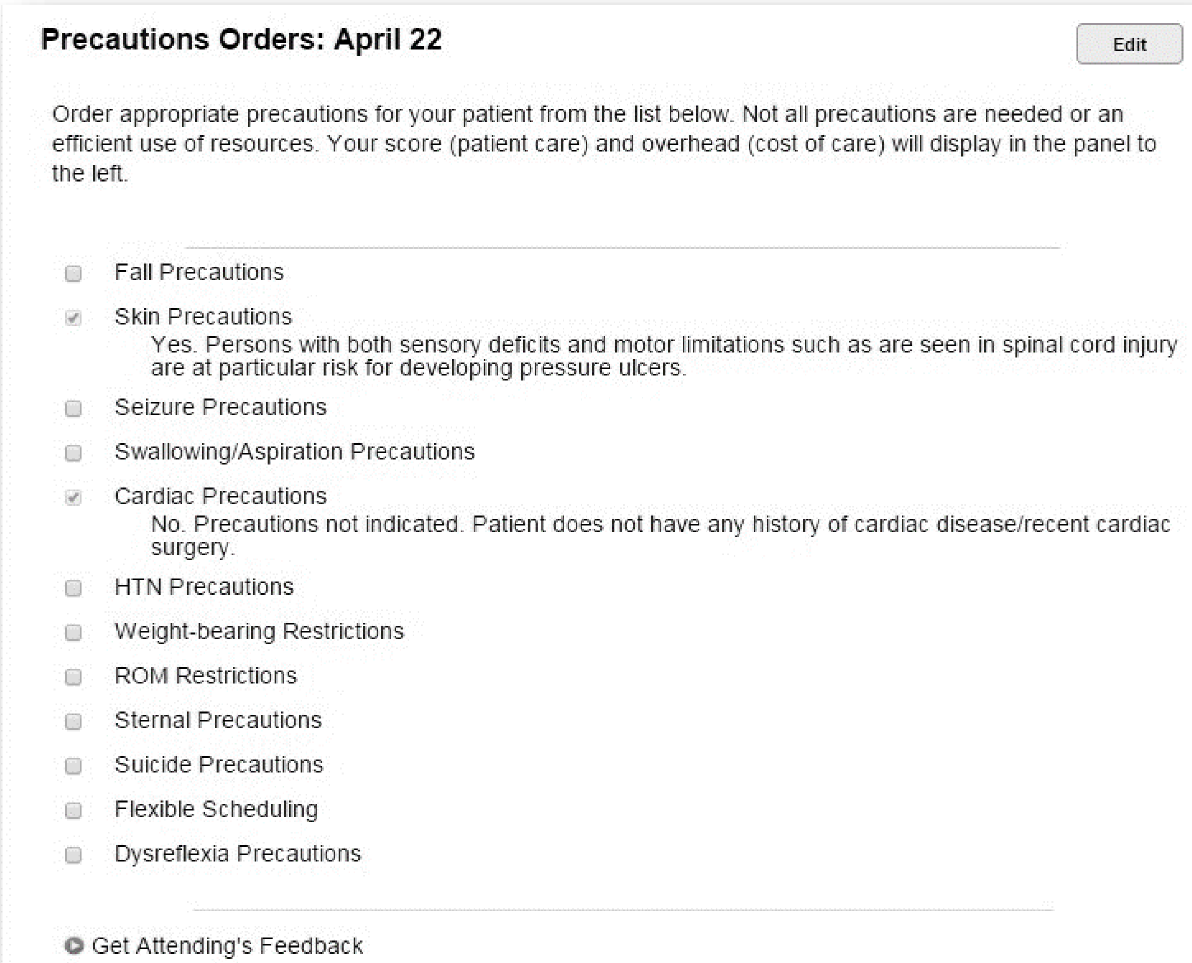


Figure 19. The precautions order grouping, mediated by a DS inquiry node programmed (in background) to track selections the learner has not explored. The learner has selected Skin Precautions and Cardiac Precautions for which positive and negative, respectively, are displayed.

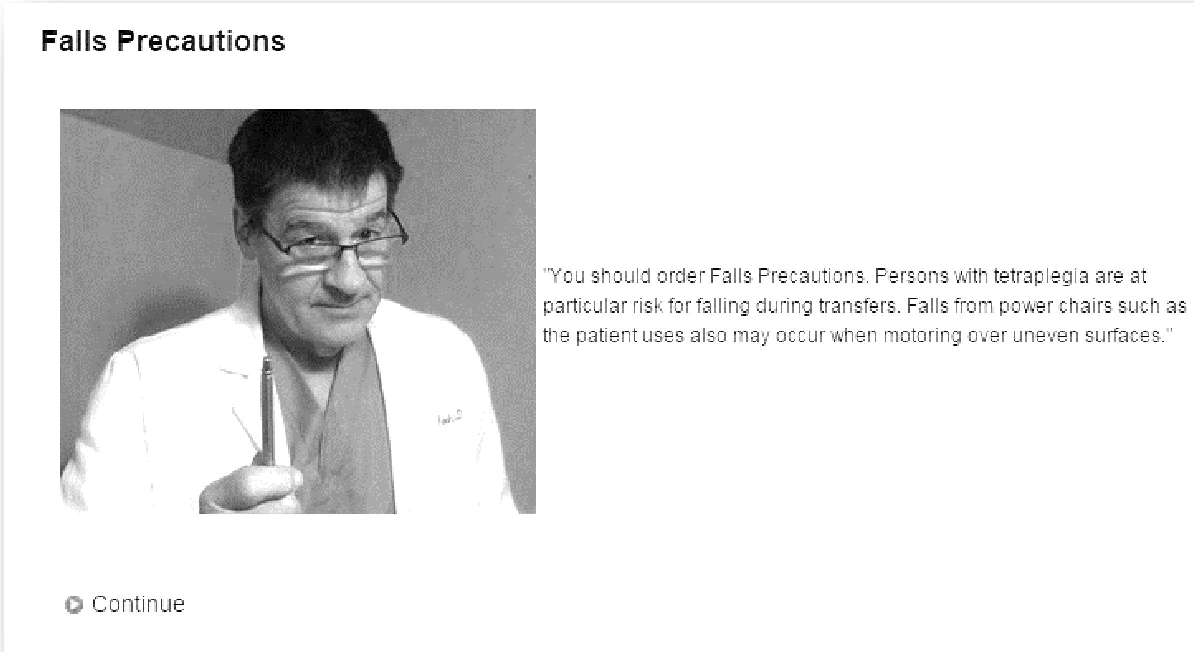


Figure 20. Dr. DuVal (actor) counsels learners who have omitted to order necessary precautions for a patient with tetraplegia, such as Matt Lane. He explains the rationale for the order.

The order-writing process provided a different context for and extended application of the item selection activity previously experienced in taking the patient's history. Learners took to the order-writing activity with animation and enthusiasm. Some described it as "fun."

> *Shari, PA-1*: Lab orders, those are fun! Ok.
>
> *Maria- PGY-2*: That [an apparent paradox in subject matter expert's advice about an item to order or not order] is *so* funny.
> *Researcher:* It's ART not all science … so they're going to be places... but you're ENJOYING this!
> *Maria:* Yeah, it's fun. … Those are really fun [orders].

Alyssa, PA-2, reflected on the exercise of writing patient orders, "I think it's great, accurate, and a good way to learn."

Emily, M-4, a new graduate contemplating her first year in residency (internship), appreciated the preparation a simulation of writing patient orders provided.

> *Emily:* I actually really *like* the idea of going through orders and like, actually *placing* the orders. 'Cause as a med student, I've only actually ever done the history and physical part, and I think that, going into my residency, I'm nervous about placing orders and what decisions to make. And so I think this is a really good thing. Also to do, also to help prepare students for residency cause it kind of takes the edge off. Yeah, I think it's really good.

Shari, PA-1, validated the exercise in the context of preclinical training. Her reflection on case-based learning, previously shared, is repeated below for comparison with Emily's experience.

> *Shari:* This is really what we struggle with now in class, is the fine details, and we ask, "When do you order this besides this? When do you order besides that?" And the answer's always, "It depends." So it's interesting to see it in terms of a patient. So you say, "Ok, this patient, I'm just going to order BMP and CBC, but since I am worried about a UTI, I'm going to order a culture and sensitivity on the urine." So it's nice to have that feedback. You don't really get that in a classroom, 'cause you CAN'T. You have to do it on *a case-by-case basis*.

Maria provided further validation of the activity in the context of her residency, where providing explicit instruction on the reasoning behind writing specific orders for specific patients was not the practice.

> *Researcher:* You're liking this part?
> *Maria:* Yeah! 'Cause it makes *sense*. It makes sense to THINK about it. Which, I don't think we do much of. We just click click click.

That the analysis node format eliminated the problem of the missed right answer was appreciated by participants. Both Emily and Shari made errors in developing the patient's diagnosis at the beginning of the order set as a result of the design of the earlier history-taking activity that allowed them to fail to uncover information about the patient that they actually needed to construct his diagnosis.

> *Emily:* That was better than the one before, yeah ‘cause I got to see which ones I missed and what not. Yes, because before I should have asked him if he had the neurogenic bladder so I missed that before and that caused me to make the second mistake later.

> *Shari:* He didn't tell me that his injury was complete, ‘cause I didn't put that question. I also didn't ask him if he had neurogenic bowel or bladder, so it didn't tell me that he had it, ‘cause I didn't know what it was, so I just skipped it, so it didn't flag me like, “Hey, he has this!”

Since the order-writing activity in the *Matt Lane* VP caught learners’ imagination and focused their interest, it provided an opportunity to explore situationality of participants’ prior education and experience with patients who have mobility and sensory impairments to observe what did and didn’t work in the framing of its operations. Table 30 focuses on writing nursing orders and maps the think-aloud comments and navigation of three participants who represented the span of clinical education and experience with patients with spinal cord injury. Shari, PA-1, came to the activity with no clinical experience with individuals with physical disabilities like Matt Lane. Emily, M-4, had done a medical school elective (3-4 weeks) in physical medicine and rehabilitation and had some exposure to patients with spinal cord injury. Maria, PGY-2, had just finished a rotation on the spinal cord injury unit when she interacted with the *Matt Lane* VP.

Unlike rehabilitation-specific orders, such as physical or occupational therapy orders, nursing orders draw on knowledge that cuts across health care domains and invokes widely accepted practices, such as maintaining a record of the patient’s vital signs. Table 31displays the feedback (developed by clinical experts who advised on the development of *Matt Lane*) encountered when learners chose items from the nursing orders grouping.

Table 30

Think-Aloud and Navigation Experience of Three Levels of Novice Learners Writing Nursing Orders

Order?	Items	Maria PGY-2	Emily M-4	Shari PA-1
Yes	Vital Signs	Vital signs. [click]	Obviously, vital signs. [click] [feedback] Oh, let's see so his blood --	I want vital signs. [click]
Yes	Record I/O	Input/output, I need that. [click]	Record ins and outs. [click]	I want his in/out because he can't, he doesn't, control it.[click]
Yes	Bowel Program	Bowel Program, he needs that. [click]	Ok, bowel program. [clicks]	Bowel program, I don't know what that means. [no click] [feedback] the bowel… it's like a big thing!
No	Above the knee TED hose	T_0. Above the knee TED hoses, doesn't need that. [no click] T_1. Above the knee TED hoses – not. [no click]	These TED hose... I think I know it, I think it might be for -- I don't really know what those are. [click]	These hose, I don't know what they mean. [no click]
No	Below the knee TED hose	T_0. Below the knee, I'm not too sure. It depends on if he's hypotensive or not during therapy. If he is, I would put that in. [no click] T_1. Below the knee TED hose -- It depends ahm --- oooh ---oooo. [no click]	[no click]	[no click]
No	Venodynes	Venydynes -- what are those? [Goes to the web to look up Venodynes] Oh, SCD's -- do I really need it? I don't think so. [no click]	Venodynes, I think he needs those. [click][feedback] Oh, he doesn't need them.	[no click]
No	Weight Every Day x 3 days	Weight every day times 3 days ... [no click]	Ok, weight every day for three days... ahm. [click]	Weigh every day x three days - Probably don't have to weigh him every day. [no click]
Yes	Weight on admission, then every week	Weight on admission -- this is what I want. [click]	Ok so weight on admission, then every week. Yeah that would be more [click][feedback] yeah, ok	I'd weigh him like every week. I don't like see him losing weight as a problem. [click]

Order?	Items	Maria PGY-2	Emily M-4	Shari PA-1
No	Discontinue Foley Catheter	Discontinue catheter -- [no click]	t_0. Foley? Does he have a Foley? He has a suprapubic, so there's no Foley really to discontinue, I don't think. T_1. I don't know if he needs, what to do about the Foley, so I'm just gonna not do that. 'Cause he has that superpubic cath, so. . [no click]	No, I'm not going to discontinue his Foley. [no click]
No	Intermittent Catheterization	Intermittent cath – what? He's got suprapubic! [no click]	[no click]	Intermittent cath -- He said he didn't know the last time he had his catheter changed, but I still wouldn't want to change it until there's a problem because I could still introduce an infection. So I would think I would keep it. I'm not going to have him -- [no click]
No	Fluid Restriction	T_0. Fluid restriction -- he's on suprapubic [no click] T_1. He doesn't need fluid restriction as he's on a superpubic (sic) cath ... he's going to pee. Ok, I'm good. [no click]	I don't think he needs any of this. [no click]	[no click]
No	Adaptive Call Bell	Adaptive call bell -- Ah yes. [click] What!? Were you on the call bell? [feedback] Oh never mind.	He needs this [click] [feedback] Oh, ok.	Yeah, I thought about an adaptive call bell. [click] No? [feedback] Oh. Ok.
Yes	Turning and Bed Positioning	Turning and bed positioning ... yes. [click]	Turning and bed -- yes, he needs that. [click]	Turning and bed positioning, yes. [click]
Yes	Skin Inspection Twice a Day	Skin inspection --yes. [click] [feedback] Right.	Ok, skin inspection. Yeah, I would think so. [click] He's at high risk for pressure ulcers. [feedback]	Skin inspection, yes. [click]
Yes	Pressure Relief While Sitting	Pressure relief while sitting -- yes. [click]	Pressure relief while sitting, yes. [click]	Ahm. I think he sits, so I'd say, yes. [click]
Yes	Foot Support Boots	Foot support boots -- does he have it? I'm guessing these are like multipodus and heel lift boots. He's an ASIA A, so he would need that. [click]	Foot support boots, I don't know. [no click] [feedback] Ok, good to know.	Foot support boots ahm [no click]

Order?	Items	Maria PGY-2	Emily M-4	Shari PA-1
Yes	Coordinate Patient/ family Education Series	Ahm, yes. [click]	T_0. Coordinate patient/family-- he doesn't really HAVE a family. His dad is in Hawaii. [no click] T_1. Ah, maybe his family, so ok I'm going to put this [click] his family, [feedback] yeah.	[no click]
Yes	Dispense Spinal Cord Injury Education materials	Yes [click]	Dispense spinal cord injury, he doesn't have ... I mean, it doesn't hurt because obviously there could be something new [click]	He doesn't need injury educational materials, but I think it would probably be, like, offensive since he obviously knows a lot, but maybe I would kind of do that, like hospital protocol. So I would pick it. I know like you have to do it but it's like offensive, maybe. [no click]

Note. Item selection or non-selection is indicated by brackets. Correct selections are noted in green. Incorrect actions and omissions are noted in red. If a learner passed over an item multiple times, these actions are noted as t_0 t_1 etc.

Table 31

Nursing Orders and Expert Feedback Provided to Learners During Order Writing Activity

Order Items	**Order Y/N**	**Clinical Expert Mentoring and Feedback**
Vital Signs	Yes	Every shift x 3 days then twice a day if stable Notify House Officer for T > 101, P > 120 or < 60, SBP > 150 or < 90, DBP > 110 or < 50, Resp > 30
Record I/O	Yes	Every shift then D/C if stable
Bowel Program	No	Every other day (EOD), Notify MD if no results for 3 days. Senna 5 tabs by mouth, EOD, Dulcolax supp by rectum EOD
Above the knee TED hoses	No	Not indicated. Controversial. Can put patients at risk for PU.[21]
Below the knee TED hoses	No	Not indicated. Controversial. Can put patients at risk for PU.
Venodynes	No	Not indicated at this time.
Weight Every Day x 3 days	No	Not indicated. PT not at high risk for fluid accumulation and transfer is disruptive.
Weight on admission, then every week	Yes	Adequate recordkeeping for patient who is difficult to transfer and not at high risk for fluid accumulation.
Discontinue Foley Catheter	No	Not indicated. Patient has suprapubic tube.
Intermittent Catheterization	No	Not indicated. Patient has suprapubic tube
Fluid Restriction	No	Not indicated. Patient has no condition at this point that would suggest fluid restriction.
Adaptive Call Bell	No	Not indicated. Patient has normal vision and hearing and sufficient dexterity to manipulate the call bell. Standard safety procedure indicates that it should always be within easy reach.
Turning and Bed Positioning	Yes	Turning the patient every two hours while in bed is often recommended to relieve pressure and prevent pressure ulcers. However, the lateral position with 90 degree rotation has been shown to result in significant trochanteric ischemia and pressure. Changing the elevation of HOB from supine to 90 degrees results in a shift of pressure points. Lower pressure readings occur in patients who are supine with HOB at 30 degrees or less and in the semi-fowler position. If patients requires to be in a HOB position higher than 45 degrees due to reasons such as respiratory (mechanically ventilated patients) or for aspiration precautions, they should be monitored more closely for PU. Remember that this patient is on CPAP[22] for OSA[23].
Skin Inspection Twice a Day	Yes	Skin inspection is very important for patients with sensory and mobility deficits such as are seen in SCI.
Pressure Relief While Sitting	Yes	Regular pressure relief while the patient is seated is a best practice.
Foot Support Boots	Yes	Foot support boots lift the patient's heels off the mattress while in bed and reduce the risk of pressure ulcers.
Coordinate Patient/family Education Series	Yes	Even though the patient is very knowledgeable and directs his own care, he should have the option of taking advantage of the hospital's education program for his family and care givers. You may also want to engage the education staff so they can consider education targeted to gaps that emerge over the course of hospitalization.
Dispense Spinal Cord Injury Education materials	Yes	Patient is very high-functioning, but SCI[24] educational materials may still be useful to him, his family and caregivers. It is a free service that most hospitals provide to patients with SCI.

[21] Pressure Ulcers
[22] Continuous Positive Airway Pressure
[23] Obstructive Sleep Apnea
[24] Spinal Cord Injury

Relative to the items that the three participants ended up including in their orders for the patient's nursing care, Maria, the most experienced learner made one error and Emily and Shari each made five, suggesting that specific experience with patients with physical disabilities in a more important situationality in targeting VPs to learners than actual years in clinical training.

Emily chose incorrectly and Shari chose correctly to have the patient weighed on admission and weekly versus every day for three days. The feedback for both of these order options informed that risk of fluid retention was the reason for a more aggressive measurement regimen. Shari's right answer, based on incorrect reasoning, was thus corrected. However, her correct choice relative to catheter management, *not* to pick either option offered, left her with no feedback. Therefore, her misunderstanding, evidenced by her think-aloud comment, of how the patient's bladder was managed was never addressed.

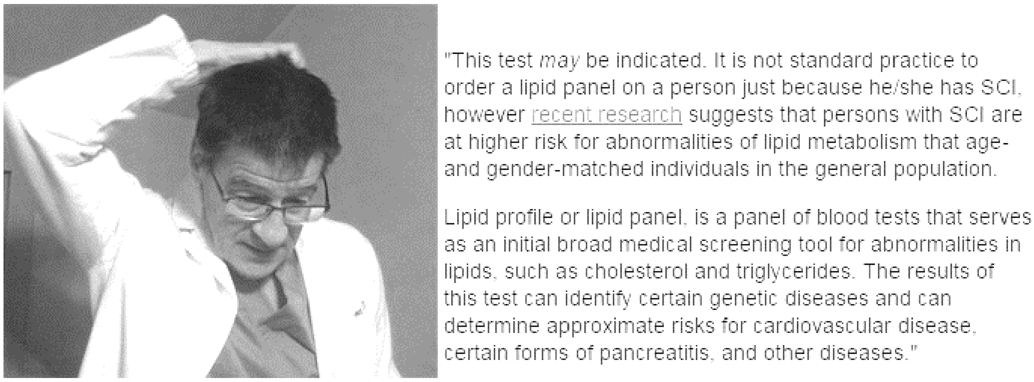
This observation suggests that learners who do not select incorrect items in a selection activity in a VP may not do so as a result of correct logic or deliberation. Again, in the case of ordering above the knee TED hose for the patient, neither Emily nor Shari knew what they were.

> *Emily:* These TED hose... I think I know it, I think it might be for -- I don't really know what those are.
> *Shari:* These hose, I don't know what they mean.

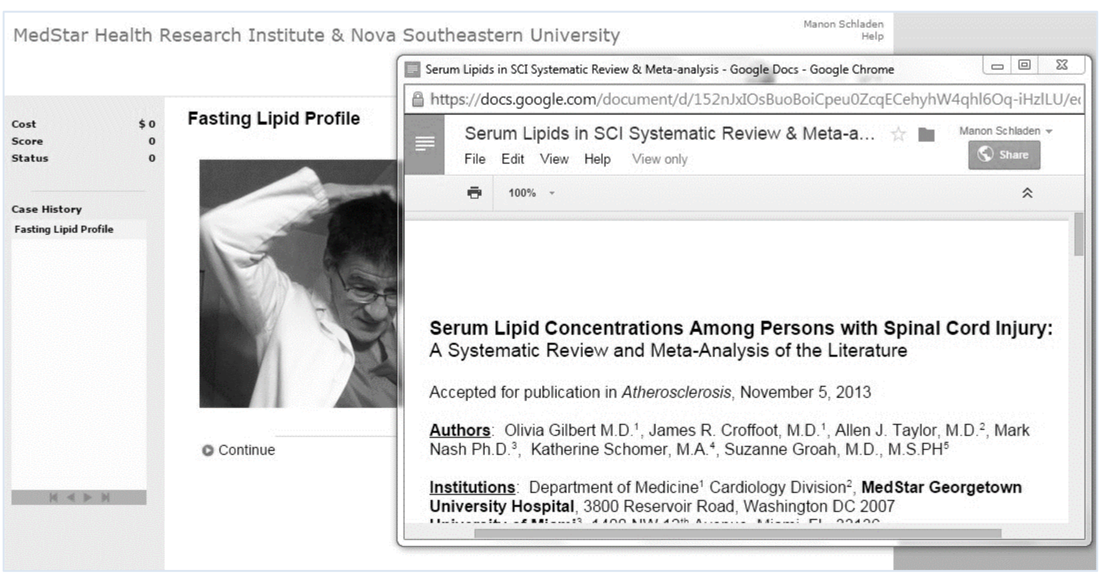
Use of TED hose is controversial in patients with spinal cord injury (personal communication, Camilo Castillo, MD, Spinal Cord Injury Specialist, MedStar National Rehabilitation Hospital, January 22, 2014), but expert consensus was to not use them as they increased the risk of pressure ulcers. Emily clicked the option and received useful feedback on her incorrect choice. Shari did not, and her learning was not advanced.

Table 32

Learner Perspective on Incorporation of New Research Knowledge into Orders Activity



Dana, PA-1: I like the link to the research! I'm not going to read it [during the testing session] because of time purposes, but I probably would.
Maria, PGY-2: Ah! Yes, he's [Maria's attending] been telling me about it.
Alyssa, PA-2: Ah, I did not know that [reading the information]!
Emily, M-4: … [I]t's always hard to keep up with the new research so it's fine if it's just presented for you, even if it's not standard of care. Although I *would* be worried that if I was going through this and I saw it ... I ordered it thinking it was standard of care -- but it DID say it wasn't standard of care --you basically said this is new and this isn't always done but it *is* important to do it. And you can back up your answer if your attending is questioning why you ordered something. So I think it was good!



Note. Top image shows text of mentoring provided on new thinking (hyperlinked) about lipids levels in persons with spinal cord injury, such as Matt Lane. Bottom image shows clicked hyperlink to the relevant systematic review (Gilbert et al., 2014), since published.

Last, in keeping with the evidence-based understanding that guided the selection of media vignettes and development of narrative for the pressure ulcer prevention VP, the order-writing activity served as further opportunity to expose learners to new knowledge emerging from research in the care of people with spinal cord injury and to model incorporation of research into practice. Table 32 shows learners' reaction to the incorporation of evidence suggesting the wisdom of monitoring serum lipids in persons with spinal cord injury who otherwise would fall outside of general-population guidelines. Learners expressed interest and enthusiasm, though one participant, Emily, noted the importance of distinguishing standard of care, currently accepted practice, from evidence that may not be accepted by one's own clinical faculty.

In the example presented in Table 32, the evidence was summarized by the virtual mentor, Dr. DuVal, and a hyperlink to the substantiating journal article presented. No learner actually clicked on the link during the testing of *Matt Lane,* however. Dana's assertion that she would probably read it (but not now) echoes other learners' responses to use of information coming from outside the current learning activity. This phenomenon will be discussed in Method 6: The Resources.

In summary, participants perceived the order-writing activity as fun. They experienced it as relevant to both pre-clinical and post-clinical training. Learner reflected that practice writing patient orders was a needed intervention that was not part of their current programs.

Learners preferred the use of the analysis node method of organizing an item selection exercise. This method removed the risk of failing to choose a correct answer, a problem several had experienced in the simple, DS inquiry node approach to item selection used to simulate taking a patient's history. The order-writing exercise facilitated comparison of learners across educational and experiential situationalities. Focused clinical experience in the subject area of the VP was identified as a more important factor in appropriateness of the content than absolute years of education and clinical experience. The danger of missed learning by not making a mistake on a selection item was identified.

Learners were receptive to incorporation of new research knowledge into order recommendations with the caveat that they be clearly identified as such. It was uncertain whether presenting articles inside an order-writing activity would lead to their actually being read.

Reviewing the Patient Electronic Medical Record (Clinical Documentation)

Matt Lane, Day 2 on the Unit, began with the activity of reviewing of the patient's virtual electronic medical record (EMR). The purpose of this review was to bring the learner up to date on the care the patient had received from the rest of the team since the learner left the hospital the previous day. Matt Lane's record contained his vital signs over the past two hospital shifts, the various assessments performed by nursing (including, importantly, the Braden Scale (Braden, 2012), a standard-of-care, pressure ulcer risk assessment and mitigation plan), lab and radiology results, and progress notes. The EMR also contained documentation of all of the activities that had taken place on Day 1. The learner, therefore, was able to navigate back to the patient's history, physical exam, and order set to review what had been done the previous day. All records appeared as they would have after review, correction and sign-off by the virtual attending, Dr. DuVal.

Records added by other health professionals between Day 1 and Day 2 of the VP were modeled on the forms in the medical record released to the study by the real Matt Lane.

The patient's actual Braden Scale, showing original errors (Figure 24), and an image of his cervical spine showing instrumentation placed during surgery after his accident (Figure 25), were available to learners.

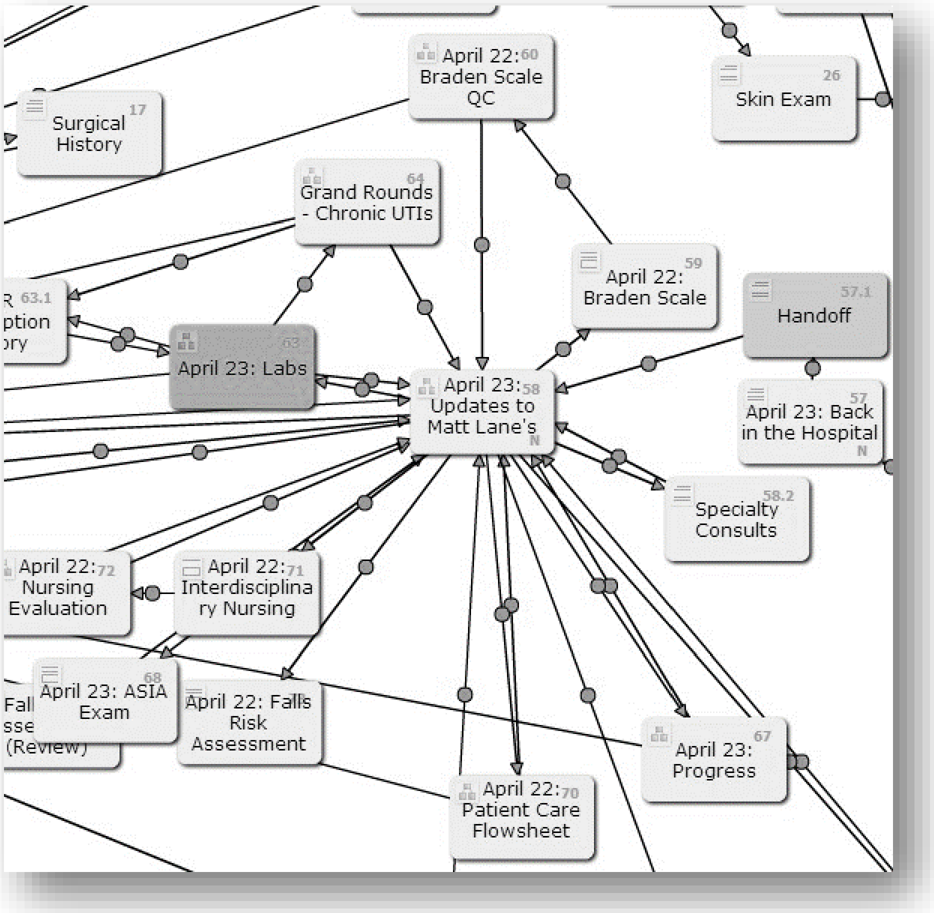


Figure 21. Matt Lane's electronic medical record (EMR), case map view. The central DS branching node served as a hub to access the various other sections of the EMR.

The EMR was constructed around a branching logic DS-node (see Appendix O

Appendix O for a detailed description of branching logic DS-nodes) that served as a hub for other nodes facilitating presentation of narrative and video content, item selection activities, and free text activities (see Figure 21). An expanded free text DS-node design was employed to provide media-enhanced interactivity around the activity of evaluating and critiquing clinical documentation in the EMR. See Appendix N for an example of how this technique was implemented (for the clinically significant Braden Scale specifically).

From the learner's viewpoint, the EMR appeared as a list of options (Figure 22), each leading to a different section of the patient's record. If learners chose to review one section, they would be given the option of returning to the EMR for continued reviewing, until they were finished with the chart and wanted to go see the patient. At that point, learners who wanted to return to review a previously visited DS-node did so through the "case history pane" (see Figure 23). Because of the large number of nodes that made up Matt Lane's virtual EMR, the number of nodes the learner found in the case history pane after moving on from the EMR was quite high.

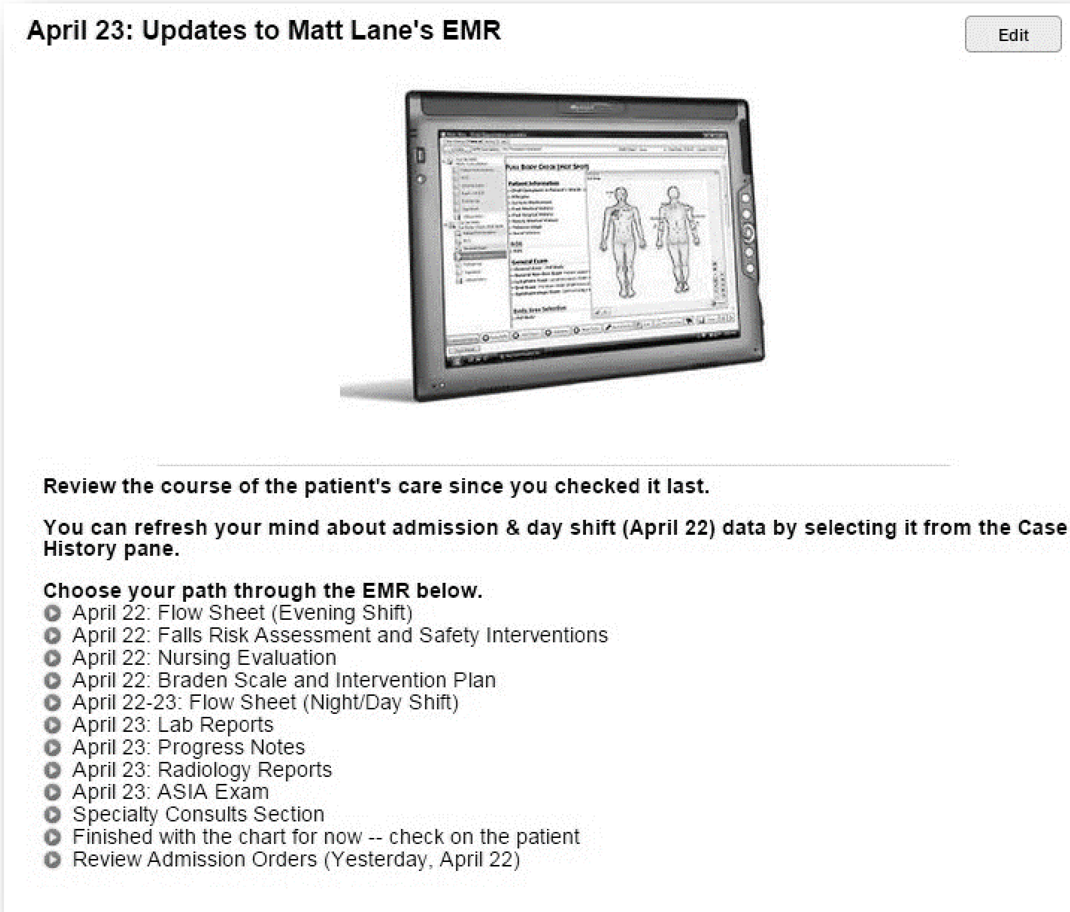


Figure 22. Matt Lane’s virtual electronic medical record (EMR) as seen by the learner.

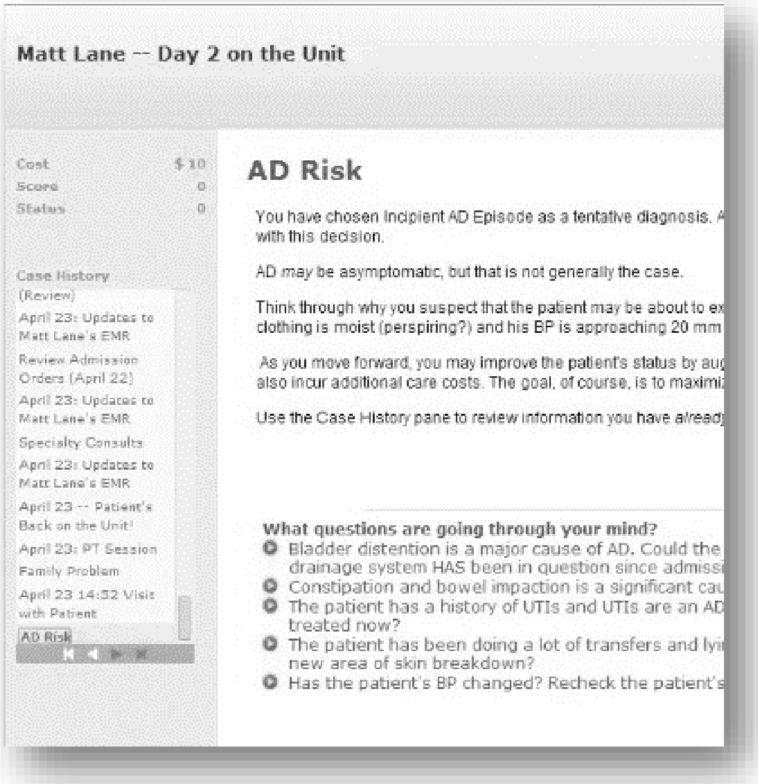


Figure 23. Screen capture of Case History pane at left. The presence of a scroll bar suggests the many nodes the learner has already traversed in working through the Day 2 VP scenario.

BRADEN SCALE FOR PREDICTING PRESSURE SORE RISK

Patient's Name Lane, Matthew Evaluator's Name Thomas Rogers, RN Date of Assessment 04/22/13

					04/22/13			
SENSORY PERCEPTION ability to respond meaning-fully to pressure-related discomfort	**1. Completely Limited** Unresponsive (does not moan, flinch, or grasp) to painful stimuli, due to diminished level of con-sciousness or sedation. OR limited ability to feel pain over most of body	**2. Very Limited** Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness OR has a sensory impairment which limits the ability to feel pain or discomfort over ½ of body.	**3. Slightly Limited** Responds to verbal com-mands, but cannot always communicate discomfort or the need to be turned. OR has some sensory impairment which limits ability to feel pain or discomfort in 1 or 2 extremities.	**4. No Impairment** Responds to verbal commands. Has no sensory deficit which would limit ability to feel or voice pain or discomfort..	~~3~~ 2			
MOISTURE degree to which skin is exposed to moisture	**1. Constantly Moist** Skin is kept moist almost constantly by perspiration, urine, etc. Dampness is detected every time patient is moved or turned.	**2. Very Moist** Skin is often, but not always moist. Linen must be changed at least once a shift.	**3. Occasionally Moist:** Skin is occasionally moist, requiring an extra linen change approximately once a day.	**4. Rarely Moist** Skin is usually dry, linen only requires changing at routine intervals.	3			
ACTIVITY degree of physical activity	**1. Bedfast** Confined to bed.	**2. Chairfast** Ability to walk severely limited or non-existent. Cannot bear own weight and/or must be assisted into chair or wheelchair.	**3. Walks Occasionally** Walks occasionally during day, but for very short distances, with or without assistance. Spends majority of each shift in bed or chair	**4. Walks Frequently** Walks outside room at least twice a day and inside room at least once every two hours during waking hours	2			
MOBILITY ability to change and control body position	**1. Completely Immobile** Does not make even slight changes in body or extremity position without assistance	**2. Very Limited** Makes occasional slight changes in body or extremity position but unable to make frequent or significant changes independently.	**3. Slightly Limited** Makes frequent though slight changes in body or extremity position independently.	**4. No Limitation** Makes major and frequent changes in position without assistance.	2			
NUTRITION usual food intake pattern	**1. Very Poor** Never eats a complete meal. Rarely eats more than ⅓ of any food offered. Eats 2 servings or less of protein (meat or dairy products) per day. Takes fluids poorly. Does not take a liquid dietary supplement OR is NPO and/or maintained on clear liquids or IV's for more than 5 days.	**2. Probably Inadequate** Rarely eats a complete meal and generally eats only about ½ of any food offered. Protein intake includes only 3 servings of meat or dairy products per day. Occasionally will take a dietary supplement. OR receives less than optimum amount of liquid diet or tube feeding	**3. Adequate** Eats over half of most meals. Eats a total of 4 servings of protein (meat, dairy products per day. Occasionally will refuse a meal, but will usually take a supplement when offered OR is on a tube feeding or TPN regimen which probably meets most of nutritional needs	**4. Excellent** Eats most of every meal. Never refuses a meal. Usually eats a total of 4 or more servings of meat and dairy products. Occasionally eats between meals. Does not require supplementation.	3			
FRICTION & SHEAR	**1. Problem** Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity, contractures or agitation leads to almost constant friction	**2. Potential Problem** Moves feebly or requires minimum assistance. During a move skin probably slides to some extent against sheets, chair, restraints or other devices. Maintains relatively good position in chair or bed most of the time but occasionally slides down.	**3. No Apparent Problem** Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair.		~~3~~ 1	13		
				Total Score	~~16~~			

Figure 24. Braden Scale pressure ulcer risk assessment with errors corrected in writing. The uncorrected instrument was retrieved from the medical records provided by the real Matt Lane to develop the VP intervention. The completing RN is pseudomized.

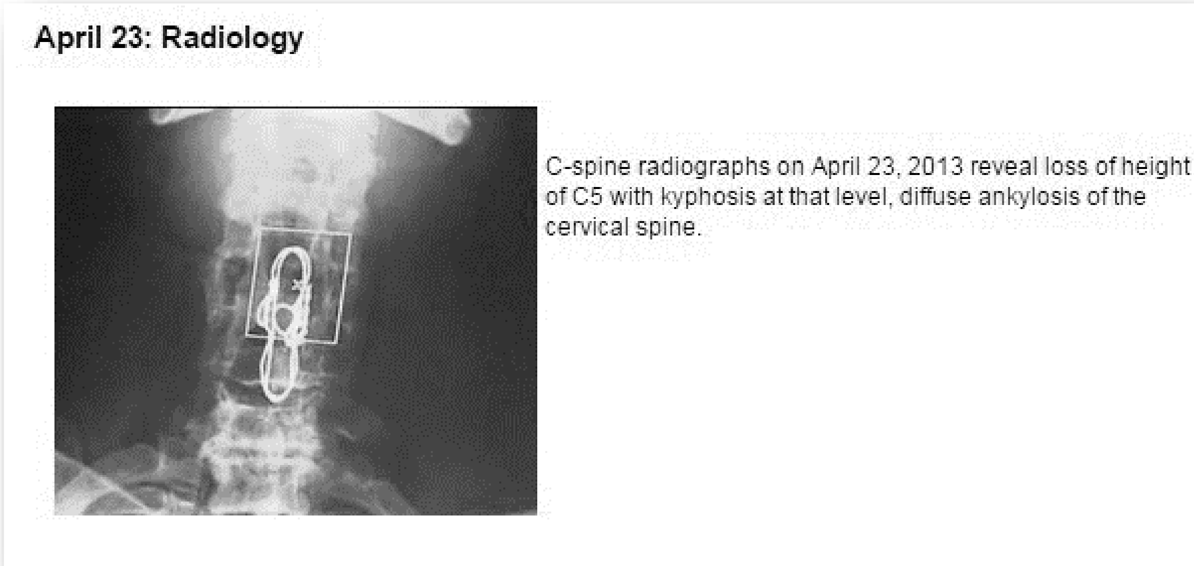


Figure 25. Cervical spine radiograph released by real-life patient who modeled the Matt Lane character for use in the electronic medical record activity.

The decision to create Matt Lane's EMR within the DecisionSim™ platform, as opposed to as an external, navigable simulation, was the result of experiences in piloting the earlier version of the VP with medical students during selective/elective coursework in physical medicine and rehabilitation (Schladen et al., 2014). The constraints of recruitment and testing in that pilot study were similar to those in the current study: test extremely busy clinical trainees whenever they had time, on whatever equipment was available, over whatever connection was available. The pragmatic consideration of accommodating clinical training schedules made flexibility the watchword.

The earlier version of *Matt Lane* instantiated the medical record on an external website to which learners could establish a connection window, which they would minimize or activate as desired. Learners who participated in the pilot used their own laptops and connected to hospital wireless through a second-tier (e.g. performance degraded), "guest" connection. Using this non-priority channel meant that media was very slow to load, and participants experienced diminished interest and motivation as a result. It was not feasible to use health system network devices for a variety of reasons relating to security concerns centered on patient confidentiality.

As a result of throughput problems experienced by learners in the pilot, a strategy to minimize connections to web resources was adopted for the design of the VP for the current study. This strategy resulted in Matt Lane's, virtual EMR being built in DecisionSim™ and configured as described: shared between a branching DS-node structure and the Case History pane function.

Learners were directed to review the patient's record *thoroughly* by the handoff communication (Figure *8*) that initiated Day 2 of the VP. Participants were free, however, to review as much or as little of the medical record as desired. Cathy, first learner to engage with Day 2 did not navigate the EMR as anticipated.

> *Researcher:* I noticed you went through the medical record really fast.
> *Cathy:* Um hum.
> *Researcher:* The way it's set up, I let you get out of the medical record, then you can't go back. Is that bad? Did you want to go back after --?
> *Cathy:* The medical record at the beginning of Day 2?
> *Researcher:* Um hum.
> *Cathy:* I barely looked at it at all. I think it's just because I was -- being impatient. But I missed a lot of, I think, important information. Like I should have [gone] through -- in real life you'd go through -- and see what they did each day -- and I didn't. … You HAVE to in real life so I don't. Like I knew I was supposed to, but I didn't want to... I didn't want to at all.

Reviewing documentation, though necessary, was not motivating to Cathy. Her comments hark back to Shari's earlier complaint while working through the EMR on Day 2: "I wanna see the patient already!"

The next two learners to interact with Matt Lane, Day 2, Shari and Zoe, *did* choose to work through the EMR. They reported confusion and feeling lost both with respect to how to interact with the EMR and why they were doing it. See Table 33.

After the first three learners tested Matt Lane, Day 2, a change was incorporated into the testing plan to make sure that learners interacted more fully with the EMR activity in order to provide feedback, particularly on the images, reports, and assessments modeled from the underlying, authentic patient case. See Method 6: The Resources for details of the learner experience with the patient information artifacts presented within the patient EMR.

Table 33

Free Navigation Experiences of the VP EMR (Electronic Medical Record)

Confusion	Learners' Experiences
About operations	*Zoe's reflection*: … I wasn't sure if I was ever going to go back, 'cause it was kind of like a blank slate. It was like, "What do you want to do next?" And I was like, "Well, I guess I'll just pick this." And I wasn't sure if there was something I was supposed to do first, like a logical answer, or if I was going to have to opportunity to do all of them. AND THEN I found out later that *I wasn't* gonna end up going back and do -- I don't know. I was a little lost.
About purpose	*Shari's think-aloud:* [on 7th recursion of the EMR "hub"] I'm actually kind of confused. Do I want to see more of this stuff? I'm pretty sure I should look at all of it. Ahm -- I don't know. I saw everything that was done yesterday -- umm I know Urology's coming -- so I guess I could look at that and see if he came …

As learners explored the EMR, what they read impelled them to go see the patient. This inclination was demonstrated by preclinical learners as well as the medical resident.

Shari, PA-1: And I know what I wanted to do was I wanted to go SEE him. But I felt like I *had* to look at everything in the medical record first, before I could even see him. [If I had] had the choice to do what I would have liked, I would have just gone straight in to talk to him after reviewing the vitals. I saw the vitals and said, "Ok, let me just go talk to him!"

Maria, PGY-2: [finishes reviewing Braden Scale]
The patient's back on the unit -- can I see him now? …
[request from researcher to continue reviewing the EMR] …
I just wanted to make sure the patient's OK.

Zoe, PA-1, further perceived that that reviewing certain parts of the patient record contributed little direct benefit to caring for the patient but required considerable time and effort to work through.

I didn't do the B one [Braden Scale], but I did the ASIA[25], and I read it and it said, you know, what do you think -- and I really ... like we learned musculoskeletal. Ok well he's damaged from C5-C6, so that explains why he can move his arms, 'caus,e he had the enervation here and here. So I kind of like, was really thinking -- I went to the next page, it was kinda like ok, he *does* have this broken here. It just confirmed it and it seemed kinda going into the pathophysiology I spend all this time thinking about. I just overthought this, for no reason. … It gave me a lot of information, that I didn't want…

Once learners progressed through the Day 2 VP to the point where they visited with the patient, returning to check facts previous gleaned from the EMR was done through the Case History pane. This proved challenging given the number of nodes accumulated there from the prior activity of perusing the EMR and the difficulty in remembering which nodes (by name) contained the information sought. Table 34**Error! Reference source not found.** provides an illustrative vignette.[26]

[25] Free text DS node with linked resources on how to perform an ASIA (American Spinal Injury Association) neuro-assessment and a copy of the patient's own, completed, ASIA exam

[26] The vignette is actually taken from the order-writing exercise at the end of Day 1. The learner's experience reviewing the EMR on Day 2 was more complex and not as demonstrative of the issue, which is a function of VP length.

Table 34

Vignette: Looking for Previously Reviewed Information

Dialog	**Actions**
Maria: Ahm... what were his other stuff? I know he had spasticity. Ahm, I think he also has OSA. Ahm, he has a history of AD, if I'm not mistaken -- where is that?	Determining the admission diagnosis
Maria: History of Present Illness?	Scrolling up and down in Case History pane
Maria: Is it here?	Clicks on *Complete Patient's History (Interview)*
Maria: Here?	Clicks on *Surgical History (Interview)*
Maria: [silent focus] *Researcher:* Ahm, scroll down a bit.	Returns to Case History pane, scrolling Clicks on *Hx of Present Illness*
Maria: Here?	Mouses over *Complete Patient's History*
Researcher: *Past Medical History*.	Mouses to *Past Medical History*, clicks
Maria: Ok, YES! *Researcher:* So that's not the right -- *Maria:* No, I was confused. Ok.	*Past Medical History* opens -- Maria and Researcher reading…

In summary, free navigation of the EMR, as an activity preliminary to visiting the patient, did not work for learners. They did not know what they were looking for in the EMR and felt unguided both operationally and in terms of purpose. Learners perceived the time spend reviewing the entire EMR provided too little benefit, commensurately, toward the mission of caring for the patient. The preference was to see the patient and consult the EMR as needed. Incorporating the EMR *inside* of DS made it an exercise, when learners were expecting a resource. A quote from Maria provides a final note on reviewing the patient record.

> I think it's good practice, to review. But to be honest, I don't think we *all* review this. Because, as long as there's no adverse event that happened to the patient, you're assuming all this is done. ... The problem is if the nurse is not documenting correctly, then you are -- if you don't ask the patient -- then you're kind of missing that part. You're a bit dependent. That's why the problem is what happens when the patient is, say, has a head injury and doesn't know. He can't answer you. That's when the problem comes on. But otherwise, documentation is generally pretty accurate.

Differential Diagnosis and Clinical Decision Making

After reviewing the EMR, learners went to see the patient, Matt Lane, whom they discovered presenting with ambiguous symptoms. Their task, subsequently, was to apply clinical reasoning to develop a differential diagnosis and treat the underlying cause of Matt Lane's symptoms. Figure 26 shows the learner-facing, branching DS-node that initiated the clinical reasoning activity. The learner's options for exploration of causes of the patient's symptoms were limited to three: a new, incipient episode of autonomic dysreflexia[27] (AD), skin breakdown[28], or failure of the patient's suprapubic tube.[29]

Whichever option learners chose for exploration, they would enter a process that would allow then to explore various logical paths and substantiate their thinking with evidence drawn from what they had learned from the patient's record or from "research" they had done by exploring the evidence-based resources offered in the course of reviewing the patient EMR information. Figure 27 displays a case map of the factors available to learners to explore in determining the appropriateness of a diagnosis of AD.

Once learners picked a diagnosis to explore, such as AD, they chose to determine the underlying cause of the putative diagnosis. Figure 28 shows the learner-facing DS inquiry node guiding thinking about whether there is evidence to suggest that the patient, Matt Lane, has a distended (impacted) bowel, a common cause of AD.

[27] Autonomic dysreflexia (AD) is a life-threatening condition experienced by people with spinal lesions at or above the level of T6 (thoracic vertebra 6). AD is precipitated by an irritation below the level of injury. Bladder and bowel obstructions are the most common causes. Undetected skin breakdown is a close second cause.

[28] Pressure ulcer

[29] A hollow, flexible tube used to drain urine from the bladder. It is placed through an incision a few inches below the navel.

Figure 26. DS branching node introducing clinical reasoning process activity for developing a differential diagnosis of Matt Lane's evolved symptoms on Day 2 of his admission.

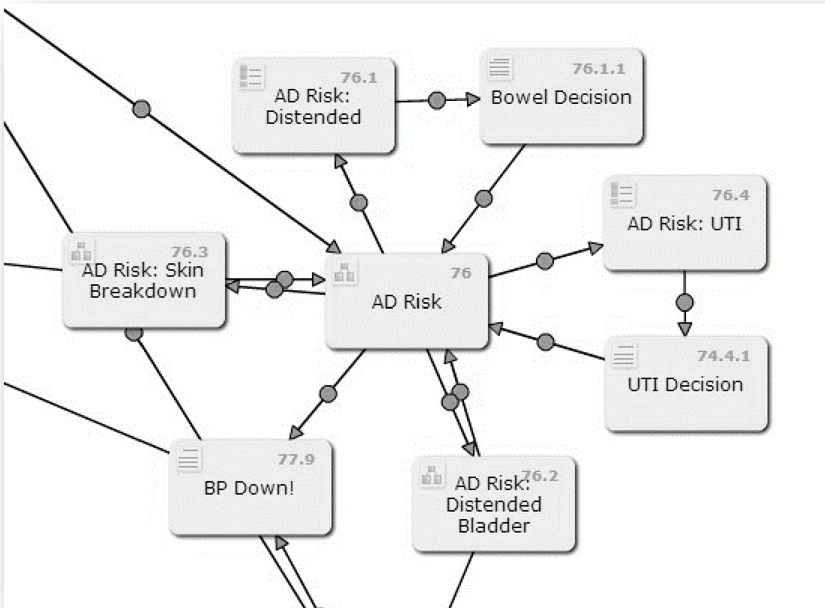


Figure 27. Case map showing organization of factors to explore in determining the likelihood that the patient is experiencing onset of autonomic dysreflexia. DS-node types employed include branching logic (ex., AD Risk), inquiry node (ex., AD Risk: UTI), and narrative (ex., BP Down!)

A satisfying experience with the differential diagnosis development activity depended on having thoroughly engaged the EMR activity (Reviewing the Patient Electronic Medical Record (Clinical Documentation) previously on Day 2 of the VP. As described, interacting with the patient's EMR as an activity did not work well. Therefore, learners began the differential diagnosis formulation activity from a negative position.

Confusion and uncertainty were consistent themes in learners' accounts of their engagement with the differential diagnosis/clinical decision making activity in Day 2 of the *Matt Lane* VP. Zoe, PA-1, was among the first three learners to test the Day 2 VP, before the testing protocol was modified to guide learners through the EMR experience that "set up" subsequent navigation of the differential diagnosis activity. Zoe's diary-like comments and reflections on her self-guided interaction with the diagnosis activity are displayed in Table

35. Zoe’s autonomous, unstructured, *naturalistic* experience provides a window on what learners’ experiences would be in the situationality specified for building an instructional design theory in the current study: of autonomous, free-choice use by clinical learners.

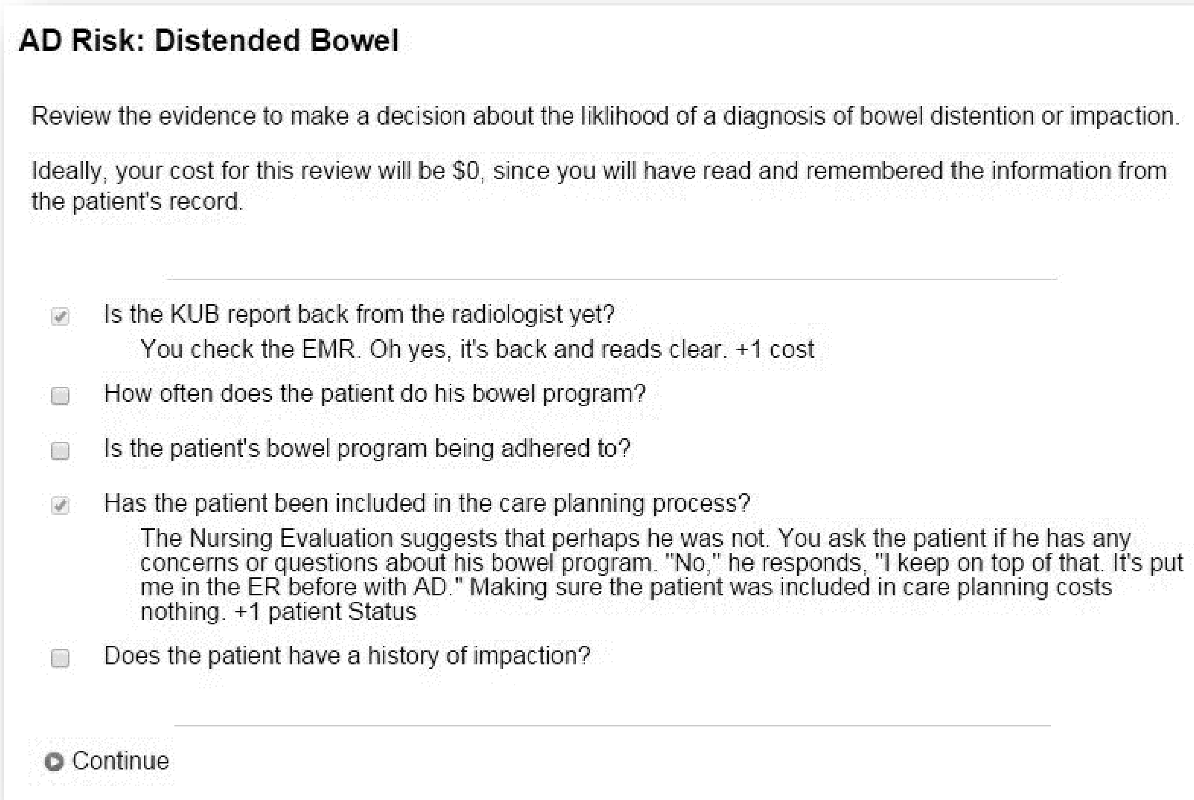


Figure 28. Learner-facing DS inquiry node guiding reasoning about whether the patient has a distended bowel, which increases the likelihood of his experience of autonomic dysreflexia (AD). The learner receives a point for taking an action that improves patient status but receives a negative cost point for failing to have retrieved/remembered the patient’s radiology results from reviewing his medical record earlier.

Table 35

Zoe's Reflection on the Decision Content and Process

Zoe's Experience	**Themes**
Ok, so now I'm with the patient and the first one reads, "OOB in his wheelchair"! I don't know what OOB means. It seems I'm kind of running into that. There's abbreviations that I'm not aware of what they are. Ah, we kind of learned in class … to try to stay away from a lot of abbreviations because it might not be universal knowledge -- or at least it's not to me yet.	1-Acronyms and inhibition of learner engagement
Ahm. so it says then that I took his vitals. Ahm, ok. I'm just getting into this again: Chest RRR, no M/G/R CTA. But the *rest* of it I get.	
But I *liked* being presented with the vitals and, "Hey figure out what's wrong with him." Cause there were abnormalities in [the] vitals that you should be able to pick up on.	2-Application of knowledge in problem-solving
I honestly don't know what autonomic dysreflexia is. It keeps coming up. So I'm kind of feeling like a lack of education to go through this case. It's asking me what's going through my mind and literally nothing because I don't know. … I'm going to just click on things now. I'm kind of confused.I'm kind of stuck. I don't know what to click at this point. It says that I'm concerned about his skin. I didn't *know* that I was concerned about his skin.	3-Foundational knowledge for case-based learning 4-Perception of guidance provided indirectly
So it's almost, the amount of freedom I was given, it was constraining because it just made me want to do things I couldn't do. I see this, now I want to do this, but that's not an option. ... I know that the point of it was to give me an option to think more broadly, but when what I wanted to do afterwards wasn't there, then I just got shunted backwards.	5-Paradoxical relationship of freedom and constraint 6-Anticipation of universe of learner responses

Zoe's Experience	**Themes**
I notice that on Day 2 it's not really telling me how I'm doing when I make decisions. It's kind of just taking me to more pages and I'm noticing that I'm getting more and more confused versus the first day when I click on something and if wasn't the greatest decision, it would sort of give you the answer and keep you on track and kind of say, "You probably wouldn't do that," or, "That probably would or would not be a concern." And now it's not giving me any feedback, so I'm feeling a little lost. Like I'm just kind of wandering through it at this point.	7-Clarity and specificity of feedback
Maybe the psychological thing -- plus or minus, cause there is still like an explanation to guide you. … I liked when you were explaining and it was plus one or minus one and like you could just move on or you could continue [selecting]. I liked that kind of like decision making.	8-Numerical scores and guidance (See Figure 28.)
I went to see if the urology consult had been called and I had to ask him [the patient] when his catheter was replaced and he said, "I told you that yesterday." (See Figure 29.) I went, "Did you? Uuugh. It's awful if you did. I don't remember you telling me that, oh my goodness." So I did *get* that part of it.	9-Learning through outcomes of errors/omissions
It's almost like two problems. His whole UTI and the suprapubic problem and then there's the ulcer problem. And the ulcer problem -- I get the point that you probably wouldn't find it unless you were looking for it, and that was the last thing even on my mind: I should have ordered boots yesterday! …You're going to look for the acute things, like a UTI, but it's something like an ulcer that will get overlooked repeatedly, 'cause people aren't thinking about that.	10-The ease with which pressure ulcer risk is overlooked
Would it be possible to have the baseline case with everything and then you can choose the difficulty level? …The instructor could select minminum information or maximum information because I think that would change how you used it. I don't know if that would be possible, 'cause I'm feeling a little overwhelmed because there's a lot of information here. But I'm like I don't know if the idea is to make decisions, I have know idea at this point.	11-Progressively challenging modulation of VP case

Figure 29. Differential diagnosis development activity feedback, question asked to patient that the clinician/learner should have remembered/noted.

The 11 themes to which Zoe directed attention are consonant with experiences of other learners and, additionally, identify several methods that may be seen as proper to GBS theory, methods that are implicit in GBS theory but not part of GBS theory, and methods that are outside of GBS theory. The implications of these 11 identified themes will be considered in Chapter 5.

Learners completed a validated, Technology Acceptance Scale (Figure 30) to rate both their Day 1 and Day 2 VP learning experiences. Day 2 activities principally revolved around 1) reviewing the patient EMR, 2) developing a differential diagnosis based on the patient's new, presenting symptoms, and 3) staging the patient's new pressure ulcer(s). The well-received staging activity (see Performing a Physical Exam) was the activity the directly preceded filling out the rating scale, but activities 1 and 2 consumed the majority of the Day 2 VP instructional time. It is difficult to determine, therefore, the proportion each of the three activities modeled in the Day 2 VP contributed to learners' rating of the overall intervention. Since feedback on the pressure ulcer staging activity was positive, the disparity between learners' rating of Day 1 and Day 2 can be attributed to some distribution between the differential diagnosis and EMR activities.

Figure 30 displays the difference in learners' experience of Day 1 and Day 2 of the *Matt Lane* VP. Compared to Day 1, Day 2 activities (EMR and clinical reasoning) did not increase learners' productivity, were hard to learn and manipulate, difficult to master, and inflexible. They were not as usable or clear as were Day 1 activities. Both days were deemed equally efficient, performance enhancing, effective, helpful, and useful.

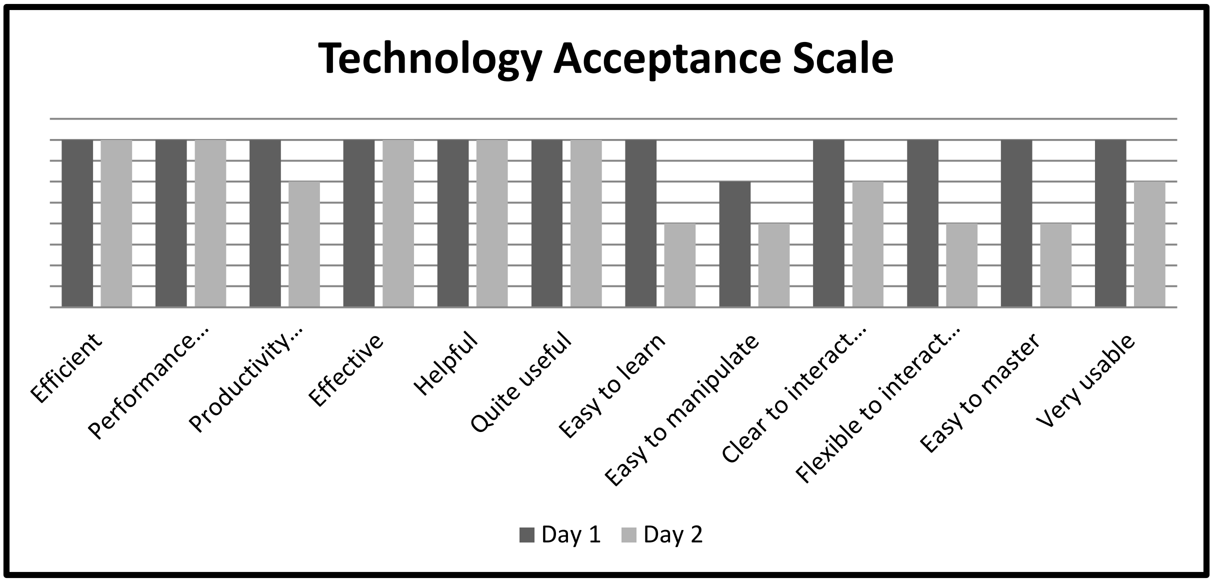


Figure 30. Scale completed by learners inside the *Matt Lane* VP two times: once after Day 1 and once after Day 2. Comparison is proportional, scaled to reflect the smaller number of learners who completed (and rated) Day 2 versus Day 1.

In summary, the differential diagnosis/clinical decision making activity did not work well for learners. It suffered from problems inherited from the EMR activity that preceded it and was foundational to it. However, the differential diagnosis activity demonstrated flaws in its own right. Principal among these shortcomings was failure to accommodate the appropriate range of knowledge (education and experience) learners brought to the activity. There was inadequate support within the activity to enable most participating learners to develop a conceptual basis for action, e.g. an “expectation,” and learning through expectation failure, key to the learning theory underlying GBS, did not happen for most learners.

Method 6: The Resources

Table 36

The Resources in Matt Lane

GBS Method	Method as Exposed in *Matt Lane, A Pressure Ulcer Prevention Virtual Patient*
The Resources	Online aggregation of best-practice and evidence-based materials guiding pressure ulcer prevention, patient-specific documents and multimedia, open searching of the Internet

The *Matt Lane* VP employed three categories (Table 36) of resources to support learning: resources to provide information about the virtual patient himself, resources to help participants learn about pressure ulcers and risks to people like Matt Lane for getting them, and open access to the Internet so learners could freely search for any information not explicitly provided

Audio and video materials provided learners access to the "person" of an individual with tetraplegia and his experiences receiving care. These materials were designed to facilitate tacit and observational learning and were integrated into the scenario operations (activities) of the VP. They were housed on YouTube and accessed within the DecisionSim™ VP platform through iframes, a technology that made it appear that the Matt Lane media were playing on the page the learner was currently viewing. Patient narrative, in dialog with the care provided, supplemented the video resources and was provided within the DecisionSim™ platform templates (e.g. media panes incorporated in the various DS-node structures).

Learners could learn more about their patient, Matt Lane, by accessing various assessments and images that were incorporated into his modeled electronic medical record (EMR). Small amounts of text and single images, such as Matt Lane's cervical spine x-ray (see Figure 25), were displayed directly in the media panes of the various DS-node activities of which they were a part. More extensive documentation, such as the patient's Braden Scale assessment, ASIA neuro-assessment, and Interdisciplinary Nursing Evaluation, were stored as PDF files on Matt Lane's Drive (Google, 2015), an account developed to coordinate *Matt Lane* VP materials. The assessments and evaluations were developed from forms found in the authentic medical record released for VP story development by the patient on whom Matt Lane was modeled. A logo for the fictitious hospital where the VP was receiving care, Northeastern Regional Hospital, was developed and substituted for the actual organizational logo on the patient forms to preserve the sense of authenticity of the documents. Sample, constructed documents can be found in Appendix P.

Learners accessed patient documents on Google Drive by clicking on hyperlinks embedded in the media panes of individual DS-nodes. Documents displayed in a new window, sized initially to four square inches. The learner could resize the display window as desired to peruse the document. This display strategy was adopted based on experience in the pilot (Schladen et al., 2014) of the *Matt Lane* VP where, originally, the document window would fill the screen. This approach caused some students difficulty in relocating the DecisionSim™ window to resume navigation of the virtual patient.

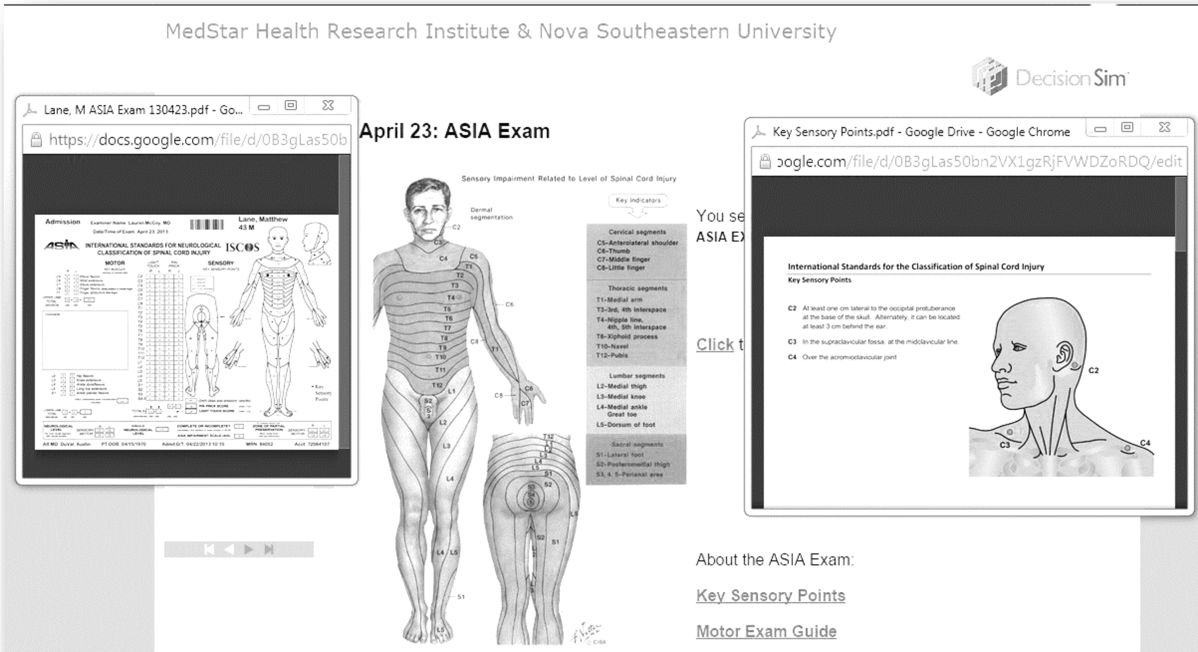


Figure 31. Matt Lane’s April 23 ASIA neuro-assessment exam. The patient’s completed assessment is popped out in the window on the left. A tutorial on how the assessment is done is popped out in the window on the right.

The four-square-inch pop-out hyperlinked window design was also used to connect learners with just-in-time information about aspects of the patient’s condition as they emerged in the unfolding VP scenario. Evidence-based fact sheets, for example, spinal cord injury statistics compiled by the Spinal Cord Injury Model Systems Data Center at the University of Alabama at Birmingham (The National SCI Statistical Center, 2012), and journal articles providing new knowledge relevant to managing the patient’s care, for example, a systematic review and meta-analysis on the impact of spinal cord injury on an individual’s serum lipid profile (Gilbert et al., 2014), appeared in the pop-out window in PDF format. Other resources, for example, a multimedia lecture on autonomic dysreflexia (Lea II, 2012), an often-observed, life-threatening consequence of getting a pressure ulcer for a person with tetraplegia, appeared in the window ready to re-size and play. Figure 31 shows the learner screen during review of the patient's ASIA neuro-assessment. The patient's completed exam and information on how the exam was conducted are simultaneously accessible in different windows.

The final resource available to learners as they worked through *Matt Lane* was the Internet itself. Participants were encouraged to minimize the VP window and look for information online, from a general population search engine or from their clinical program resources as preferred.

As was discussed earlier in the context of scenario operations, participants endorsed the use of video in developing the VP. Video provided an element of realism and a certain truth value to the patient case and clinical interactions depicted (Table 22). Learners also appreciated text-based narrative (Table 23) for its potentially greater efficiency. As Dana, PA-1, observed, "[It's] quicker for me to read than listen."

No learner was observed to have difficulty manipulating the video media. A portion of the patient history activity involved listening to the patient, understanding, and synthesizing the information he provided. Though some participants were dissatisfied with the quality of the patient's field-captured audio, no participant required coaching in stopping, rewinding, and restarting the media to review what the patient said. Apart from the issue of audio quality, and a single instance where the video was slow to load, video worked well as a resource for the VP.

As anticipated by their responses to the technology questions (see Figure 5) on the survey participants completed before interacting with *Matt Lane*, all were "digital natives:" persons born after 1980 and fluently conversant in online technology (Prensky, 2001).

> *Researcher:* You seem to be comfortable moving around from window to window, is that because you are on your [personal] computer?

Stacey, PA-1: I don't know. …I think it's just that I'm comfortable with windowing.

A screen shot of one participant's desktop, characteristic of the approach participants adopted to interacting with *Matt Lane*, can be viewed in Appendix Q. The learner's screen shows a layering of five windows, the top two generated from the VP activity. Included in the mix of windows is a word processing application for note-taking. Stacey framed this as a normative practice for clinical learners, though she did not realize it was an option herself when she tested *Matt Lane*.

> *Stacey:* What I was thinking the whole time was, "Oh, I wish like I had a pen and paper to write down some [notes]!" Even if, like, there was a Word document open or something, just to be taking notes like you *normally* would.

Participants speculated on using an externally linked site to model the entire patient EMR instead of just the patient data it contained. Table 37 sets forth some of their ideas.

Table 37

Reworking the Matt Lane EMR Using Windowing

Key Themes	***Learners' Ideas***
Simultaneous viewing	*Dana:* I don't know if it would be possible, if I had two windows open and I had it on a big screen, in a separate window where I could look at them at the same time. That would be helpful.
Separation of chart [EMR] and treatment process	*Stacey:* I think [it would work better for me] to have the chart in a separate window and throughout the treatment process…
Continuous accessibility	*Shari:* I think I would almost like to have it in a separate window that I could have open over here and just click back to it …so you could click back and have reference to it, versus feeling like you're going to get lost if you navigate away because it's designed for you to keep going. So I think it would be nice if you had the medical record in a separate window where you could, like, almost click through it: "Oh, let me click on vitals. or lab values"
Intuitive organization of data	*Zoe:* I'm picturing like, you know, Microsoft Word -- How you have the notebook version, and you have a template for Microsoft Word that looks like a notebook and there's, like, tabs. Oh, let me flip to meds real quick. I can flip to this." Maybe that would make it seem like I can keep going back. I kept getting like -- "Well, am I going to be able to read all of this, or do I have to pick what I want to read?" – whenever I was going through. But in real life, you'd be able to.
Continuous comparison	*Zoe* (idea #2): Is it possible to have a sub-window in the, like a pane at the bottom? A medical record I worked with before, where it was a window you were working with primarily and then there's a secondary window where you could pull up lab values. So you could be writing a note and pull up lab values beneath it. So you kind of referenced it.

Similar to their appreciation of seeing and hearing an actual patient and authentic care activities, learners also affirmed, though less enthusiastically, the value of working with actual clinical documentation. The contrast between the two "realities" is brought to light by the comments of two, first-year students in Table 38.

Table 38

Relative Appeal of Clinical Realities: Patient Care Versus Documentation

About watching a transfer and clinician interactions	*Zoe, PA-1:* Sometimes, I think it's not quite as comprehensive [preclinical training] as you would wish. Until you get to rotation. Obviously. So I think this is a nice connector to like, "Look, you're in a hospital!" and "Look, there's PT!" and this is what they do, and this is how they transfer the patient, even just, "Here's what they *look like* in a hospital room."
About working with actual assessment instruments	*Dana, PA-1*: It was definitely interesting. I just wish I knew more about you know had the background knowledge to kind of appreciate it more. But it was nice to see the actual forms that they use. You know what it would look like in real life. We don't get to see a lot of examples like that. We learn, oh there is a rating scale called this, this is what it's used for. We don't see it in actual use. You know what it looks like on a day-to-day basis.

Learners had the technical "know-how" to work with an external medical record and the documents in it as well as the training resources linked to those documents to explain them. Most participants didn't have the time, or perhaps even the need, to engage the training resources. Shari's recounted (see discussion in the EMR activity in the previous section), that she spent a lot of time learning about how the patient's neurological condition was determined to little effect in addressing his current problems. Other participants also found training resources interesting in principle but not immediately relevant. See Table 39.

It is a tenet of GBS that the learner should not be asked to do more than is necessary to accomplish the mission of the current scenario (Schank et al. 1999, p. 176). Including ancillary and tangential resources in *Matt Lane*, therefore, may introduce unnecessary complexity and constitute a deviation from GBS.

Table 39

Potentially Inappropriate Resources in Matt Lane

Topic	**Learner Experiences**
Lipid profiles after spinal cord injury	*Dana:* I like the link to the research! I'm not going to read it [during the testing session] because of time purposes, but I probably would.
How to perform an ASIA neuro-assessment	Shari: [Pulls up ASIA worksheet instructions.] "Why not? [Sees the length.]---This is like *way* more than I would want to read right now."
	Emily: Ok I'm not going to click on it [hyperlink to ASIA exam] just because I know what the ASIA exam – actually, let me click on it just so I can read about it later, so I don't want to do it right now.
	Maria: [Clicks on the ASIA exam link] Obviously I'm not going to look at that.
How to diagnose autonomic dysreflexia	*Dana:* It's a video I could watch if I wanted to? *Researcher:* It's a 20-minute lecture on autonomic dysreflexia. *Dana:* Oh that's interesting. I wouldn't have time to do it now, but I would definitely do it later.

It worked for learners – they did it readily -- to pull up a new browser window and search online for information they didn't have using general purpose search engines. Examples of terms searched include adaptive call bell, ASIA exam, autonomic dysreflexia, baclofen pump, CPAP, TED hose, and Venodynes. They were not always without apology for using the efficient but extra-academic means of information retrieval.

> *Dana, PA-1:* [thinking aloud, testing Day 1]: Like I'm looking this up on Google to find out what the baclofen pump does and the risks online -- and I looked up FES because I didn't know what that was. …Looking up what adaptive call bell is too because I don't know what that is. .... I should probably not use Google but … I mean I would USE like an internal little dictionary if it existed… sometimes I end up at databases from Google anyway.

Table 40

Should Matt Lane Incorporate Hyperlinks to Provide Just-in-Time Information?

Key Points	**Learners' Reflections**
• Trustworthiness of information • Removal of burden of evaluating the credibility of information received	*Dana, PA-1:* Yeah that would be easier ... it takes a little bit of time to figure out which websites are actually legitimate and then, you know half of them are blogs, and it's not.. yeah it would be easier to have a hyperlink to an actual, medical website, like something that we use like Merck or MedScape or Up-to-Date or something like that that would be a lot easier, actually.
• Efficiency	*Maria, PGY-2:* I'd look it up myself, actually. It would kind of make the cases a bit long, a bit too long [if I couldn't pick the information source myself].
• Optional activation of link – ignore it if you don't need it • Avoid lengthy texts • Explanations should appear on hover	*Emily, M-4:* If you're unsure, then you can look at it. …And it would be good for even, maybe, the junior medical students and also the residents 'cause residents are so used to just, ahm, they don't - I won't - have a lot of time to like really read all these long versions. So if it's like this, and don't know something, you can just float over it and it will come up. Yeah. That's a good idea.
• Equivocal perceptions of "click aways"	*Emily, M-4:* I personally hate to navigate away from my page. … I don't like clicking away from the page and then having to go back to the page I was working on. …Ahm, but... and some people LIKE that some people like seeing it and go like, "Ok you click back and you click forward. I think it's just a personal preference."

Learners were of different minds as to whether unknown terms in the narrative of *Matt Lane* should be hyperlinked to explanatory resources for just-in-time learning. Table 40 shares learners' reflections and summarizes key points. Thoughts about this strategy were that it increased the credibility of information uncovered but also removed control from learners for selecting information sources that met their needs. The very act of "clicking away" from one's current focus was seen as potentially dissonant to some people. The idea that information could appear on mouse hover was proposed. This latter strategy would work only for very short texts, however.

In summary, the patient chart (EMR) forms modeled on authentic documents were successful. Learners demonstrated excellent online skills and managed multiple windows on their computers with mastery. Training materials about the patient's condition, in contrast to materials reporting the patient's condition, were little used. The explanation given was that they were too lengthy to access in the period of time given to testing *Matt Lane*.

Learners were self-efficacious in managing their own knowledge gaps, opening a new browser window and searching online when they encountered unfamiliar terms. They were divided on the appropriateness of searching for health information online and whether incorporating hyperlinks to all unfamiliar concepts in the *Matt Lane* VP might not be recommended. Learners advanced varying opinions. Hyperlinks increased reliability of information but decreased learner autonomy. The act of clicking away from one's page of focus to follow a hyperlink was seen as potentially dissonant. Information that would display on mouse-over without navigating the learner away from the current page was presented as a possible solution. The display-on-mouse-over strategy, however, is extremely limited in the amount of text it can deliver.

Method 7: The Feedback

Table 41

The Feedback in Matt Lane

GBS Method	Method as Exposed in *Matt Lane, A Pressure Ulcer Prevention Virtual Patient*
The Feedback	Learner experience of decision outcomes, detailed explanatory feedback from scenario characters at key junctures in patient care

When asked about what aspects of the Matt Lane VP worked, and didn't work to enhance her experience, Stacey, PA-1, offered first and foremost:

> I *really* liked the feedback! Like I said, the program that we use now, you choose questions and it doesn't tell you whether it's appropriate or not. So you can go and ask hundreds of questions if you want, and the professor has to go in and see what you asked and sometimes we get graded on it.

Schank et al. (1990) present concise recommendations for implementation of the GBS Feedback Method. As noted by their editor, Reigeluth, the method is broken into *kinds* of feedback: 1) through the consequences of learner actions in the scenario, 2) through coaches who offer just-in-time information to scaffold learning, and 3) through domain experts who relate stories that pertain to experiences similar to those the learning is having in scenario (p. 178).

Implementation of all three kinds of feedback identified by the method is not a requirement of GBS Theory. As brought forward in Table 41, initial examination of *Matt Lane* indicated that the VP provided feedback in the form of kind #1, consequences, and kind #2, coaches. Notably, stories are used extensively in *Matt Lane,* but they are mostly the stories of the patient, not stories of health care providers. While it is part of the culture of patient-centered care to see the patient as a "teacher," the patient role is not the role played by leaners in the VP. Therefore, when the information transmitted through Matt Lane, the patient, isn't a consequence of learner action (kind #1 feedback), it has been primarily cast as a resource, rather than as kind #3 feedback, domain expert stories, for the purpose of mapping VP methods to GBS Theory methods. Table 42 maps the feedback methods used in Matt Lane to those identified within GBS Theory.

Table 42

Matt Lane Feedback Methods Mapped into GBS Theory

Context (Scenario Operations)	*Matt Lane* Methods	GBS Methods			
		Feedback			Resources
		Kind #1 Consequences	Kind #2 Coaching	Kind #3 Experts' Stories	
Return of handoff	Free text DS-node, model responses		X		
History: Capturing patient's concerns	Free text DS-node, model responses		X		
History: Asking appropriate questions	DS inquiry node response (patient)	X			
History: Asking appropriate Questions	DS inquiry node response (best practice, affirmation or correction)		X		
History: Asking appropriate Questions	DS inquiry node response (quantitative score)[30]				
History: Choosing to explore patient's social and functional history	DS narrative node (patient's personal narrative)				X
Physical: Pressure ulcer staging	DS MCQ node – correction with rationale (provision of criteria)		X		
Writing patient orders	DS analysis node group – affirmation or correction, with rationale		X		
Writing patient orders	DS analysis node group – affirmation or correction, without rationale (e.g. "not indicated)[30]				
Writing patient orders	DS analysis node group – mentoring from virtual attending on missed correct orders, summary of orders indicated		X		
Review of EMR, assessment critique	Extended, free text DS-node, summary of errors, errors shown marked up on document		X		
Review of EMR, assessment critique	DS-branching logic nodes, score incremented for each EMR assessment engaged[30]				
Differential diagnosis	DS-branching logic nodes, score incremented for each dead-end path pursued[30]				
Clinical decision making	DS branching logic and free text nodes, patient reaction	X			
Clinical decision making	DS inquiry nodes response, (affirmation or correction, with rationale)		X		
Clinical decision making	DS inquiry node response (quantitative score) [30]				
Clinical decision making	DS narrative node with video (clinical demonstration of correct preventative intervention)	X		X	

[30] Method not accounted for by the GBS Feedback Method

Feedback functioned within the *Matt Lane* scenario operations, or activities, to help learners carry out the mission of providing care for the patient. Learner experience with each of the three kinds of feedback defined in GBS Theory and with feedback that does not specifically align with GBS Theory, will be described in the sections that follow.

Coaching

As can be seen in Table 42, kind#2 feedback, coaching, predominated. Coaching assumed three forms in the VP:

1) Model responses against which learners could compare their own responses (free text DS-nodes);
2) Personalized mentoring on missed correct decisions and summation of overall decision task (analysis node group);
3) Impersonal affirmative or corrective feedback, sometimes with and sometimes without provision[31] of rationale.

Developing written response to a situation in a VP scenario provides learners the opportunity to gather their thoughts and advance a proposition relative to the issue. Table 43 summarizes learners shared of their experience of receiving model responses to their free text entries in the VP. Dana, PA-1, noted that the process seemed “right” to her and similar to her expectations for learning [e.g. from a preceptor] in an actual clinical situation. Zoe, PA-1, however was confused as to how to use the model to evaluate her own response. Shari, PA-1, pointed out the potential problem that learners would NOT, actually, have the capacity to

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[31] In keeping with a more clinical education traditional style, non-personified, anonymous feedback sometimes did not provide a rationale for correction or affirmation. Table 31displays the anonymous feedback conveyed by the DS inquiry node that provided the structure for the activity of writing Matt Lane’s nursing orders. Order-writing activities evolved as the VP was revised. Statements with no rationale such as the “not indicated” response should the learner choose to order Venodynes (compression stockings) were not changed, since the diction replicated the feel of how traditionally, medical culture strove for more and more succinct communications.

accurately measure their own responses against the model and hence, would not improve their knowledge as intended. Zoe felt she benefited more from model feedback when it was presented as mentoring from a virtual attending physician (extended free text node design).

Table 43

Learners' Experience of Model Feedback to Their Free Text Propositions

Key Points	**Learner Experiences**
Model answers conform to expectations	*Researcher*: How do you feel about that kind of feedback? …You type in what you think, and then get the supposedly complete answer? *Dana, PA-1*: No, I mean that's the right way to do it. I don't really know what to do, so I need guidance in this situation. It doesn't bother me. I assume that's what I'd get in real life.
Confusion over how to use model feedback in self-assessment	*Zoe, PA-1*: I was as little confused for the parts where we were allowed to type. I wasn't even sure if it got my response. Like I don't know if it has the ability to see what I had typed and interpret whether what I typed is the answer or not. … It's kind of like the feedback was explaining what I should have typed and I DID type that.
Personalization of model feedback enhances understanding	*Zoe, PA-1* [about an extended free text node, Day 2]: So I don't really have much to enter into this space on that page because I don't really know how to interpret some of this. So [typing response] …I do like, on the next page, the physician reviews it and says, "Among the important things to know are --" because, like I just said on the previous page, I really didn't know what was important. So this is helpful.
Risk of failure to properly self-assess from the model	*Shari, PA-1:* I like having what a correct response would be and comparing it to my own. So it's almost like I'm assessing my own feedback. At the same time, I would think that maybe a feedback like this, if I'm over-confident or something, I would be less likely to admit that I was wrong. It's kind of gray-area, feedback. It's really dependent on me interpreting whether what I wrote is similar to this. … I have a background in English, so I have like a writing background, so maybe I would be more thinking … I think that it's an effective feedback tool, although it might over-inflate me.

The device of having feedback delivered from a virtual attending is consonant with the formulation of coaching in GBS Theory. “As a student performs tasks within a GBS, an online coach following his or her progress can offer advice when needed, providing a just-in-time source to scaffold the student through tasks” (Schank et al., 1990, p. 178).

In the Matt Lane VP, learners had Dr. DuVal, the attending, spinal cord injury expert in charge of Matt Lane’s hospital unit to provide them just-in-time mentoring on their orders and other decisions relating to managing Matt Lane’s case. As previously described, one of the functions Dr. DuVal served, when brought to life in an analysis node complex, was to prevent learners from failing to choose a correct item in providing care. Table N shows learners receptiveness to the person and functionality of the virtual Dr. DuVal.

Table 44

Learner Experiences of the Character and Functionality of the Virtual Attending “Coach”

Key Points	**Learner Experiences**
“Trust” in the virtual mentor	*Stacey, PA-1:* [stuck on a decision in the Day 1 order set] Well I don't really know, so I'm gonna see what Dr. DuVal says.
Finding the missed right answer	*Researcher:* Hold on a second, You just went through a decision [Day 2 VP]. Uh, how did you feel about that? You were presented with a possible situation, and then it gave you feedback? *Stacey:* I liked that, but… I was hoping that after I continued, I was hoping it would tell me if I missed anything. *Researcher:* Like with the orders? *Stacey:* Umhmm.
Increased focus	*Cathy, PA-1:* I think I might have taken away more when it was the doctor explaining it. It was more in-depth than just the right or wrong really quick. ‘Cause when I see it's right, I'm "Ooh, ok," and I just keep going, and I don't read why it's right, even if I guess. It's just, I got it right. Like, “Oh, I got a point.” But the explanation, I think I took more time on.
Favorite part of the intervention	*Researcher:* And then you have the feedback of like yesterday in the order set -- you get immediate feedback if it's right or wrong but you don't want order too many things that are wrong, there's a risk that you'll leave that section and not order things that are right. So then Dr. DuVal comes back and tells you the things that you missed. And then at the end -- *Zoe, PA-1:* I really liked that! *Researcher:* You liked that? *Zoe:* That was probably my favorite.
Reassurance	*Shari, PA-1*: Day 1 is really good. … Also in Day 1, we have our physician right there. He's not there on the second day. That whole, here are the nursing orders, and he tells you if it's right or wrong, that's not IN day 2. I liked that from day 1.
Character appeal	*Researcher:* Does having the personality of the attending alleviate the tedium of --?

Key Points	Learner Experiences
Why not video?	Dana, PA-1: Yeah, kind of gives him a little character. It's better than just reading a whole list of all the things you should have done. The facial expressions, you know. And it just makes it a bit more real I guess. I don't know why he's not speaking though. Only the patient giving little -- you know what I mean? He isn't a video. I don't know if it needs to be. I was just wondering.
Adding Realism	*Cathy, PA-1:* I like the guy's faces, by the way. I guess he's a real person?
Importance of Character Presentation	*Emily, M-4:* The picture is not very good though. His eyes are closed.

Learners enjoyed their "relationship" with the virtual attending character and described his presence as reassuring. Cathy, PA-1, liked the expressiveness of the character ("the guy's faces) across the various feedback nodes believed feedback from the virtual attending increased her focus. Dana, PA-1, would have like the virtual attending to be as realistically developed as Matt Lane himself, with audio and video. Emily, M-4, was unhappy that she could not make eye contact with the virtual attending in one feedback node. Pragmatically, learners appreciated that the device of the virtual attending addressed the problem of a missing a learning point related to item selection activities.

Though the character of the virtual attending, Dr. DuVal was appreciated and may have increased both engagement and confidence, non-personified feedback also worked for learners. With respect to non-personified feedback, learners shared:

> *Zoe, PA-1*: I feel like I learned a lot because there was feedback as you went, so I wasn't like confused as to how I was doing because you were constantly like kind of reassuring me, and you were give logical reasons like what that wasn't maybe the best decision but it wasn't like a reprimand where you felt like stupid. It was you know like, "Well, that's a nice thought, but here's why maybe it isn't the most efficient thought to have." So I liked that.
>
> *Andie, M-1*: I like getting the feedback and especially the "why" you would or would not consider. That's why I want to click on ALL of them [right or wrong], because of the "why"!

Andie's comment suggests that providing a rationale for feedback, particularly if it is non-personified, may be a factor in its appeal (see footnote 31). This suggests that non-personified feedback that merely states whether the answer is right or wrong does not work for learners. Andie’s experience compares with Zoe’s experience of feedback from MCQ questions discussed below.

As previously noted, maintaining independence of feedback messages in item selection lists (e.g. as mediated by the DS inquiry node, used both by itself and as a precursor to analysis node groupings in *Matt Lane*) emerged as an important factor in maintaining the learner experience of coherence in VP activities. One learner’s observation provides counsel on creating feedback in item selection activities.

> *Stacey, PA-1:* I think that that would be better [to reveal feedback], like after I had chosen everything, instead of right away. Because I noticed in one of the situations, I ordered the CMP, and they said a BMP would be more appropriate. I don't know the difference between that, but that was the next choice, and I hadn't chosen it.
> *Researcher:* Need to be sure one doesn't give the other one away?
> *Stacey:* Yeah.

The pressure ulcer staging activity was well-received, but the manner of providing feedback (also non-personified) disconcerted at least one learner. The activity was presented using a DS MCQ (multiple choice question) node. When the learner chose the stage of the displayed ulcer incorrectly, the MCQ node responded with a description of the stage the learner had chosen (to reference against the pressure ulcer image) preceded by a red “x.”

> *Zoe, PA-1:* The right or wrong, and there's a bunch of choices, was kind of a little bit intimidating. Where I'd pick an answer and it was wrong, I'd think "ok" and then I'd pick another answer and it was wrong, I'd go, “Ok, I'm going to try a third time.” It's kind of like, you're wrong, you're wrong, YOU’RE WRONG!

Consequences

Feedback, as a consequence of learner actions, worked best when it the consequence was immediately experienced. Zoe’s experience, already described in the context of the clinical decision making activity (Table 35, theme 9) highlight the impact of immediate feedback on one’s actions.

> Zoe, PA-1: I went to see if the urology consult had been called and I had to ask him [the patient] when his catheter was replaced and he said, “I told you that yesterday.” (See Figure 29.)
> I went, “Did you? Uuugh. It's awful if you did. I don't remember you telling me that, oh my goodness.”
> So I did *get* that part of it.

In contrast, Shari’s experience demonstrates dissonance felt when one’s action actually constitutes an omission and its proximity to the consequence is distant. Figure 32 superimposes Shari’s think-aloud comments as she tries to makes sense of how failing to review a document earlier in the VP scenario could have led to Matt Lane’s current problem of bilateral pressure ulcers on his heels.

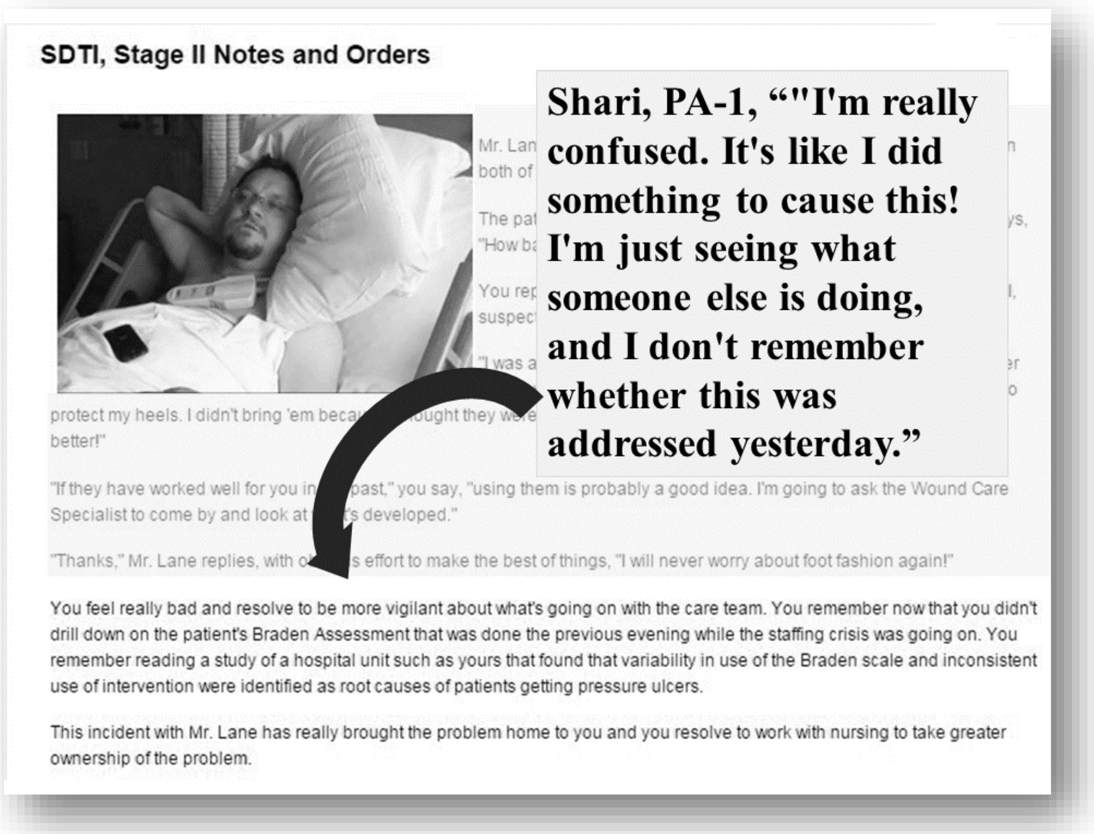

Figure 32. The learner is confused when the consequence and the action (decision) that allowed it to take place are neither immediate nor well-linked.

Expert Stories

Videos depicting *clinicians* performing patient care activities, for example dealing with the patient's spasticity, transferring the patient, and putting foot support boots on his feet to prevent further skin damage, may meet GBS criteria for expert stories. GBS does not specify the mode of expert story delivery. Video demonstrations of clinical skills provided very specific, visual, "how to" information and were very much appreciated by learners for their reality and truth value. See Table 22 for learner experiences with video exposition.

Scoring

Quantitative scoring, incorporated into the *Matt Lane* VP, is nowhere mentioned in GBS Theory. It is, however, an undeniable factor in the day-to-day lives of medical trainees and taken as a given in medical culture. In the current study, learners demonstrated increased focus and motivation when there was a quantitative goal associated with their activity. Table 26 and Table 27 display the thought processes of two learners, Shari, PA-1 and Maria, PGY-2, as they worked through an activity aimed at capturing the patient's past medical history. This activity set point values at the outset. The way these learners, representing opposite ends of the experience spectrum among participants, approached the activity was similar. They continuously monitored their progress against the quantitative goals set for the activity. Maximizing their score motivated these learners. Other learners were less interested or not interested at all, in having a score. Table 45 displays some of their differing perspectives.

Learners found having a score useful to guide appraisal of next steps and, a slightly different focus, as a gage of performance. A score was also seen as a way to identify areas of weakness to help plan future learning. Among the learners who claimed less interest in scores, it was noted that "status" and "cost," in a virtual patient are useful for monitoring patient well-being as they are learner performance. Finally, where scores are provided, learners advised they be clear. This was not always the case in the *Matt Lane* VP, learners advised.

Table 45

Learner Perspectives on Scoring in a VP

Key Points	**Learner Experiences & Perspectives**
Quantitative marker to guide next steps	*Zoe, PA-1*: Maybe the psychological thing -- plus or minus, cause there is still like an explanation to guide you. … I liked when you were explaining and it was plus one or minus one and like you could just move on or you could continue [selecting]. I liked that kind of like decision making.
Preference for qualitative versus quantitative feedback	*Stacey, PA-1*: I think I'm a little bit different from a lot of my classmates who like want scores and things like that. I liked the feedback when I would do something wrong, so no that wouldn't be an appropriate question but I think I learn more from feedback than from numbers.
Gage of performance Timing of giving scores dependent on context of learning versus (stakes) testing	*Maria, PGY-2*: I do, because I'd like to know how well I'm doing. The problem would be IF I were to know the score in the middle, would I feel discouraged with the whole scenario or would I rather have it towards the end? Yeah, I think if it's, if I'm not being tested on it, if this is just like a learning module, I'd like to have it in the end. But if it's like an actual test question, it might be helpful to have it right then and there.
Score as quantifier of patient status versus learner performance	Andie, M-1: I am not as grade oriented as most others, but I do like to see how the patient improves and how the cost of care may be impacted.
Transparency of score: what it means	Maria, PGY-2: I think I just forgot that I have my score right here [gray pane] so ... and I think I'd want to know where you got the -- I know where the 8 was from, but I don't know where the other score was from. So that would help to kinda go like... “Ok, so these are your scores.”
	Shari, PA-1: I was doing things and one of my scores was changing and I couldn't remember what score or what relation, or what I was doing right or wrong.
Identification of areas for further learning	Maria, PGY-2: And I think if the intention is to teach somebody who's never been like exposed to spinal cord, like the history part ah and then directing care and all you can give status for that and they'll accumulate points and when they're like, “Oh, these are the areas where I'm missing points,” they can always go back and then, you know, kinda like be more specific?

Timing of Feedback

Just-in-time provision of feedback is a tenet of GBS Theory. Cathy, PA-1, liked the immediacy of feedback in *Matt Lane*: “When it's like the immediate feedback, I do like that cause it's the immediate, "Ooh I got it right," and you have the feeling that you got it right. … I like it … how the program self corrects the student with almost immediate correction.”

Shari, PA-1, provided insight through her think-aloud comments that in the case of providing immediate feedback on multiple issues, topics needed to be ordered according to importance to avoid dissonance. This factor had not been considered in the design of analysis node groups in *Matt Lane.* Below is Shari’s reaction to feedback provided on the nursing orders she wrote:

> Bowel program! --- It's not, I would think it would give me the feedback in order of their importance! So when the first feedback I saw was to give ‘em information [patient education], I was like, “Ok, I didn't get anything else wrong.” And now I’m hearing, like, the bowel, and it's like a BIG thing!

In the analysis node group design, if learners selected all items necessary for patient care (e.g. do not fail to select a correct item), there was no affirmatory feedback and learners were subject to disappointment. Shari commented further in her think-aloud on encountering such a circumstance: “Ok, so it didn't tell me that I got everything right. Sort of on to the next thing now, instead of like positively reinforcing, “Oh, you picked the right things!”

Summary

In summation, the manner in which feedback was performed in *Matt Lane* conformed, generally speaking, to the GBS Feedback Method. The principle deviation was the use of quantitative scores to provide feedback in the VP, a usage not envisioned by GBS Theory. In accordance with the multimedia focus of the VP, video was used to provide expert stories (analogous GBS feedback kind #3) where the stated and the tacit and observational intermingled to provide feedback to the learner. The most frequently used feedback method in Matt Lane corresponded to kind#2 GBS feedback: coaching. The virtual attending, Dr. DuVal, provided a personified coach and was enthusiastically received by learners. Other types of coaching, provision of models for learner self-comparison against their own propositions and non-personified affirmation and correction, were more equivocally received. Feedback through consequences of action (GBS kind #1) was successful in *Matt Lane* when the action and consequence were tightly linked and proximate in time. Immediate feedback was generally appreciated, given successful maintenance of independence in item selection activities. Finally, when providing feedback on multiple items, the need to do so based on the items relative importance was recognized. The importance of providing both corrective and affirmative feedback consistently was underscored.

Matt Lane **Methods Not Defined in Goal-Based Scenarios Theory**

Life Model

The patient-centered life-view and the approach to caring for patients it engenders underlies every aspect of the design of *Matt Lane*. It constitutes an eighth method, one not accounted for within GBS Theory. That scenarios have real-life application and hence meaning for learners is inherent in the Case-Based Reasoning learning theory on which GBS Theory is based. The continual focus in *Matt Lane* on the reality of the patient and his experience of the health care environment goes beyond the principle of semblance of reality to careful presentation of actual patient reality, grounded in a real patient case, for the learner to engage. It is, therefore, a design Method which may be called the Life Model Method. It goes beyond a learning goal or objective and is associated with the outcomes envisioned for the *Matt Lane* VP as discussed in Method 1: The Learning Goals (see specifically Table 10).

The Life Model Method orchestrated the design and development of *Matt Lane* around the audio, video, and clinical documentation made available by the real (small "r") patient on whose experiences the VP was based. This method both worked and didn't work. How learners experienced the Life Model has been recounted throughout the analysis of *Matt Lane* as it traced through the GBS framework.

The presence of the Life Model, mediated through video and narrative, piqued the learner's interest and, at the same time, invoked the learner's emotions. The Life Model engaged both the ration and emotional sides the learner.

> *Cathy:* Because seeing ... just like the videos ... exposure to that ... when you're in class they say these words and I didn't have *any idea* of what any of that looked, so that was really cool. I learned more from this, than other things, honestly.
>
> Zoe: [thinking aloud] So now I'm watching the videos from PT. …Ok I'm watching the moisture video. This is kind of my first look into the care of a real patient, these videos. Ok now I'm watching the shear video.
>
> *Zoe*: There's feelings involved … There's dialog in there that sounded like it was something he's actually say. Maybe it was. … I liked that there was emotion coming or even frustration, 'cause that's real. Patients *do* get frustrated. They *do* feel ignored. And that's an important component also. It's often difficult to convey – Yeah, to be receptive to their feelings, to pick up on that. "Oh, he's feeling neglected, he's feeling like" -- you know. I like that there [were] feelings involved.
>
> *Cathy:* I really liked the narrative. It was a story. I felt like I was in it, you know what I mean? I really, really liked that. It was like the quotes, and then like the dog's wagging his tail. It wasn't boring at all.

The Life Model promoted engagement, even though the objective case itself may not have been intrinsically motivating to some learners.

> *Shari:* This isn't a topic that interests me -- I wouldn't be inclined to do my own research. But if it *was* a topic I was really interested in, I think I *would* do my own research. So I guess it depends on, ahm, what the topic was.
>
> *Shari*: [about the real Matt Lane, after viewing the credits on the last Day 1 video] I was just thinking I would love to meet him. He seemed like such a great person.

See Table 22 and Table 23 for more positive experiences of the Life Model in video and narrative.

An aspect of Life Model media that did not work as well was its field-recorded quality, particularly that of the audio component. Listening to the patient in circumstances where what he said needed to be interpreted exactly, for example during capture of his medication list, was less successful than listening to him interacting with his clinicians, for example. Maria, PGY-2, who was, in fact, familiar with medication regimens typical of persons with spinal cord injury, had to listen to the patient numerous times to understand his medication list. Her experience, already shared in Table 21, is repeated below.

> *Maria:* It's a bit hard to hear certain words, so I'm just gonna replay it [replays video]. I still can't hear some of the words he said, but I think what he said was that I still have pretty good tone and is it going to go away with the baclofen. I'm just going to play it one more time and increase the volume. [plays video a third time] Yeah, I think that's it.

Text-based narrative related by the patient, though perceived by some learners as being too much reading, was appreciated for its ability to communicate the Life Model underlying it (see Table 23). Much of the text-based narrative was transcribed from unusable audio media provided by the model patient.

The unsuccessful EMR activity (see Reviewing the Patient Electronic Medical Record (Clinical Documentation)) was built on the premise that the patient's authentic records were valuable and learners, engaged by his person, would also be motivated to review his documentation. Learners were motivated to see the *patient* on Day 2, but not to immerse themselves in his documentation isolated from his actual presence. Shari's (PA-1) frustration is reiterated below.

> *Shari:* And I know what I wanted to do was I wanted to go SEE him. But I felt like I *had* to look at everything in the medical record first, before I could even see him. [If I had] had the choice to do what I would have liked, I would have just gone straight in

> to talk to him after reviewing the vitals. I saw the vitals and said, “Ok, let me just go talk to him!”

Finally, reliance on Life Model artifacts drove construction of the clinical decision making process learners would engage in ways that frustrated the learner. The exchange below took place in the focus group discussion after Zoe and Shari (PA-1’s) tested Day 2 of *Matt Lane*.

> *Zoe:* Is it possible to see him *before* he goes to therapy? Like, do I have to see the medical record, and then I can see him? Or -- like in your videos -- is there a way to structure it so I can see him in the beginning and then maybe see him again? I don't know how your videos are controlled.
> *Researche*r: Obviously the video can't drive the intervention, however that is why I set it up that way. He tells all that stuff to Cara, the PT, and I can't get her out of the video. That's why it's like that. All of that talk is *there*.

In summation, the Life Model Method affirms the learning theory, Case-Based Reasoning, that underlies GBS Theory but it is not accounted for within GBS methods. The Life Model Method is part of a philosophy of patient-centered care and patient empowerment with a particular focus on people with chronic physical disabilities. The extra-GBS method promoted learner engagement by providing, literally, a window on real clinical interactions and through appeal to the learner’s emotions by displaying the humanity of the patient as he copes with his medical complaint. The real Matt Lane sought out the researcher to create the video artifacts that support the Life Model Method. It has been the researcher’s experience that other patients who live with disabilities have similar interest in helping clinicians learn about both the medical and psychosocial realities of chronic conditions, though they may not have the drive to initiate that Matt Lane displayed. Finally, whereas the person of the Life Model was engaging, his clinical artifacts, however authentic, were not similarly so. Design dependence on a limited library of Life Model media at times contorted the development of the VP storyline and frustrated the learner.

Chapter 4 Summary

Chapter 4 described characteristics of participants in the VP instructional design study. The chapter set forth information about participants' prior education and experience. Information was also presented on participants' use of computing technology. Learner situationalities and circumstances of testing were tabulated and presented. The analysis process followed for the study was explained.

Each of the seven methods inherent in GBS Theory was described and its implementation in *Matt Lane* explored by recounting learner experiences in working through the VP. How methods used to create *Matt Lane* were like and unlike GBS methods was examined. A method operating in Matt Lane that was not accounted for in GBS Theory, the Life Model Method, was identified. What worked and didn't work in *Matt Lane* to promote learning was explored.

Chapter 5

Conclusions

The goal of the study was to develop an instructional design theory of virtual patients (VPs) for use in autonomous learning. An existing, two-module VP, *Matt Lane, A Pressure Ulcer Prevention Virtual Patient*, was tested with ten clinical learners and examined against the methods of the instructional design theory, Goal-Based Scenarios (GBS). All of the methods that make up GBS Theory were found to be present in the *Matt Lane* VP. A method not specifically accounted for in GBS Theory, the Life Model Method, was identified. This latter method, grounded in the world-view of patient-centered care and patient empowerment, mediated Case-Based Reasoning learning theory as did the methods defined by GBS.

Since GBS Theory is defined by all seven of its methods, it follows that these methods are interrelated and work in conjunction, according to the theory, to provide positive instructional experiences. As they were manifest in the *Matt Lane* VP, the methods grouped into two sets of three, with one overarching GBS method, Learning Goals, that provided the blueprint that determined what the VP was a*bout* along with the non-GBS Life Model Method that provided the filter for *how* the goals were communicated. The Mission, Role, and Cover Story methods functioned as a triad to set up the scenario. The Scenario Operations Method was the most extensive method, supported by the Mission triad along with Resources and Feedback. The non-GBS feedback kind, Scores, augmented the GBS Feedback Method. Figure 33 illustrates the researcher’s gestalt of the relative weight of GBS methods in the *Matt Lane* VP as they were experienced by *Matt Lane* learners.

The Mission Method, with its related Role and Cover Story Methods, provided the "kick-start" to the VP scenario. They remained important throughout the scenario but were static. Scenario Operations, on the other hand, were multiple and changing. It was supported by the Resources and Feedback Methods, but had properties of its own that impacted the overall success of the VP. A discussion follows of what worked and didn't work for learners relative to GBS and non-GBS methods, the implications of those outcomes and their implications for further research.

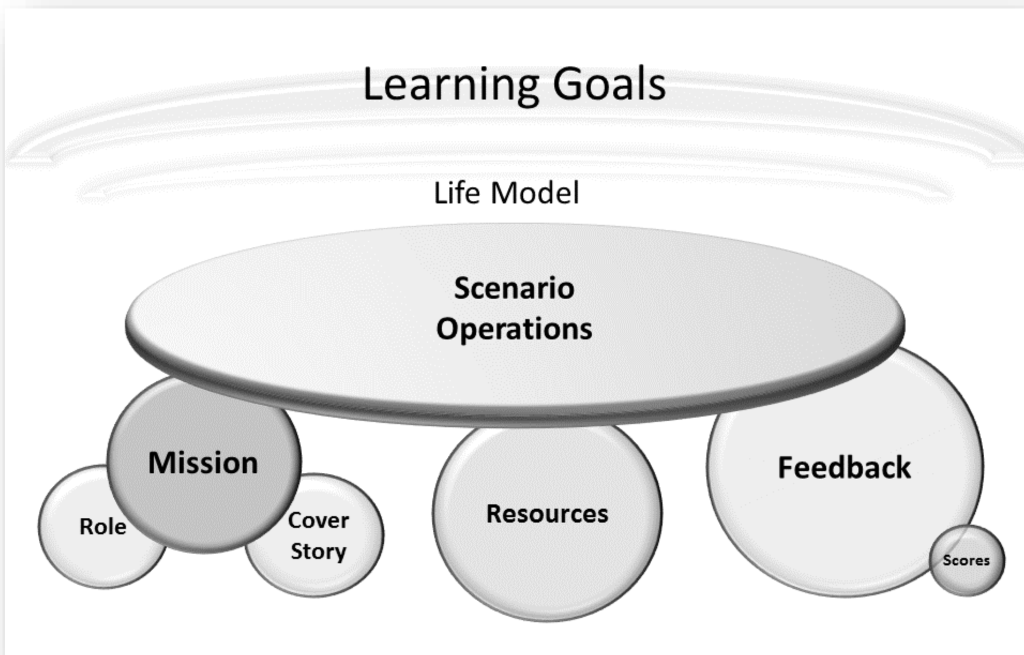

Figure 33. Graphical representation of the relationship among GBS methods and non-GBS methods in the *Matt Lane* VP, conceived to convey the differences among GBS methods according to hierarchy, size, depth, and kind as they related to experiences of learners in *Matt Lane*.

The Learning Goals Method

Among the principles inherent in traditional storytelling is not giving away too much of the plot. To do so would deprive the story of its impact and provide negative incentive to the "audience" to stay engaged. Therefore, learners in the *Matt Lane* VP were not clearly and explicitly informed of the full scope of the VP learning objectives and anticipated learning outcomes. Learners received orientation to the purpose of the *Matt Lane* VP through "handoff communications" (see Figure 7), which, modeling a clinical communications best practice, communicated the *mission* of the scenario and in which the learning *goal* was implicit. See Table 10 for an explanation of how the concepts of *goal, objective,* and *outcome* differ.

Many learners were unprepared for the disability culture into which they were thrust in *Matt Lane*. Where this sudden immersion did work, access to real patient and clinical experiences were pivotal. Learners who had experience working in inpatient rehabilitation with patients with physical disabilities took the disability culture, self-management affirming orientation of the *Matt Lane* VP story in stride. Others were uneasy with this counter-medical model approach to health care scenarios. This uneasiness may have interfered with the overall goal of teaching a patient-centered approach to care of a patient with mobility and sensory impairments. GBS Theory, notably, while insisting that scenario development begin with a "very clear idea of what we want our students to learn" (Schank et al., 1999, p. 173), it is silent on how and to what degree that idea should be explicated to the learner.

The entertainment industry provides a model for giving prospective viewers a clear (and engaging) idea what a film is about, without spoiling the story: the trailer. An analogous device might address the problem of learner uncertainty on encountering unfamiliar concepts in *Matt Lane*.

Learner descriptions of a need for directedness, preparation, and simplification were key factors identified with goals that didn't work. Explicit, up-front, sharing of the learning goals, objectives, and projected outcomes of VP interaction is recommended. This description of goals should also make it clear to learners what the benefit is to them of engaging with the VP. This recommendation does not suggest a change to the Learning Goals Method of GBS for VPs, but added guidance for instructional designers on how it can best be implemented.

The Mission Method

The mission in *Matt Lane* was to provide care to a patient with spinal cord injury who was at high risk for skin breakdown due to motor and sensory impairments. An important qualifier of the Mission Method in GBS is that it be intrinsically motivating. In the case of the *Matt Lane* VP, only two participants among the learners who interacted with the VP indicated that they would have found a patient with tetraplegia innately interesting outside of the research context. That said, even given lack of interest in pressure ulcer prevention, spinal cord injury, physical medicine and rehabilitation, or empowerment of patients to be active participants in management of their own health conditions, various aspects of providing care, aspects that have application beyond the specific case focus of the VP scenario, may provide a second layer of intrinsic interest.

Observation of how intently learners approached various tasks in working through the VP, such as the reasoning process underlying framing questions in taking a patient history or deciding which labs to order for a particular patient, suggests that there may be multiple levels at which learners can be intrinsically engaged, and kept engaged, with a VP once they have made the initial decision to interact with it. This consideration is essential to the development of instructional design theory for autonomous, and particularly voluntary, no-stakes (e.g., not mandated by one’s training program, not for credit) VP cases.

The need to provide a connection for the learner to the particular VP case is particularly relevant for instructional contexts such as the one out of which *Matt Lane* arose. In the case of *Matt Lane*, the choice of content was driven by a federally-sponsored disability research and training grant among the goals of which were to raise awareness about the health experience and care needs of people with mobility impairments. Implicit in the awarding of the grant was the recognition that there was *not* much interest among primary care providers in the health care needs of such individuals. The purpose of developing the VP, therefore, was to create interest, as opposed to leveraging pre-existing interest, and provide instruction to improve on, rather than sustain, the practice status-quo. It is not a unique situation for instructors to be in the position of having to find creative ways to teach topics learners don't find intrinsically interesting. It may be more unique, particularly in the health sciences, to set out to teach an emerging perspective. This motivation aligns with those more at home in the arts. The VP modality was, perhaps, appealing for this reason. Because VPs are always story-based, and particularly because they increasingly incorporate multimedia, the line between teaching existing principles and changing hearts, minds, and practice (metanoia) blurs. Born out of the psychosocial side of health and disability research, *Matt Lane* rode this line.

Matt Lane, therefore, addressed a situationality of VP use beyond mere autonomous interaction. It addressed the context of learning for change in health care. That context suggests a further situationality relevant to *Matt Lane*: VPs as learner-selected, enrichment activities. This latter situationality adheres to the expectation that a VP-for-change would not be a standard part of the medical curriculum. Such "disruptive" products might find their ultimate best use in continuing medical education (CME) as opposed to undergraduate or graduate programs. Design of VPs for CME is a topic for further research.

The Cover Story Method

The Cover Story provides the pretext for carrying out the Mission in a GBS. In the case of *Matt Lane*, the Cover Story was tightly linked with place: a hospital rehabilitation unit where the learner is a new staff member. The inpatient setting decreased the relevance of the VP for many of the PA participants who didn't see themselves working with patients in hospital-based systems of care. One of the preliminary designs of *Matt Lane* (not implemented for lack of media) envisioned a shift between inpatient and outpatient settings, which constitute different practice environments with different constraints and different practitioner inter-relationships.

The Cover Story works in conjunction with the Mission to define a case that is appealing to the learner, a case that the learner will find intrinsically motivating and want to open and engage with. As previously proposed, once inside a case, another layer of incentives may still keep the learner engaged.

Learners testing *Matt Lane* who did not have an established interest in physical medicine and rehabilitation or spinal cord injury, *did* have pre-existing interests that were addressed in the *Matt Lane* VP. These interests were successfully anticipated by most of the high-level clinical tasks inherent in the scenario's Mission: taking a patient history, performing a physical exam, writing patient orders, engaging in clinical reasoning, and developing a differential diagnosis.

As learners engaged with the VP, the personal presence of the Matt Lane character and the life texture of his story (e.g. application of the non-GBS Life Model Method) enhanced engagement helped keep learners attentive to a case they might not otherwise have perused outside of a research context.

The Role Method

The Role Method defines the part the learner will play in a GBS and, together with the Mission and Cover Story Methods, is the final leg of the triad that provides the scenario context. The Role Method, as implemented in *Matt Lane*, merely provided a label to the standard set of duties a generalist health care provider would carry out on a hospital unit. All learners, therefore, would play the same role, but under different names. This situation reflects the actual function of medical residents, physician assistants, and nurse practitioners in many clinical settings. Learners were not pre-advised of the fungible nature of roles relative to patient care duties in *Matt Lane.*

Some participants' approach suggested that they understood "role" in the fantasy gaming or theatrical context of role-play. Most did not recognize the offer of a role as a real choice, so they just went where they thought they belonged: down the path of the profession for which they were in training.

No learner indicated that she found it enjoyable, intrinsically motivating, to use the VP scenario to imagine herself in the full-fledged professional role for which she was training or another, perhaps in higher status role if one concedes the (controversial) proposition that the physician role is the high-status role in health care. Given the option of the physician, physician assistant, and nurse practitioner provider roles, all participants in the study chose to play the role of the type of care provider for which they were in training. The reasons learners provided for choosing their own professions were that they felt they had a better understanding of what their own professions were supposed to do in a clinical scenario and that they wanted to pick the option that would provide them the most learning benefit in their present programs, the latter being of paramount concern.

The two PA students who provided feedback in a small focus group further found the prospect of performing their ultimate professional roles, even in scenario, intimidating, and would have preferred to select an advanced (PA-2, clinical year) trainee role, "the next step," instead. This preference may be in keeping with a prior study of role-playing in health care that found a choice of higher status characters to predominate, except among persons with very brief work experience (Libin et al., 2010).

The manner in which learners approached Mission, Cover Story and Role in *Matt Lane* suggests that learners' most fundamental motivation to *start* a VP case is commensurate with their perception that the case will be a good investment of their time, further their clinical training goals and, ultimately, advance their ultimate career objectives. In program-assigned cases, trust that the case is relevant to training objectives is implicit. In cases learners choose for enrichment, the most likely niche *Matt Lane* will occupy, that relevance must be established. The *Matt Lane* VP could be improved by clearly identifying, and optimizing, the cross-cutting clinical skills it helps learners develop. Explication of this relevance should be highlighted in the advertisement[32] of learning goals, objectives, and outcomes previously recommended.

The Scenario Operations Method

If learners who are self-directed in choosing a VP case are "drawn in" by the appeal of the Mission, Cover Story, and Role set-up, continued engagement depends on the success

[32] The word "advertisement" implies, intentionally, that VP's for enrichment will most likely be selected from a library of cases, increasingly freely available, online to all interested learners.

of the VP's Scenario Operations (activities and their appealing organization, "plot") in delivering on the initial promise anticipated. The *Matt Lane* VP Scenario Operations were framed as the clinical tasks of taking a patient history, performing a physical exam (with a focus on the skin exam and identification of pressure ulcers), writing patient orders, reviewing clinical documentation, and developing a differential diagnosis based on the patient's symptoms and engaging in clinical reasoning. These activities found approval with *Matt Lane* participants, who endorsed them as relevant, cross-cutting clinical tasks that health care providers routinely do in real, professional environments. The activities, therefore, meet the test for being intrinsically motivating to learners.

The choice of tasks to model as VP scenario operations was successful in all cases *but* reviewing clinical documentation. This "activity" would have been better framed as a resource and will be discussed in the context of the GBS Resources Methods.

The clinical activities that constituted Scenario Operations were developed using a rich library of authentic patient audio and video (the Life Model Method) and presented across the various interactive templates (DS-nodes) that are part of the DecisionSim™ platform used to produce the *Matt Lane* VP. DS-nodes facilitated presentation of content, text or media, for learner interaction using a variety of structured mechanisms (see Table 9).

Use of Free Text in Structuring Scenario Operations

One of the interactive structures available in the DecisionSim™ platform for structuring Scenario Operations, free text DS-nodes (see Appendix I), allowed the learner to interact with the presented content, think, write, and get a model response as feedback.[33] On

[33] The Feedback Method, inevitably, will be discussed to some extent in the context of scenario activities since each activity, in fact, incorporated feedback.

direct query, most learners approved this method. They did not express enthusiasm about it however, and several intrinsic problems came to light.

Dissonance can occur when the model response is similar to the learner's own response. Instead of feeling affirmed, the learner may feel unheard. The expectation that technology will be "smart" should be increasingly common as semantic analysis of text becomes increasingly accurate and commonplace. Modern learners experience a high level of machine intelligence every time they type a query into an online search engine. Given the ubiquity of smart phones, "Googling" has become the reflexive response to any question that comes to one's mind.

Though *Matt Lane* was designed and tested as a simple, educator-authored, narrative VP versus a high-tech (Kenny et al., 2009) or sophisticated game-based (Innovations in Learning Inc., 2015; Toro-Troconis, Kamat, & Partridge, 2011) simulation of patient interactions, the demarcation between what level of intelligence can be expected from a learning intervention should be made clear to avoid learner dissonance, disappointment, and disengagement with the VP scenario. Tasks that the free text DS-node facilitated included return of handoff communication, capturing the patient's chief complaint and medication list (from audio), documenting the patient's concern about a certain treatment (from audio), and, in a modified free text node (see Appendix N), critiquing clinical documentation.

Though learners enjoyed seeing and hearing Matt Lane (Life Model Method), the exercise of listening to the patient, rewinding, and listening again, did not ring true. Table 21 lists several ways in which the activity did not work for learners. The activity didn't really simulate clinical reality. In a real patient interaction, the exchange would be two-way: the clinician would be able to ask the patient questions in addition to listening to him. Further, the quality of the audio (captured live in the hospital) was an issue for some, introducing frustration and tedium at the need to rewind and listen numerous times to figure out what the patient was saying.

Added to the lack of fidelity to real life, many learners were uncertain about the process of self-evaluation against a model. As was seen earlier in Table 43, learners expressed concern over their ability to really understand how their responses might or might not be comparable to the model provided. Interestingly, there may have been less uneasiness when the model was presented as coaching from the virtual attending physician, Dr. DuVal (see Zoe's second comment, Table 43). The underlying problem of whether one is capable of self-evaluation given a "correct" answer remains, but learners may not perceive it the problem when presented in personified form. This potential disconnect has serious implications for learning with VPs and is a topic for further research.

The free text DS-node was actually developed to allow the learner's text response to be transmitted to an instructor who would then be able to provide the learner a personalized critique. Given that *Matt Lane* was examined in a context of autonomous learning where instructor feedback was neither provided nor its effect studied, the use of free text structures and model feedback was only moderately successful. The use of patient media in these interactions was engaging and, to some extent, may have "carried" the activities. Given the situationality of no instructor involvement, which would be the case of VPs learners self-select for enrichment, the free text approach to developing activities would be better reworked using another approach, such as item selection. More research is needed to examine learners' experience of free text in VPs followed up with asynchronous, instructor feedback.

Use of Item Selection in Structuring Scenario Operations

DS inquiry node structures were used to implement item selection in the *Matt Lane* VP. In item selection activities, learners evaluated groups of items, made decisions about them, and received feedback. The clinical tasks of forming questions to ask the patient in the course of taking a history, writing patient orders (labs, therapy, etc.), and diagnostic reasoning were developed based on the item selection model in DS inquiry nodes. Learners enjoyed working with DS inquiry nodes (Appendix L), both alone and especially in conjunction with analysis nodes that addressed some of the limitations of stand-alone inquiry nodes (Figure 18, Figure 19, Figure 20).

Clinical activities modeled in DS inquiry nodes riveted learners' attention, even in the absence of media appeal. Refer to Table 26 and Table 27 for the trace of two learners' experience working through the decision making process involved in choosing how to frame question to the patient about his past medical history.

Item selection activities, to a great extent, worked for learners in *Matt Lane*, but created dissonance when they did not. Dissonance, as experienced in *Matt Lane,* interrupted whatever flow[34] learners were experiencing in the scenario and caused them to disengage. Inquiry node design requires care to avoid dissonance. Major risks, as uncovered in testing of *Matt Lane*, included permitting the learner to fail to choose a correct answer containing information the learner would later need to use in decision making and designing items that were not independent, given that the structure of the basic DS inquiry node does not restrict learners' pick order. Errors of non-independence in *Matt Lane* led to "giving away" one correct response based on another response and, conversely, making a response designed to

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[34] Positive psychology concept articulated in 1990 by Mihály Csíkszentmihályi where the individual is focused and engaged. Flow is identified as the optimal state for learning (Csíkszentmihályi, 2004).

be correct incorrect in light of feedback to a response clicked in an unanticipated (by the instructional designer) order.

An expansion of the DS inquiry node function, the analysis node group, removed the risk of learners' failing to choose a correct item. If learners exited an inquiry node without having selected all the items that were correct, the analysis node invoked a cascade of just-in-time correction, followed by a summary of all the correct actions the learner should have taken in addressing a particular point of patient care. Overall, analysis node groups were successfully employed in constructing Matt Lane's admission orders writing activity. However, in the case that the corrective cascade was not properly prioritized, for example, correcting the learner about failing to give the patient literature on his condition before correcting her about an omission that was potentially life-threatening, dissonance was, again, experienced.

The DS inquiry and analysis node complex was not sensitive, however, to wrong items *not* chosen for the wrong reason. Table 30 examines how three learners went about writing nursing orders for Matt Lane and provides an example of why this lack of sensitivity may be important to achieving VP learning goals.

The VP specific instance studied, *Matt Lane*, could be improved by correcting item selection errors that created dissonance. A broader finding is the importance of avoiding dissonance to maintaining learners' engagement in VPs. Dissonance effectively stops the story. But for the research context in which interacting with the *Matt Lane* VP took place, learners would have experienced decreased motivation to continue.

Use of Multiple Choice Questions in Structuring Pressure Ulcer Staging

MCQ DS-nodes were used principally for the clinical activities of skin exam and pressure ulcer staging. The latter activity was intrinsically interesting to learners but the red "x" they received when they picked a wrong answer, coupled with objective, un-friendly feedback, was deflating: "… you're wrong, you're wrong, YOU'RE WRONG!" . See Table 29 for the torturous path the learner who provided this quote took through the effort of grading Matt Lane's pressure ulcer.

The MCQ approach was little explored in *Matt Lane*. The problems the small use there was uncovered related to the delivery of feedback. This method is treated in a dedicated section later in this report.

The Electronic Medical Record As a Scenario Operation

Reviewing clinical documentation, the patient electronic medical record (EMR), was not engaging. Learners perceived the process as tedious; they were motivated to see the patient, not his documentation. Even though the documents the EMR contained were modeled on authentic patient records, reviewing the patient record as an activity was not realistic. In real life, clinicians look back and forth between the patient and his documentation. The patient's assessments, labs, and x-rays, along with linked tutorials and journal articles, actually constituted *resources*, but modeling the patient record in DecisionSim™ platform constrained its use in that manner. The system does not readily accommodate, within the same virtual patient, constraining and sequencing learners' navigation for some segments and leaving it open for others, particularly where a large number of DS-nodes are involved, as would be the case in a realistic EMR. Modeling the patient record in the context of Resources versus Scenario Operations, is recommended.

Differential Diagnosis and Clinical Decision Making as Scenario Operations

The differential diagnosis and clinical decision making activities also did not work well, as a whole, for learners. Isolated segments were engaging to learners who participated later in the testing cycle after the researcher began guiding traversal of the EMR and discovery and appraisal of the information it provided. Given that the EMR was highly unappealing as an activity, the first few learners to test *Matt Lane* skipped it entirely or gave it cursory and incomplete attention. The information it provided, however, was critical to the later activities of clinical decision making and developing a differential diagnosis of the patient on Day 2 of hospitalization.

The level of complexity of the diagnosis activity was too great; with three potential diagnoses in the mix. Unnecessary complexity violates GBS guidance for designing Scenario Operations: “students should not need to do more than is necessary for the learning goals to be addressed” (Schank et al., 1990, p. 176). Requiring learners to disambiguate pressure ulcer risk from other risks faced by a patient with spinal cord injury was experienced as overwhelming and caused them to disengage. “Lost”, “confused,” and lack of guidance were descriptions that characterized the Day 2 VP experience.

Based on learners’ experience and feedback, an amplification to GBS Theory with respect to complexity of VPs is recommended. A range of novice learners were recruited for the study based on the researcher’s experience that most clinicians are novices when it comes to caring for a patient with a rare condition such as spinal cord injury. The natural course of chronic stage spinal cord injury is that, over time, secondary conditions accrue. An authentic spinal cord injury patient, 20 year post injury, is inherently complex. This conundrum poses a challenge in exposing general-practice providers (and particularly those still in training who may be most receptive to new models of practice) to faithful models of spinal cord injured patients while managing cognitive load, (Van Merriënboer & Sweller, 2010) the amount of new information individuals can process of the relative short time span of a virtual patient case. The problem of complexity will be reprised in discussion of the Life Model Method, which was a significant driver of the *Matt Lane* VP but not native to GBS Theory.

The Resources Method

Learners were masterful navigators of the *Matt Lane* VP as an online technology (refer to Figure *5*). They were perfectly comfortable playing and replaying videos, opening, resizing, and maintaining browser windows, retrieving documents, and going out to the Internet to look up terms with which they were unfamiliar. When connectivity problems, such as network drops or slow-to-load media, were encountered, learners took them in stride. In contrast to the dissonance that cognitive discontinuities precipitated, no aspect of learners' observed interactions with technology caused them to disengage from the VP.

As described in the section, The Scenario Operations Method, optimal use of the VP was constrained by learners' not have the patient's medical record as a resource, always at the ready, in another window. Learners were unable to consult the patient record in a manner consistent with actual clinical practice.

There was a presumption, inherent in the Life Model method, that authentic clinical forms, particularly the ones that described the real Matt Lane on whom the VP was modeled, would be best for learning. That presumption rested on 1) the *appeal of the real* that learners did, in observation, experience and 2) the further presumption that actual clinical forms, since they are *used*, are well-designed and tested for usability. Learners said that they appreciated the real forms, but found them hard to understand. The forms were not intuitive.

The *Matt Lane* VP also provided vetted, evidence-based resources (fact sheets, an exam "how to," clinical algorithms, journal articles, and an online tutorial) as hyperlinks inserted at places in the scenario where they were relevant to care issues under consideration. When learners did interact with these kinds of resources -- about the patient's condition versus about the patient specifically -- it was only in a cursory fashion. See Table 39 for examples of how learners did *not* engage VP-provided, informational resources.

Time considerations figured consistently in learners' rationale for not accessing provided materials, even though they stated they would find them useful. GBS defines the role of resources in a scenario as helping the learner complete the case at hand (Schank et al., 1999, p. 177). *Matt Lane's* provision of excessive resources may, therefore, be seen as a practice outside of GBS. Stopping to study a document takes learners out of the scenario, effectively, requires them to disengage. It is recommended, therefore, that learners not be expected to appraise evidence or boil down procedural content. In the context of an autonomously navigated VP scenario, the minimal amount of targeted information should be provided, just in time, to allow the learner to negotiate decision points in the VP.

Learners demonstrated, and some acknowledged, their preferred information seeking technique: online search aimed at finding just the right amount of information to allow them to move forward with a task. Schank et al. (1999, p. 177) prescribe providing learners with rich and well-ordered resources. The Internet was not the efficient and ubiquitous tool at the time GBS Theory was promulgated that it is now. Learners were divided on whether the assurance of information accuracy they would get from VP-provided hyperlinks to pre-vetted information was worth the task interruption they would experience by clicking on them (see Table 40). Research on the effect of clicking away on performance, and differences in the effect this activity has on high- versus low-prior-knowledge learners, is equivocal (Slava Kalyuga, 2007). Maintaining a separate window to a search engine may be a “cleaner” way of managing interactions. One learner suggested a strategy where if the learner moused over any unfamiliar term, particularly acronyms, an explanation would display and the learner’s current viewing context would be maintained.

Since VPs are, by definition, online, the Internet is an available mega-resource that has the capacity to compensate for failure to anticipate the individual learner’s information needs. Maximizing learners’ flexibility in resource discovery, to suit individual preferences, is recommended.

The Feedback Method

GBS identifies three kinds of feedback: consequences of learner actions, coaching, and expert stories. Table 42 lists all the occasions where feedback was provided in the *Matt Lane* VP, maps them to the three kinds of GBS feed, and identifies feedback methods used in *Matt Lane* that were not defined within GBS Theory.

Most instances of feedback in the *Matt Lane* VP served to provide coaching. Coaching was provided in both a personified format, through the medium of a virtual attending physician clinical mentor (Dr. DuVal), and as non-personified, anonymous, affirming or correcting feedback, with and without rationale, on the learner’s choices in the VP. DS inquiry nodes (and to a lesser extent, MCQ nodes) were used to provide non-personified feedback. Personified feedback was provided through inquiry node/analysis node groupings. Coaching was also provided through model responses as a function of DS free text nodes.

Feedback, in general, worked to enhance learners' experience of the VP. Many learners, in addition, evidenced specific awareness of the mechanism of feedback in learning, a phenomenon that increased their ability to reflect on their own learning interactions with *Matt Lane*. Problems with model responses, mediated through DS free text nodes, and the various problems associated with feedback delivered through DS inquiry nodes independently or as part of an analysis node grouping, were previously described and discussed in the context of the The Scenario Operations Method.

Personified feedback (e.g. by the virtual attending, Dr. DuVal) always provided the rationale for why the learner was receiving correction. Non-personified feedback with rationale, as experienced through DS inquiry nodes, also worked well to engage learners. The desire to explore inquiry nodes for the reasons *why* a choice was right or wrong, threatened at times to overwhelm the mission of providing care for the patient. See Andie's experience of clinical reasoning activities in Chapter 3, Method 7: The Feedback. Inquiry nodes that provided feedback without rationale were few, and no learner response was observed. In the case of the MCQ nodes that provided the structure for pressure ulcer staging, non-personified feedback gave the learner the description of the stage chosen along with a red "x" or green check to signify right or wrong. This kind of feedback characterized the stage the learner chose, but did not explicitly link the learner's choice to characteristics that were *not* in the image. See Table 29 for one learner's repeated false starts at staging a pressure ulcer, possibly due to the lack of guidance provided by the non-specificity of the feedback.

In *Matt Lane*, both personified and non-personified feedback with rationale were successful. There were no observations of learners' reaction to feedback without rationale (the pressure ulcer staging feedback previously described is an equivocal case) upon which to base a hypothesis of impact. As previously noted in the discussion on model feedback, learner experience with personified feedback is a subject for further research.

Providing feedback as the consequence of an action or decision worked well in *Matt Lane,* provided that the consequence and its precipitating action were closely linked in time. Inquiry nodes that involved framing questions to the patient provided two layers of feedback. The first layer was the patient's actual reaction to the communication. The second was anonymous feedback explaining why the patient may have responded as he did. This approach to providing consequential feedback was effective. See theme 9 in Table 35 for one learner's heartfelt response to the patient's reaction to her inappropriate question about his catheter.

If there was only a subtle connection between the learner's action or omission and its consequence, or if the action/omission and its consequence were distance in time from one another, the learner experienced the consequence as dissonant. The optimal spacing between an action or decision and the revelation of its consequence to the learner is a design question with currency in VP development (King, Scott, Davidson, & Bope, 2014). The experience of learners with the *Matt Lane* VP, however, prompts the recommendation that act and consequence be non-subtle or occur in very fast succession.

Stories, narrative and video enactments, in *Matt Lane,* came principally from the patient, Matt Lane himself. Even given the focus of the VP on modeling the patient directing his own care, these stories are different from the expert stories envisioned in GBS Theory. The principal difference lies in role identity. As cast by GBS, experts are more advanced practitioners of the skills targeted by the scenario goal. Therefore, only the artifacts depicting other clinicians "doing" may be considered expert "stories." In a multimedia context, reading a physical therapist's description of her interaction with the patient over foot support boots and watching/listening to it over video are functionally the same "stories." Learners appreciated both video and narrative in *Matt Lane* for the true-to-life pictures they painted, and both worked well (see Table 22 and Table 23). There were, however, no non-video, clinician stories in the VP and the interaction described is the only expert story addressed toward the consequence of an action or omission for which the learner may have been responsible. Due to such minimal exploration, there are no recommendations for using expert stories to provide feedback in VPs.

Quantitative scores are not considered feedback in GBS Theory, but they were conceived as a feedback sub-method in *Matt Lane* as they provided learners information on how they were doing in the course of providing care. Scores worked well in the VP when what they signified was clear, consistent with the guiding function of feedback. Scoring was used in taking the patient's past medical history and provided both motivation and guidance to leaners as they decided what information they really needed from the patient and how to ask it. See Table 26 and Table 27 for examples of how learners referenced their changing scores to guide decision making in the past medical history activity.

Not all learners cared about scores. Those who *did* saw them as a way to gage their performance and identify areas where they might need further work. Scores didn't serve these functions across the broader VP, however. Learners forgot to notice how their scores changed (in a pane at the left of the screen) across the various activities for which their correct decisions earned, and their incorrect decisions lost, them points. Scoring worked locally, at the activity node level, to enhance learners' motivation as it told them how they were doing in a way that they could understand and act on. At the global level, scoring was meaningless, and ceased to qualify as feedback. A low score, with no meaning attached to it, was deflating and disengaging.

Scoring can be effectively used in very localized applications, such as item selection activities, provided it serves to guide learners in successful completion of the activity. It should be used with care in broader contexts, especially in more lengthy VPs. No recommendation is made to incorporate scoring as a sub-method in GBS for VPs

Elements Present in the *Matt Lane* VP not Accounted for by GBS Theory

The Life Model

The Life Model Method relied on using an actually patient case, followed faithfully as possible, to construct a VP responsive to the Learning Goals. This method worked for learners in that it yielded a VP case that conveyed a credible, multidimensional person whose experience of chronic disability, spasticity, and recurrent pressure ulcers rang true because this experience was grounded in an actual lived reality. The method did not work well in that it tended to constrain development of the VP story to meet the availability of patient media to construct interactions.

Use of Video

Video was used to create a sense of the person of the VP to engage learners and to orient them to common procedures involved in providing care to a person with physical disability. Video successfully allowed learners to identify risks in the hospital environment first-hand, for instance, to see and hear (scraping) the shear forces that occur in transferring a patient from wheelchair to bed. Video demonstrated a greater ability than text to accurately characterize a patient's presentation. See the last entry in Table 23 for an example of how video corrected a learner's misconceptions about the patient's physical function formed from text-based narrative. Lengthy videos were not as well-appreciated. Clinical learners have well-developed text-scanning skills and too lengthy video risked restlessness in the learner, and disengagement. Reading provided the learner control over the pace of going through the intervention that video did not.

Use of real patient video is recommended to provide multisensory (e.g. seeing and hearing), three-dimensional information for characterizing a patient. The available patient media should not drive the scenario, however.

Use of Narrative

Text-based narrative also worked for learners. As previously noted, text gave learners more control over the pace of their interaction with the VP. As with video, lengthy exposition in text risked losing the learner's focus. Text-based narrative was described as having story value and working together with video, expanding in text what had been observed in patient and clinician interactions. From a design perspective, text was invaluable in filling in the gaps in available patient media.

Dialog between the patient and the learner, addressed in the second person, was used in the VP to model appropriate communications while at the same time providing the learner information on the patient to use in decision making. Learners were divided as to whether this technique worked. Dialog allowed authentic patient quotes from otherwise unusable video to be incorporated in the scenario. One learner recommended simulating dialog through item selection activities where the learner could choose a question to ask the patient and the patient's authentic expression could be incorporated in the feedback. More research is needed on the application of hypertext narrative in VP design.

Complexity

The need to manage complexity in instructional design has been addressed by Elaboration Theory (Reigeluth, 1999; Reigeluth & Rodgers, 1980) and its Simplifying Conditions Method (SCM) may be particularly relevant to refining the Life Model Method as it was experienced in the *Matt Lane* VP. The purpose of SCM is to create a simple-to-complex progression for acquiring knowledge and skill that is holistic. Rather than separating knowledge acquisition from its application, the simplest, real-world case is identified, the "epitome." The tasks involved in handling the epitome are then analyzed and sequenced and the epitome case developed for the novice learner. Progressively more complex version may be built on the epitome.

The SCM creates no contradiction with the methods of GBS. The Feedback Method, particularly when it finds expression through coaching or expert stories, provides a ready means to carry the learner over complexities, while maintaining an authentic patient characterization. Engaging the SCM in online scenario-based learning recognizes the bounded reality of the virtual world as it currently exists. Learners experienced an essential paradox in working through *Matt Lane*. On the one hand, the Life Model patient drew learners into the scenario by his almost palpably real presentation. On the other hand, the full range of real life responses were not available to the learner. Maria's (PGY-2) identification of the problem of premature curtailment of interaction with the patient (see Table 21) demonstrated the disparity that exists between real and real*istic* clinician-patient dialog. SCM provides a means to compensate this disparity. *Matt Lane*, despite its need for improvement, demonstrated that discovery learning, learning through doing, can take place in a virtual patient environment. Learners, however, need to be guided to avoid colliding with the scenario's very real "walls" (e.g. limitations) with the resultant experience of dissonance and disengagement.

The Life Model Method, though immature, possesses great truth value. Only patients are authorities on their experience, and only patients can make this experience available to providers for their edification and potential translation to practice. Given the inherent complexity in building a case from an authentic patient record (video, narrative, and clinical documentation), the SCM should be used in conjunction with the Life Model. This recommendation applies specifically to the situationality of VPs for patient-centered care and VPs for practice change, which are the overlapping but non-identical categories in which the *Matt Lane* VP falls. Caveats for limitations on the length of both video and narrative in developing VPs adhere for use of media in autonomous, learner-chosen VPs generally.

Summary of Conclusions

All methods that are part of GBS Theory were identified in the *Matt Lane* VP. A newly identified method, the Life Model Method, was also present in *Matt Lane*. The expression of methods formed a particular pattern in the VP. Learning Goals provided overarching direction but were interpreted through the Life Model. Mission, Role, and Cover Story formed a logical triad and provided the context for the VP scenario. These Methods were essential to learner engagement with the VP. Scenario Operations were supported by the Mission triad, Resources and Feedback.

The Learning Goals were not fully elucidated to the learner. Specifically, the learner was inadequately prepared for the patient-centered care and disability health empowerment orientation of *Matt Lane*. The importance of connecting learners with the content of the VP and helping them understand why it is relevant to them was identified.

Two additional situationalities of relevance to instructional design theory building emerged from the testing of Matt Lane with learners: the situationality of instruction designed to teach patient-centered care, with the underlying implication of teaching for practice change; and the situationality of not only autonomous use but self-selection of a VP for interest and enrichment.

The clinical activities identified for development as Scenario Operations were relevant to learners. Free text exercises with model feedback were not found to be useful in replicating clinical interactions faithful to real life. In the absence of asynchronous feedback from a live instructor, their use was not recommended. Feedback in the form of model responses was not as enthusiastically received as was feedback (with rationale) from item selection activities, or, particularly when delivered by a virtual mentor.

The electronic medical record presented as an activity in Matt Lane was recommended to be reworked as a Resource. Resources provided by the *Matt Lane* VP, including the patient's clinical documentation were inappropriately lengthy and complex and detracted from the learner's immersion in the scenario. It was recommended that they provide just the information needed by the learner to get past a current decision point. Learners used the Internet intensively and successfully in finding information as they worked through *Matt Lane*. Continued leverage of Internet searching was recommended.

The nascent Life Model Method was found to be relevant to the situationalities adherent in the *Matt Lane* VP. Its use of video and narrative to create an authentic patient presence was valuable in patient-centered learning. Limitation to the length of both video and narrative segments was recommended to prevent learner disengagement. The greatest risk was of the Life Model Method was found to be it tendency toward excessive complexity. The

Simplifying Conditions Method (SCM) from Elaboration Theory was recommended for incorporation into the Life Model Method to manage complexity.

Recommendations

Consideration of the outcomes of testing of the *Matt Lane* VP with learners suggested a set of recommendations to improve the VP instance (Table 46). These recommendations were grounded in principles of VP design that emerged in the course of the study. These nine principles, in turn, have implications for VP instructional design theory. The following refinements to GBS Theory are recommended for VPs where the following situationalities apply:

1) the learner is autonomous, not learning in a group;

2) the learner is self-directed, the VP has been chosen by the learner for interest or enrichment; and

3) the topic of learning is patient-centered, with the expectation that the outcome of interacting with the VP will be a change in perspective on the patient experience.

A fourth situationality that applies relates to technology used to go online. Observations about how learners managed windowing relate specifically to using a laptop, desktop or potentially a tablet computer, though this later technology did not figure in the testing of *Matt Lane*. Working through a VP on a mobile device as small as a smart phone would provide a different environment for switching between the patient and resources and is a topic for further research.

Table 46

Recommendations for Improvements to Matt Lane, Methods Implicated, and Areas of Applicability for ID Theory

Recommendation for Improvements to the *Matt Lane* VP Instance			Area of Applicability for ID Theory			
		Methods Implicated	Autonomous learning	Self-directed, Enrichment learning	Patient-centered learning	Technology: Laptop/ Desktop
1	Explicitly reveal learning goals, objectives, and projected outcomes; Philosophical orientation/worldview of author. **Principle: Promote clarity and transparency to avoid learner confusion.**	GBS Learning Goals	Yes	Yes	Yes	Yes
2	Enumerate anticipated learner benefits from interacting with the VP both in terms of skills learned and relevance to training programs and career objectives. **Principle: Intrinsic motivation is grounded in personal relevance.**	GBS Learning Goals	Yes	Yes	Yes	Yes
3	Rework the EMR as a Resource, not an activity. Make it continually available in a window separate from the VP so the learner can manipulate it as preferred. **Principle: Resources should be continually available to learners in a VP.**	Resources (primary), Life Model, Scenario Operations,	Yes	Yes	Yes	Yes
4	Remove model responses as a Feedback Method. Rework free text activities as item selection activities. **Principle: Self-evaluation against a model may not leave the learner with a sense of certainty, particularly in the absence of instructor feedback.**	Feedback (primary) Scenario Operations	No, in the case that there is an instructor to evaluate the learner's responses	Yes	Yes	Yes
5	Rework activities and feedback to remove dissonance. **Principle: Dissonance is to be avoided as it causes learners to disengage.**	Scenario Operations, Feedback, Resources	Yes	Yes	yes	Yes
6	Reduce complexity by defining the epitome[35] case for Matt Lane, using the Simplifying Conditions Method from Elaboration Theory.	Life Model (primary), Mission;	Yes	Yes	Yes	Yes

[35] Term used in Elaboration Theory for the simplest, holistic case.

Recommendation for Improvements to the *Matt Lane* VP Instance			Area of Applicability for ID Theory			
		Methods Implicated	Autonomous learning	Self-directed, Enrichment learning	Patient-centered learning	Technology: Laptop/ Desktop
	Revisit Learning Goals and Mission. Rework Scenario Operations, Resources, and Feedback to support epitome case. **Principle: Management of complexity is essential in creating VPs from Life Models.**	Scenario Operations, Resources, Feedback				
7	Remove links to full-text and multimedia resources, cite them in the materials providing information on the VP. Distill the essence of information provided in former links to focus on the minimum information that will help learners through relevant decision points. Add as hyperlinks; mouse-over pop-outs for very brief information such as definitions and acronyms used to enhance realism. There should be no further reading within the VP case proper. Reading pulls the learner out of the scenario. **Principle: Provide the least amount of explanation possible to support the learner's decision making in a VP.**	Resources (integrating with Scenario Operations and Feedback)	Yes	Yes	Yes	Yes
8	Facilitate online searching. No change needed in current VP. **Principle: Online resources compensate design failure to anticipate learner information needs.**	Resources (integrating with Scenario Operations and Feedback)	Yes	Yes	Yes	Yes
9	Make sure the learner sees the error that led to Matt Lane's pressure ulcer and explicitly chooses or does not choose to address it. **Principle: Model learning from consequences so that learner acts/omissions and their consequence are close in time or the relationship between the two is non-subtle.**	Scenario Operations, Feedback	Yes	Yes	Yes	Yes

Learning Goals

As defined within GBS, the Learning Goals Method does not provide explicit guidance on communicating the purposes of the intervention to the learner. Based on Principle 1: Promote clarity and transparency to avoid learner confusion, explicit communication to the learner is recommended. Principle 1 was derived from observations of learner confusion over presentation of the patient-centered world view which, at times, runs counter to the medical model which may be more familiar to clinical learners.

Another principle that applies in the context of learning goals is Principle 2: Intrinsic motivation is grounded in personal relevance. GBS counsels that scenarios should be intrinsically motivating to learners. In the case of a patient-centered care VP that calls for learners to reflect on how they will practice, the relevance of the experience the VP will present to their present training program as well as to their ultimate career goals must be clearly shown.

Life Model (new)

The Life Model method prescribes using authentic patient media, documenting actual patient experiences and perspectives to develop scenarios for learning patient-centered care. This method promotes fidelity of both content and exposition.

Management of complexity is an essential when creating VPs that actually work to enhance learning from Life Models is Principle 6. This principle should also be taken into account when defining the learner's mission in the scenario, as well as in developing the Scenario Operations, Planning Resources, and designing Feedback. The new, Life Model Method is anticipated by the Mission in GBS by that method's counsel to choose a mission that is realistic. The process recommended for managing complexity in implementing the

Life Model Method is incorporation of the Simplifying Conditions Method from Elaboration Theory.

Mission

As discussed in the Life Model Method above, guidance to qualify aspirations to realism in defining the scenario mission with consideration of the management of complexity, Principle 6, should be incorporated into the Mission Method.

Cover Story

No specific modifications are recommended to this method.

Role

No specific modifications are recommended to this method.

Scenario Operations

Since Scenario Operation always work in conjunction with Resources and Feedback, principles articulated here will also have applicability to those latter methods and vice versa. The most important principle is Principle 5 *Dissonance is to be avoided as it causes learners to disengage*. Guidance to specifically test for dissonance in VPs should be added to this method and referenced in Feedback and Resources, where it is also likely to be highly relevant.

Resources

Several principles provide guidance particularly applicable to Resources for VPs. It is perhaps not surprising that this should be the case given the changes in resource availability due to the expansion of the Internet that has occurred in the decades since GBS was articulated.

Principle 3, *Resources should be continually available to learners in a VP*, is grounded in the Life Model Method. The most likely way of ensuring that resources are always available is to place them online in an organized structure that the learner can access and navigate in a separate window from the one holding the VP. This principle has implications for design (what not to do) of Scenario Operations as well.

Principle 7, *Provide the least amount of explanation possible to support the learner's decision making in a VP*, is consonant with counsel already present in GBS Theory. It should be refined for the specifically online context that was not fully functional at the time of GBS Theory's publication in 1999.

Principle 8, *Online resources compensate design failure to anticipate learner information needs*, should provide guidance to Resource planning. Curtailing learners' information seeking according to their own, developed strategies threatens to impede their learning in a VP, introduce frustration and disengagement.

As has been noted, recommendations for refinement of the Resources Method are based in the situationality of using a laptop or desktop to go online to engage the VP.

Feedback

The remaining principles apply most specifically to the Feedback Method of GBS. Principle 4, *Self-evaluation against a model may not leave the learner with a sense of certainty, particularly in the absence of instructor feedback*, is cautionary guidance that should be incorporated into the Feedback Method but have implications for the design of Scenario Operations as well since Feedback always works in conjunction with scenario activities.

The final recommendation for additional guidance to the Feedback Method comes from Principle 9, *Model learning from consequences so that learner acts/omission and their consequences are close in time or the relationship between the two is non-subtle*, constitutes more specific guidance on learning from consequences that GBS already incorporates.

Summary of Recommendations for Refinement to GBS Theory for Virtual Patients

In summation, one new method, Life Model, is recommended to be incorporated into GBS Theory to refine it to guide instructional design of VPs for the situationalities of autonomous use, learner-directed selection, and patient-centered content. Other refinements provide additional guidance for tailoring VPs based on the situationalities specified. Refinements with respect to GBS Resource Methods may have broader applicability among VPs and other types of scenario-based learning as well since they speak to the greater availability of resources online than they were when GBS Theory was first proposed. The situationality of laptop or desktop use to go online was noted.

Suggestions for Future Research

The following topics for further research were identified in the course of analysis of learner experience in the *Matt Lane* VP study:

Appeal of Patient-Centered Care VPs in CME (Continuing Medical Education)

Patient-centered care VPs teach the perspective of the patient, which may be different from the medical model that health provider trainees may be focused on trying to assimilate to. Accordingly, patient-centered VPs were identified as “disruptive” products which might find their ultimate best use in continuing medical education (CME) among seasoned providers whose greater experience and sense of confidence would make them more comfortable in considering the patient view and how it might be incorporated into practice.

The Effect of Personified Feedback, "Virtual Mentors," On Learners' Critical Thinking in Virtual Patients

An observation during testing of *Matt Lane* was that learners had greater confidence in their understanding of feedback received from a virtual mentor than they did when they received feedback as a model response to a question. Given that the content underlying both model responses and responses of virtual mentors are the same, what implication does the device of the virtual mentor have for learner critical thinking?

Learner Experience of Free Text Response with Model Feedback and Asynchronous Instructor Follow-up

Learners expressed reservations about learning from free text entries followed by model response feedback, and no instructor follow-up, in the *Matt Lane* VP. More research is needed to examine learners' experience of free text in VPs when there is subsequent, elaborating feedback from an instructor asynchronously.

The Use of Hypertext in Virtual Patients

One of the suggestions to emerge from learners testing Matt Lane was to rework what could be somewhat lengthy texts in the well-received item response format to simulate dialog with the patient. Hypertext narratives are an art form that has received some attention in research (Wardrip-Fruin & Harrigan, 2004). More research is needed on the application of hypertext narrative in VP design.

Instructional Design Criteria for Smart Phone VPs

The recommendation to provide Resources in a VP via a separate, online window arose in the situationality of using a laptop or desktop computer to go online. Switching between VP scenarios and supporting resources on small devices such as smart phones will likely yield different design criteria.

Summary of Research

Background, Problem, and Research Goal

Errors in clinical reasoning and accurately diagnosing patients' health conditions pose a serious problem to the provision of quality health care. Pressure ulcer prevention is an area that cuts across medical specialties, offers significant benefits to patient health and well-being, and for which improved instructional methods are needed. Online, interactive virtual patients (VPs) offer a promising strategy for increasing new clinicians' exposure to patient cases to help them build expertise. However, no instructional design theory exists to guide VP development to foster clinical reasoning generally or pressure ulcer prevention, diagnosis, and treatment skills specifically.

The goal was to develop an instructional design theory of VPs in clinical education with diagnosis of pressure ulcer risk, prevention, assessment (if not prevented), and treatment as the content focus. GBS theory provided an appropriate framework for formative research on the instructional design of VPs. Three research questions were developed to guide a formative research study on an existing VP instance teaching pressure ulcer prevention, diagnosis, and treatment. The purpose of these questions was: to identify areas where *Matt Lane, A Pressure Ulcer Prevention Virtual Patient,* embodied GBS principles and where it diverged from them; to investigate what components of GBS worked and didn't work with learners in the context of VPs, and to recommend improvements to the GBS theory to tailor it to guide the design of VPs. The relevance and significance of the study was supported by both the impact of missed diagnosis and treatment of pressure ulcers and the interest of the medical education research community in the potential of VPs to extend the training benefits of face-to-face patient encounters.

Review of the Literature

Review of the literature focused on four areas relevant to developing an instructional design theory of VPs for teaching diagnostic/clinical reasoning. These areas were 1) the cognitive processes underlying clinical reasoning and development of diagnoses, 2) current and historical approaches to teaching clinical reasoning in the health sciences, 3) the types of VPs that have been developed and their effectiveness, and 4) instructional design theory relevant to VP design.

Researchers agree that clinical reasoning expertise develops through exposure to many and varied patient cases and draws on both deliberate (logico/hypothetico-deductive) and automated or intuitive processes and that the thinking of experts is characterized by a higher degree of automated thinking than is that of novices. This duality in the cognitive processes underlying diagnostic reasoning is mirrored in the approaches that have been taken to teach it. Problem or case-based learning, PBL, is a technique now well-established in health sciences education once dominated by the lecture approach to instruction. PBL is generally preferred by learners over traditional, didactic, lecture-based instruction, but measurement of its effect on learning outcomes has been challenging. Research that PBL is not *inferior* to traditional methods is persuasive.

VPs, as online, interactive patient cases, fit within the PBL approach to curriculum development. They promise to increase learners' exposure to a variety of patient cases and aid maturation of clinical reasoning skills. Increasing availability of user-friendly, low-cost authoring/development technology has made VPs increasingly feasible, particularly VPs of the hypertext narrative genre. Like other PBL interventions, the effect size of VPs on clinical reasoning skills acquisition is small. A need for theory-based research on VP instructional design was identified in the literature. GBS was confirmed as a promising theory for extension to VP design.

Methodology

Formative research, a form of qualitative, case study research, was used to refine an existing instructional design theory, GBS, to develop a theory of VPs for the teaching of clinical reasoning. *An in vivo,* naturalistic case focused on a VP to teach pressure ulcer prevention, assessment, and treatment, *Matt Lane,* was examined as an instance of GBS.

Matt Lane employed a narrative, branching logic/hypertext VP format. This format represented a mature technology. Two modules depicting two days in the hospitalization of the patient, Matt Lane, were examined for recommendations for modifications to GBS theory for the situationality of VPs. Criteria as set forth by Krefting (1991) were employed in the study to assure the conduct of credible (rigorous) research that is principally qualitative in nature. The framework developed by Miles and Huberman (1994) was used to guide the research process to support the steps of data reduction, display, and conclusion drawing and verification.

Participants and Analysis

Ten clinical trainees drawn from physician assistant students, medical students, and medical resident tested the *Matt Lane* VP. The manner in which of the seven methods inherent in GBS Theory was implementation in *Matt Lane* was explored. Those seven methods were defined as: Learning Goals, Mission, Cover Story, Role, Scenario Operation, Resources, and Feedback. How methods used to create *Matt Lane* were like and unlike GBS methods was examined. A method operating in *Matt Lane* that was not accounted for in GBS

Theory, the Life Model Method, was identified. What worked and didn't work in *Matt Lane* to promote learning was explored.

Conclusions

All methods that were part of GBS Theory were identified in the *Matt Lane* VP. A newly identified method, the Life Model Method, was also present in *Matt Lane*. The expression of methods formed a particular pattern in the VP. Learning Goals provided overarching direction but were interpreted through the Life Model. Mission, Role, and Cover Story formed a logical triad and provided the context for the VP scenario. These Methods were essential to learner engagement with the VP. Scenario Operations were supported by the Mission triad, Resources and Feedback.

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The clinical activities identified for development as Scenario Operations were relevant to learners. Free text exercises with model feedback were not found to be useful in replicating clinical interactions faithful to real life. In the absence of asynchronous feedback from a live instructor, their use was not recommended. Feedback in the form of model responses was not as enthusiastically received as was feedback (with rationale) from item selection activities, or, particularly when delivered by a virtual mentor.

The electronic medical record presented as an activity in *Matt Lane* was recommended to be reworked as a Resource. Resources provided by the *Matt Lane* VP, including the patient's clinical documentation were inappropriately lengthy and complex and detracted from the learner's immersion in the scenario. It was recommended that they provide just the information needed by the learner to get past a current decision point. Learners used the Internet intensively and successfully in finding information as they worked through *Matt Lane*. Continued leverage of Internet searching was recommended.

The nascent Life Model Method was found to be relevant to the situationalities adherent in the *Matt Lane* VP. Its use of video and narrative to create an authentic patient presence was valuable in patient-centered learning. Limitation to the length of both video and narrative segments was recommended to prevent learner disengagement. The greatest risk was of the Life Model Method was found to be it tendency toward excessive complexity. The Simplifying Conditions Method (SCM) from Elaboration Theory was recommended for incorporation into the Life Model Method to manage complexity.

Refinements to GBS Theory for Virtual Patients

In summation, one new method, Life Model, is recommended to be incorporated into GBS Theory to refine it to guide instructional design of VPs for the situationalities of autonomous use, learner-directed selection, and patient-centered content. Other refinements provide additional guidance for tailoring VPs based on the situationalities specified. Refinements with respect to GBS Resource Methods may have broader applicability among

VPs and other types of scenario-based learning as well since they speak to the greater availability of resources online than they were when GBS Theory was first proposed.

Appendix A

Researcher's Personal Disclosure

I have worked in and around the health care field for nearly my entire career though I am not, myself, a licensed clinician. I completed a pre-med/nursing undergraduate academic sequence intending to become a registered nurse but as a result, principally, of family needs (e.g. the presence of young children) I ended up in the information technology end of the health care system. Many years later, I returned to graduate school to study biomedical engineering and became involved with rehabilitation and disability research, a field in which I have now worked for 15 years.

I have always had a very strong interest in the well-being of the elderly and persons with disabilities. I worked in long term care as a nursing student where I daily experienced the difficulties associated with protecting the skin in vulnerable, mobility-impaired individuals: topic area of the *Matt Lane*, pressure ulcer prevention VP. My perspective on provision of care is more aligned with nursing philosophy, principles and practice than with medicine. I liked the rehabilitation care environment because it is very team-based and collaborative. I am excited about the increasing emphasis on interdisciplinary care I see taking hold in domains beyond rehab.

I personally believe that game technology-based VPs are the way of the future and have a great deal more potential as learning tools than do hypertext/branching logic VPs. By the same token, I don't believe that game technology-based VP scenarios, as resources are presently available to actually create them, provide more than a glimmer of that potential. I believe that hypertext/branching logic narrative VP will ultimately be replaced by more sophisticated ones using game technology, but at the present time, branching logic platforms such as DecisionSim™ are the mature technology in which work can actually be *done*. As I work, therefore, to develop theory, I will always be considering how a method shown to be successful or unsuccessful in the narrative VP might work in a game technology-based VP.

I am also a strong proponent of qualitative research methods and am enthusiastic about conducting a qualitative study in health sciences education where quantitative methods are the norm. A learning intervention is not a pharmaceutical product. If it is treated as one, a quantitative researcher can calculate an effect, but will not know what the "active ingredients" in the intervention are. That requires understanding the experience of the intervention in its parts by the learner.

Appendix B

Matt Lane VP Study Education, Experience, and Technology Use Survey

Education & Experience Questions: Virtual Patient Study

Thank you for participating in this study of online, interactive cases -- virtual patients -- in health professions training. Please answer the following six questions about your prior education and experience.

***1. Please enter your study ID.**

***2. Which profession are you in training for right now?**

- Physician
- Nurse/Practitioner
- Physician Assistant
- Other (please specify)

***3. Describe briefly where you are in your program right now.**

***4. Please describe your clinical experience. Include experiences during training. Check as many as apply. If you haven't worked with patients yet, choose "None."**

- Acute care
- Amputees
- Brain Injury
- Cancer
- Developmental disabilities
- Emergency department
- Family medicine
- Geriatrics
- Home care
- Inpatient rehabilitation facility
- Intensive care unit
- Medical unit
- Mental health
- Orthopedics
- Pediatrics
- Peri-operative/Operating Room
- Post-traumatic stress disorder
- Skilled nursing facility
- Spinal cord injury
- Stroke
- Surgical unit
- NONE
- Other

Other (please describe)

Education & Experience Questions: Virtual Patient Study

***5. How many years of clinical experience do you have? Include clinical experience while a student or trainee and experience that took place BEFORE you started your current program.**

- ◯ Less than 6 months
- ◯ 6 months to 1 year
- ◯ 1-2 years
- ◯ 2-3 years
- ◯ 3-4 years
- ◯ 4-5 years
- ◯ 5-6 years
- ◯ 6-7 years
- ◯ 8-9 years
- ◯ 9-10 years
- ◯ more than 10 years

A greater amount of time (please specify)

***6. Online technologies are increasingly a part of health care provision and training. Approximately how OFTEN you currently use a computer, on- or offline, to do the following activities?**

	never	rarely	monthly	weekly	daily
To perform clinical documentation and other hospital-related activities	☐	☐	☐	☐	☐
To do activities such as word-processing, making spreadsheets, or managing finances	☐	☐	☐	☐	☐
For passive entertainment activities such as watching movies	☐	☐	☐	☐	☐
For interactive entertainment activities such as playing video games	☐	☐	☐	☐	☐
To find information or do research	☐	☐	☐	☐	☐

***7. What is your gender?**

- ◯ Female
- ◯ Male
- ◯ Prefer not to answer

Thank you very much for answering the questions on this survey. Please click "done" to submit.

Appendix C

Technology Acceptance Scale

This scale is a validated short version (Chin et al., 2008) of an earlier scale (F. D. Davis, 1989) measuring technology acceptance in terms of perceived usefulness and perceived ease of use. It will be given to participants following their interaction with the *Matt Lane* VP. Table 47 below shows the scale in concise form.

Table 47

Technology Acceptance Scale -Fast Form (Adapted to the specific case of the Matt Lane VP from Chin et al., 2008, pp. 692-693)

Usefulness	*Circle one choice in each row.*
To aid me in managing a patient as risk for skin breakdown, the PUP VP, as an educational technology is --	efficient/inefficient performance enhancing/performance degrading productivity increasing/productivity decreasing effective/ineffective helpful/unhelpful quite useful/quite useless
Ease of Use	*Circle one choice in each row.*
To aid me in managing a patient as risk for skin breakdown, the PUP VP, as an educational technology is --	easy to learn/difficult to learn easy to manipulate/difficult to manipulate clear to interact with/obscure to interact with flexible to interact with/rigid to interact with easy to master/difficult to master very usable/very cumbersome

Appendix D

Matt Lane VP Semi-Structured Interview Script

This interview is designed to take place immediately following the participant's interaction with the PUP VP. It represents the participant's reflection on his/her experience with the VP intervention. The script below represents an initial point of departure. As each participant is interviewed, the researcher will apply what she has learned in the course of the interview with subsequent participants. The interview should take no more than 30 minutes.

Interviewer: You've just finished interacting with a virtual patient, VP, case where the goal was to diagnose a patient's risk for getting a pressure ulcer, order appropriate preventive interventions, and manage care as your orders went forward, some correctly implemented and some not. I'd like to talk about your perception of using online case-based, narrative scenarios to learn PUP. Could you share some of the thoughts you had as you worked through the PUP VP scenarios? What worked and what didn't work, from your perspective?

Initial Probes:

1. There were five learning objectives to the VP scenarios you just completed. Were they clear, intuitive, as you worked through the VP? What would you think they were based on the experience you just had?
2. Was the "mission" of the scenario compelling? What was your impression of the mission?

3. Which professional role did you choose to play in the scenario? Was it important that the role you chose aligned with how you see yourself engaging – either now or in the future – in providing health care?

4. How did you feel about the actions you were able to carry out in the scenarios? Were they realistic? Were there constraints? How would you have liked to have seen scenarios operations modified?

5. The resources you were given were chosen because they represented either the evidence base or best practice and they were important to helping understand the errors that were occurring in the PUP VP scenario. Did you feel you would have liked additional resources? Can you share which or what type of resources would have made working through the scenarios a better learning experience?

6. Think back specifically with respect to feedback. It was given both the correct mistakes and to confirm correct decisions. Sometimes the feedback was consequential, e.g. something bad happened as a result of a decision made. Sometimes the feedback was corrective, e.g. the attending would suggest a different order from the admission order set. How did you feel about these approaches? Which was more useful for learning?

7. Did you learn anything from this VP case? If so what? If not, what could have been done differently to provide a better learning experience for you?

8. How did you feel about the scenario generally? Did it reflect clinical realities as you have experienced them?

9. How did you feel about the characters in the scenarios? Were they realistic? Did they promote or detract from your desire to keep working through the scenario?

Appendix E

Resources Needed to Conduct the *Matt Lane* VP Study

Software, Licenses, Accounts

NVivo10©: qualitative data analysis software, cloud-based

DecisionSim™: virtual patient authoring system, online

Evernote: mobile, cloud-based multimedia note-taking application

Join.me: Screen sharing application and plug-in

Microsoft OneDrive: cloud-based data backup resource

Microsoft Office 365: cloud/computer-based word processing and spreadsheet creation

Screencast-O-Matic: Screen recording (audio and video) software

SurveyMonkey®: Online survey creation and delivery system

Hardware

Audio recorders (2)

Headphones

Laptop computer with wireless capability

Mobile cellular phone

Appendix F

IRB Approvals: Nova Southeastern University & MedStar Health

NOVA SOUTHEASTERN UNIVERSITY

MEMORANDUM

To: Manon M. Schladen, MSE, EdS
Graduate School of Computer and Information Sciences

From: David Thomas, M.D., J.D. JD for DT
Chair, Institutional Review Board

Date: August 1, 2013

Re: *Formative Research on an Instructional Design Theory for Virtual Patients in Clinical Education: A Pressure Ulcer Prevention Clinical Reasoning Case*
Research Protocol No. 07071308Exp.

I have reviewed the revisions to the above-referenced research protocol by an expedited procedure. On behalf of the Institutional Review Board of Nova Southeastern University, *Formative Research on an Instructional Design Theory for Virtual Patients in Clinical Education: A Pressure Ulcer Prevention Clinical Reasoning Case* is approved in keeping with expedited review categories #6 and #7. Your study is approved on **July 28, 2013** and is approved until **July 27, 2014**. You are required to submit for continuing review by **June 27, 2014**. As principal investigator, you must adhere to the following requirements:

1) CONSENT: You must use the stamped (dated consent forms) attached when consenting subjects. The consent forms must indicate the approval and its date. The forms must be administered in such a manner that they are clearly understood by the subjects. The subjects must be given a copy of the signed consent document, and a copy must be placed with the subjects' confidential chart/file.

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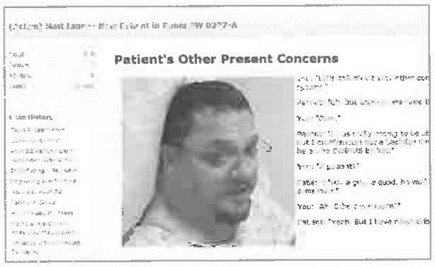
5) FINAL REPORT: You are required to notify the IRB Office within 30 days of the conclusion of the research that the study has ended via the IRB Closing Report form.

The NSU IRB is in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46) revised June 18, 1991.

Cc: Dr. Ling Wang
Dr. Martha Snyder
Ms. Jennifer Dillon

Institutional Review Board
3301 College Avenue • Fort Lauderdale, Florida 33314-7796
(954) 262-5369 • Fax: (954) 262-3977 • Email: *irb@nsu.nova.edu* • Web site: *www.nova.edu/irb*

LOOKING FOR PARTICIPANTS IN A STUDY ON VIRTUAL PATIENTS



WHAT'S A "VIRTUAL PATIENT"?

A "virtual patient" is an online, interactive case that simulates diagnosing and treating a real patient.

WHY ARE YOU STUDYING THEM?

Virtual patients can help fill in gaps in clinical experience by providing the opportunity to manage more numerous and varied patient cases than may be available in actual clinical rotations. The technology is new, however, and research is needed to understand how to design virtual patients to augment clinical curricula.

You are invited to participate in a study of an online, narrative virtual patient based on a real patient's experience!

HOW LONG WILL IT TAKE?

The study will take about 90 minutes and can be completed at your clinical site at a time that is convenient for you. You will receive a $15 gift card as a thank-you gift for participating.

WHO CAN PARTICIPATE?

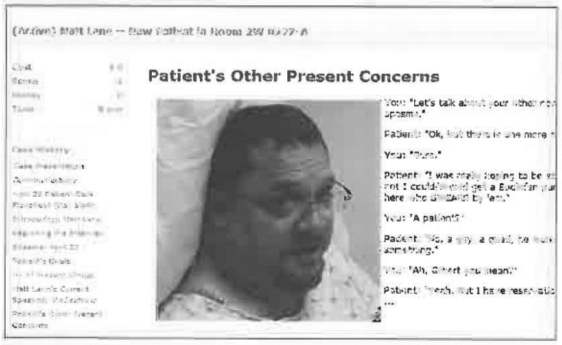
This virtual patient is appropriate for:

- **3rd and 4th year medical students**
- **Advanced practice nursing students**
- **Nursing students**
- **Physician assistant students**
- **Residents (all specialty areas)**

HOW CAN I GET MORE INFORMATION ON THIS?

Call or text Manon Schladen, Doctoral Candidate, Graduate School of Computer and Information Sciences, Nova Southeastern University at 202-302-1931 or email her at LMANON@NOVA.EDU

LOOKING FOR PARTICIPANTS IN A STUDY ON VIRTUAL PATIENTS



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- Residents (all specialty areas)

HOW CAN I GET MORE INFORMATION ON THIS?

Call or text Manon Schladen at 202-302-1931 or email her at MANON.SCHLADEN@MEDSTAR.NET or at LMANON@NOVA.EDU

NOVA SOUTHEASTERN UNIVERSITY
Institutional Review Board
Approval Date: JUL 28 2013
Continuing Review Date: JUL 27 2014

IRB number:	2013-112	**Clinical Site IC Version:**	V1.130428
Project Title:	Formative Research on an Instructional Design Theory for Virtual Patients in Clinical Education		
Principal Investigator:	Manon M. Schladen	**Institution:**	MedStar National Rehabilitation Hospital

MedStar Health Research Institute Informed Consent for Educational Research

INTRODUCTION

We invite you to take part in an investigational research study called *"Formative Research on an Instructional Design Theory for Virtual Patients in Clinical Education."* You were selected as a possible participant in this study because you are currently involved in a training program in medicine or nursing. Please take your time to read this form, ask any questions you may have and make your decision.

WHAT IS THE PURPOSE OF THIS STUDY?

This study is being done to develop an instructional design theory for the use of virtual patients, online interactive patient cases, in clinical education. This study is part of doctoral work being conducted at Nova Southeastern University to develop an instructional design theory of virtual patients. NSU IRB Protocol# 07071308Exp. Findings from this study will provide guidance to faculty and instructional designers on how to best use virtual patient technology to support development of clinical reasoning skills.

WHAT ELSE SHOULD I KNOW ABOUT THIS RESEARCH STUDY?

It is important that you read and understand several points that apply to all who take part in our studies:

- Taking part in the study is entirely voluntary and refusal to participate will not affect any rights or benefits you normally have;
- You may or may not benefit from taking part in the study, but knowledge may be gained from your participation that may help others; and
- You may stop being in the study at any time without any penalty or losing any of the benefits you would have normally received.

The nature of the study, the benefits, risks, discomforts and other information about the study are discussed further below. If any new information is learned, at any time during the research, which might affect your participation in the study, we will tell you. We urge you to ask any questions you have about this study with the staff members who explain it to you and with your own advisors prior to agreeing to participate.

NOVA SOUTHEASTERN UNIVERSITY
Institutional Review Board
Approval Date: JUL 28 2013
Continuing Review Date: JUL 27 2014

WHO IS IN CHARGE OF THIS STUDY?

The investigator is Manon Maitland Schladen, MSE EdS.

WHO CANNOT PARTICIPATE IN THIS STUDY?

IRB Approval Stamp
(ORI USE ONLY - DO NOT CHANGE ANY INFORMATION IN THIS SECTION)

IRB number:	2013-112	**Clinical Site IC Version:**	V1.130428
Project Title:	Formative Research on an Instructional Design Theory for Virtual Patients in Clinical Education		
Principal Investigator:	Manon M. Schladen	**Institution:**	MedStar National Rehabilitation Hospital

You cannot be in this study if any of the following apply to you:

- If you are involved in the design data collection or interpretation of results in this study.
- You are NOT a medical or nursing trainee, for example, a resident, medical student, nursing student, physician assistant student, advanced practice nursing student.
- You do NOT have a basic understanding of how to take a patient history and perform a physical exam
- You possess the advanced clinical skills that are the topic of the virtual patient scenario. (If this is the case, it will be evident from the initial survey of your education and experience if you decided to be in the study.)

HOW MANY PEOPLE WILL TAKE PART IN THE STUDY?

About 24 people will take part in this study, worldwide. 12 people will be recruited at this site.

WHAT HAPPENS IF I AGREE TO BE IN THE STUDY?

The investigator will meet you at a time and place convenient to you with a laptop workstation with wireless Internet access. You will be assigned a study number that will identify your information instead of your name. Using the study workstation and your study ID, you will go online to complete a questionnaire on your education and experience. Then you will examine, diagnose and treat a virtual patient. When you have finished interacting with the virtual patient, you will complete a short scale to provide your evaluation of it. Then you will participate in an interview with the investigator who will ask questions to guide you in providing feedback on what worked and what didn't work to help you learn through the virtual patient. It will take you about an hour to complete the virtual patient, questionnaire and scale. The interview will take no longer than 30 minutes. The maximum amount of time you will spend in the study session will be about 90 minutes total. The session will be audio-recorded. The investigator may contact you after the study session to make sure she has understood what you've expressed about your experience with the virtual patient. This interaction should only take a few minutes and may be over the phone or through e-mail.

HOW LONG WILL I BE IN THE STUDY?

We think you will be in the study for the 90 minutes of the actual study session. The investigator may follow up with you at a later time when she is analyzing the information you provided to make sure she has accurately understood what you have communicated about your experience with the virtual patient.

You can stop participating at any time.

WHAT ARE THE RISKS OF THIS STUDY?

IRB number:	2013-112	**Clinical Site IC Version:**	V1.130428
Project Title:	Formative Research on an Instructional Design Theory for Virtual Patients in Clinical Education		
Principal Investigator:	Manon M. Schladen	**Institution:**	MedStar National Rehabilitation Hospital

Risks to you are minimal, meaning they are not thought to be greater than other risks you experience every day. Being recorded means that confidentiality cannot be promised. You may not learn anything from the virtual patient and you may not find it interesting. You may feel bad if your interaction with the virtual patient points up gaps in your knowledge.

ARE THERE ANY BENEFITS TO TAKING PART IN THE STUDY?

You may or may not get any direct benefit from being in this study. We cannot promise that you will experience any benefits from participating in this study. We hope the information learned from this study will benefit others in the future. We also hope that you will learn from the virtual patient case and find the technology enjoyable.

WHAT OTHER OPTIONS ARE THERE?

You always have the option to not be in this study. If you decide NOT to be in this study, it will have NO effect on your residency, medical, nursing or other training program or other evaluations.

WHAT ABOUT CONFIDENTIALITY?

If you agree to participate in this study, you will be assigned a number and all of your study data will be managed through this identifier, not by your name. The key linking you to your identifier will be kept in an encrypted file on the investigator's password-protected laptop. All data will be password protected, whether stored in the cloud or on the investigator's computer.

This research project will include digital audio recording of the interview and any comments you will make while you are interacting with the virtual patient. You will be encouraged to "think aloud" while you work through the virtual patient. This audio recording will be available to be heard by the investigator and personnel approved by the institutional review board. The recording will be uploaded to a password-protected folder in the investigator's online storage space and erased from the recording device. The recording will be transcribed by the investigator. She will use earphones while transcribing your comments and interview to guard your privacy. The digital file of your comments and interview will be kept for 36 months from the end of the study. The recording will be destroyed after that time by selecting permanent deletion from online storage. Because your voice will be potentially identifiable by anyone who hears the recording, your confidentiality for things you say on the recording cannot be guaranteed although the investigator will try to limit access to your comments and interview as described in this paragraph.

No faculty, mentor, or supervisor involved in your training program or work will be informed of whether you participated in this study or not.

WILL I BE PAID FOR PARTICIPATING IN THIS STUDY?

NOVA SOUTHEASTERN UNIVERSITY
Institutional Review Board
Approval Date: JUL 28 2013
Continuing Review Date: JUL 27 2014

IRB number:	2013-112	Clinical Site IC Version:	V1.130428
Project Title:	Formative Research on an Instructional Design Theory for Virtual Patients in Clinical Education		
Principal Investigator:	Manon M. Schladen	Institution:	MedStar National Rehabilitation Hospital

You will not be paid for participating in this study. You will receive a gift card not to exceed $15.00 in monetary value in consideration of your time and to thank you for your participation. Materials and information obtained from you in this research may be used for commercial or non-commercial purposes. It is the policy of MedStar National Rehabilitation Hospital, MedStar Health Research Institute, MedStar Health, Inc. and its affiliated entities not to provide financial compensation to you should this occur.

WHAT ARE THE COSTS AND TIME COMMITMENTS TO PARTICIPATE IN THIS STUDY?

You do not have to pay anything to be in this study. We think being in this study will take about 90 minutes of your time. The study session is designed to occur on a study laptop with a wireless Internet connection at your clinical or academic site to minimize travel and inconvenience to you. If the investigator follows up with you by phone or email to ask a question about her understanding of your experience with the virtual patient, this should only take a few minutes.

WHAT ARE MY RIGHTS AS A PARTICIPANT?

- You have the right to be told about the nature and purpose of the study;
- You have the right to be given an explanation of the exactly what will be done in the study and given a description of potential risks, discomforts, or benefits that can reasonably be expected;
- You have the right to be informed of any appropriate alternatives to the study;
- You have the right to ask any questions you may have about the study;
- You have the right to decide whether or not to be in the study without anyone misleading or deceiving you; and
- You have the right to receive a copy of this consent form.

By signing this form, you will not give up any legal rights you may have as a research participant. You may choose not to take part in or leave the study at any time. If you choose to not take part in or to leave the study, your regular education will not be affected and you will not lose any of the educational benefits you would have received normally. We will tell you about new information that may affect your welfare or willingness to be in this study.

WHOM DO I CALL IF I HAVE QUESTIONS OR PROBLEMS?

For questions about the study, contact the investigator, Manon Schladen, at 202-302-1931 or the co-investigator and supervisor of doctoral research, Dr. Martha Snyder, at (800) 986-2247 x22074.

For questions about your rights as a research participant within the MedStar Health system, contact the MedStar Health Research Institute. Direct your questions to the Office of Research Integrity at:

Address:	MedStar Health Research Institute 6525 Belcrest Rd. Suite 700 Hyattsville, MD 20782	Telephone: Toll Free: Fax	(301) 560-2912 (800) 793-7175 (301) 560-7336

IRB number:	2013-112	**Clinical Site IC Version:**	V1.130428
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Principal Investigator:	Manon M. Schladen	**Institution:**	MedStar National Rehabilitation Hospital

You may also address any questions about your rights as a participant in doctoral research to:

Human Research Oversight Board (Institutional Review Board or IRB)
Nova Southeastern University
(954) 262-5369/Toll Free: 866-499-0790
IRB@nsu.nova.edu

SIGNATURES

As a representative of this study, I have explained the purpose, the procedures, the possible benefits and risks that are involved in this research study. Any questions that have been raised have been answered to the individual's satisfaction.

______________________________ ______________
Signature of Person Obtaining Consent — Date of Signature

Printed Name of Individual Obtaining Consent: ______________________

I, the undersigned have been informed about this study's purpose, procedures, possible benefits and risks, and I have received a copy of this consent. I have been given the opportunity to ask questions before I sign, and I have been told that I can ask other questions at any time. I voluntarily agree to be in this study. I am free to stop being in the study at any time without need to justify my decision and if I stop being in the study I understand it will not in any way affect my present or academic, training, or other program rights or evaluation.

______________________________ ______________
Participant's signature — Date of Signature

Printed Name of Participant ______________________

As the Principal Investigator (or his designee) for this research study, I attest that the participant has voluntarily agreed to be part of this study, the risks and benefits of the study have been fully explained, and any questions have been addressed to the participant's satisfaction.

______________________________ ______________
Principal Investigator's Signature — Date of Signature

NOVA SOUTHEASTERN UNIVERSITY
Institutional Review Board
Approval Date: JUL 28 2013
Continuing Review Date: JUL 27 2014

IRB Approval Stamp
(ORI USE ONLY - DO NOT CHANGE ANY INFORMATION IN THIS SECTION)

NOVA SOUTHEASTERN UNIVERSITY
MEMORANDUM

To: Manon M. Schladen, MSE, Ed.S.
Graduate School of Computer and Information Sciences

From: David Thomas, M.D., J.D.
Chair, Institutional Review Board

Date: May 22, 2014

Re: *Formative Research on Instructional Design Theory for Virtual Patients in Clinical Education: A Pressure Ulcer Prevention Clinical Reasoning Case*—NSU IRB Protocol No. 07071308Exp.

I have reviewed the above-referenced research protocol in keeping with Continuing Review requirements by an expedited procedure. On behalf of the Institutional Review Board of Nova Southeastern University, *Formative Research on Instructional Design Theory for Virtual Patients in Clinical Education: A Pressure Ulcer Prevention Clinical Reasoning Case* is approved. Your study is approved on **May 22, 2014** and is approved until **May 21, 2015.** You are required to submit for continuing review by **April 21, 2015.** As principal investigator, you must adhere to the following requirements:

1) CONSENT: You must use the stamped (dated consent forms) attached when consenting subjects. The consent forms must indicate the approval and its date. The forms must be administered in such a manner that they are clearly understood by the subjects. The subjects must be given a copy of the signed consent document, and a copy must be placed with the subjects' confidential chart/file.

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Cc: Dr. Ling Wang
Dr. Martha Snyder
Ms. Jennifer Dillon

Institutional Review Board
3301 College Avenue • Fort Lauderdale, Florida 33314-7796
(954) 262-5369 • Fax: (954) 262-3977 • Email: *irb@nsu.nova.edu* • Web site: *www.nova.edu/irb*

IRB number:	2013-112	Clinical Site IC Version:	V2.140429
Project Title:	Formative Research on an Instructional Design Theory for Virtual Patients in Clinical Education		
Principal Investigator:	Manon M. Schladen	Institution:	MedStar National Rehabilitation Hospital

MedStar Health Research Institute Informed Consent for Educational Research

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WHO IS IN CHARGE OF THIS STUDY?

The investigator is Manon Maitland Schladen, MSE EdS.

WHO CANNOT PARTICIPATE IN THIS STUDY?

IRB number:	2013-112	**Clinical Site IC Version:**	V2.140429
Project Title:	Formative Research on an Instructional Design Theory for Virtual Patients in Clinical Education		
Principal Investigator:	Manon M. Schladen	**Institution:**	MedStar National Rehabilitation Hospital

You cannot be in this study if any of the following apply to you:

- if you are involved in the design data collection or interpretation of results in this study.
- You are NOT a medical or nursing trainee, for example, a resident, medical student, nursing student, physician assistant student, advanced practice nursing student.
- You do NOT have a basic understanding of how to take a patient history and perform a physical exam
- You possess the advanced clinical skills that are the topic of the virtual patient scenario. (If this is the case, it will be evident from the initial survey of your education and experience if you decided to be in the study.)

HOW MANY PEOPLE WILL TAKE PART IN THE STUDY?

About 24 people will take part in this study, worldwide. 12 people will be recruited at this site.

WHAT HAPPENS IF I AGREE TO BE IN THE STUDY?

The investigator will meet you at a time and place convenient to you with a laptop workstation with wireless Internet access. You will be assigned a study number that will identify your information instead of your name. Using the study workstation and your study ID, you will go online to complete a questionnaire on your education and experience. Then you will examine, diagnose and treat a virtual patient. When you have finished interacting with the virtual patient, you will complete a short scale to provide your evaluation of it. Then you will participate in an interview with the investigator who will ask questions to guide you in providing feedback on what worked and what didn't work to help you learn through the virtual patient. It will take you about an hour to complete the virtual patient, questionnaire and scale. The interview will take no longer than 30 minutes. The maximum amount of time you will spend in the study session will be about 90 minutes total. The session will be audio-recorded. The investigator may contact you after the study session to make sure she has understood what you've expressed about your experience with the virtual patient. This interaction should only take a few minutes and may be over the phone or through e-mail.

HOW LONG WILL I BE IN THE STUDY?

We think you will be in the study for the 90 minutes of the actual study session. The investigator may follow up with you at a later time when she is analyzing the information you provided to make sure she has accurately understood what you have communicated about your experience with the virtual patient.

You can stop participating at any time.

WHAT ARE THE RISKS OF THIS STUDY?

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Risks to you are minimal, meaning they are not thought to be greater than other risks you experience every day. Being recorded means that confidentiality cannot be promised. You may not learn anything from the virtual patient and you may not find it interesting. You may feel bad if your interaction with the virtual patient points up gaps in your knowledge.

ARE THERE ANY BENEFITS TO TAKING PART IN THE STUDY?

You may or may not get any direct benefit from being in this study. We cannot promise that you will experience any benefits from participating in this study. We hope the information learned from this study will benefit others in the future. We also hope that you will learn from the virtual patient case and find the technology enjoyable.

WHAT OTHER OPTIONS ARE THERE?

You always have the option to not be in this study. If you decide NOT to be in this study, it will have NO effect on your residency, medical, nursing or other training program or other evaluations.

WHAT ABOUT CONFIDENTIALITY?

If you agree to participate in this study, you will be assigned a number and all of your study data will be managed through this identifier, not by your name. The key linking you to your identifier will be kept in an encrypted file on the investigator's password-protected laptop. All data will be password protected, whether stored in the cloud or on the investigator's computer.

This research project will include digital audio recording of the interview and any comments you will make while you are interacting with the virtual patient. You will be encouraged to "think aloud" while you work through the virtual patient. This audio recording will be available to be heard by the investigator and personnel approved by the institutional review board. The recording will be uploaded to a password-protected folder in the investigator's online storage space and erased from the recording device. The recording will be transcribed by the investigator. She will use earphones while transcribing your comments and interview to guard your privacy. The digital file of your comments and interview will be kept for 36 months from the end of the study. The recording will be destroyed after that time by selecting permanent deletion from online storage. Because your voice will be potentially identifiable by anyone who hears the recording, your confidentiality for things you say on the recording cannot be guaranteed although the investigator will try to limit access to your comments and interview as described in this paragraph.

No faculty, mentor, or supervisor involved in your training program or work will be informed of whether you participated in this study or not.

WILL I BE PAID FOR PARTICIPATING IN THIS STUDY?

IRB number: 2013-112		**Clinical Site IC Version:**	V2.140429
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You will not be paid for participating in this study. You will receive a gift card not to exceed $15.00 in monetary value in consideration of your time and to thank you for your participation. Materials and information obtained from you in this research may be used for commercial or non-commercial purposes. It is the policy of MedStar National Rehabilitation Hospital, MedStar Health Research Institute, MedStar Health, Inc. and its affiliated entities not to provide financial compensation to you should this occur.

WHAT ARE THE COSTS AND TIME COMMITMENTS TO PARTICIPATE IN THIS STUDY?

You do not have to pay anything to be in this study. We think being in this study will take about 90 minutes of your time. The study session is designed to occur on a study laptop with a wireless Internet connection at your clinical or academic site to minimize travel and inconvenience to you. If the investigator follows up with you by phone or email to ask a question about her understanding of your experience with the virtual patient, this should only take a few minutes.

WHAT ARE MY RIGHTS AS A PARTICIPANT?

- You have the right to be told about the nature and purpose of the study;
- You have the right to be given an explanation of the exactly what will be done in the study and given a description of potential risks, discomforts, or benefits that can reasonably be expected;
- You have the right to be informed of any appropriate alternatives to the study;
- You have the right to ask any questions you may have about the study;
- You have the right to decide whether or not to be in the study without anyone misleading or deceiving you; and
- You have the right to receive a copy of this consent form.

By signing this form, you will not give up any legal rights you may have as a research participant. You may choose not to take part in or leave the study at any time. If you choose to not take part in or to leave the study, your regular education will not be affected and you will not lose any of the educational benefits you would have received normally. We will tell you about new information that may affect your welfare or willingness to be in this study.

WHOM DO I CALL IF I HAVE QUESTIONS OR PROBLEMS?

For questions about the study, contact the investigator, Manon Schladen, at 202-302-1931.

For questions about your rights as a research participant, contact the MedStar Health Research Institute. Direct your questions to the Office of Research Integrity at:

Address:	MedStar Health Research Institute 6525 Belcrest Rd. Suite 700 Hyattsville, MD 20782	Telephone: Toll Free: Fax	(301) 560-2912 (800) 793-7175 (301) 560-7336

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SIGNATURES

As a representative of this study, I have explained the purpose, the procedures, the possible benefits and risks that are involved in this research study. Any questions that have been raised have been answered to the individual's satisfaction.

Signature of Person Obtaining Consent ______ Date of Signature ______

Printed Name of Individual Obtaining Consent: ______

I, the undersigned have been informed about this study's purpose, procedures, possible benefits and risks, and I have received a copy of this consent. I have been given the opportunity to ask questions before I sign, and I have been told that I can ask other questions at any time. I voluntarily agree to be in this study. I am free to stop being in the study at any time without need to justify my decision and if I stop being in the study I understand it will not in any way affect my present or academic, training, or other program rights or evaluation.

Participant's signature ______ Date of Signature ______

Printed Name of Participant ______

As the Principal Investigator (or his designee) for this research study, I attest that the participant has voluntarily agreed to be part of this study, the risks and benefits of the study have been fully explained, and any questions have been addressed to the participant's satisfaction.

Principal Investigator's Signature ______ Date of Signature ______

LOOKING FOR PARTICIPANTS IN A STUDY ON VIRTUAL PATIENTS

WHAT'S A "VIRTUAL PATIENT"?

A "virtual patient" is an online, interactive case that simulates diagnosing and treating a real patient.

WHY ARE YOU STUDYING THEM?

Virtual patients can help fill in gaps in clinical experience by providing the opportunity to manage more numerous and varied patient cases than may be available in actual clinical rotations. The technology is new, however, and research is needed to understand how to design virtual patients to augment clinical curricula.

This study is part of doctoral work being conducted at Nova Southeastern University to develop an instructional design theory of virtual patients. NSU IRB Protocol#07071308Exp.

You are invited to participate in a study of an online, narrative virtual patient based on a real patient's experience!

HOW LONG WILL IT TAKE?

The study will take about 90 minutes and can be completed at your clinical site at a time that is convenient for you. You will receive a $15 gift card as a thank-you gift for participating.

WHO CAN PARTICIPATE?

This virtual patient is appropriate for:

- Medical students
- Advanced practice nursing students
- Nursing students
- Physician assistant students
- Residents (all specialty areas)

NOVA SOUTHEASTERN UNIVERSITY
Institutional Review Board
Approval Date: MAY 2 2 2014
Continuing Review Date: MAY 2 1 2015

HOW CAN I GET MORE INFORMATION ON THIS?

Call or text Manon Schladen at 202-302-1931 or email her at LMANON@NOVA.EDU or at MANON.SCHLADEN@MEDSTAR.NET

Appendix G

Permission to Recruit from NSU Physician Assistant Programs

NOVA SOUTHEASTERN UNIVERSITY

Re: Permission to Recruit Students from Physician Assistant Programs at Nova Southeastern University to Participate in a Doctoral Study Entitled, "Formative Research on an Instructional Design Theory for Virtual Patients in Clinical Education: A Pressure Ulcer Prevention Clinical Reasoning Case"

Dear Ms. Schladen,

I believe that your research in the area of theory to guide design of online interactive cases to enhance clinical reasoning skills may be of benefit to students in training as physician assistants (PAs). Therefore I provide my consent for you to approach physician assistant students studying in Nova Southeastern University's programs to participate in your study.

I understand that your study will be approved by the Institutional Review Board (IRB) at Nova Southeastern University before you begin recruitment efforts and that you will provide me with a copy of your notice of IRB approval. Students' performance in the course of interacting with your study materials will not influence their grades or program evaluation in any way. Though you may contact PA faculty to help you inform students of your study, no faculty member or other person in authority over students will be informed as to whether any student participated in your study or declined. I also understand that the only incentive provide to students to participate will be a small thank you gift (coffee shop gift card) that has a monetary value not to exceed $15.00.

I wish you luck in your work with our students and look forward to the knowledge it hopefully will generate to further the education of PAs and other health care providers.

Sincerely,

William H. Marquardt, MA, PA-C
Associate Professor & Associate Dean

Health Professions Division
College of Health Care Sciences
3200 South University Drive • Fort Lauderdale, Florida 33328-2018
(954) 262-1200 • Fax: (954) 262-1181

Appendix H

Codebook

Codebook Hierarchical Name	Item Description
Nodes\\ID Theories	ID Theories that seem touched upon, in addition to GBS. Created as a top level, parent node to organize the children.
Nodes\\ID Theories\Cognitive Load	Experiences related to or suggestive of Sweller's Cognitive Load Theory
Nodes\\ID Theories\Elaboration Theory	Experiences related to or suggestive of Reigeluth's Elaboration Theory
Nodes\\ID Theories\Emerging Non-GBS Methods	Parent node for criteria that don't cleanly fit into GBS but might well be considered to be design methods
Nodes\\ID Theories\Emerging Non-GBS Methods\Cohesion & Guidance	Learner's experience of how well the virtual patient hangs together. Examine for overlap with Confusion/What To Do Next. Cohesion and guidance are essential components to the successful experience of an online goal-based scenario, such as is a virtual patient
Nodes\\ID Theories\Emerging Non-GBS Methods\Cohesion & Guidance\Default Exploration Mode	Is there a predominent way learners navigate through choice matrices that may be a default or baseline approach? For instance -- in order of presentation?
Nodes\\ID Theories\Emerging Non-GBS Methods\Cohesion & Guidance\Summary	Summing up the learning points from a segment, as in the Order Sets, before moving on.
Nodes\\ID Theories\Emerging Non-GBS Methods\Comic Relief	A momentary segue from the serious narrative to relieve the tension of the effort.
Nodes\\ID Theories\Emerging Non-GBS Methods\Immersion	The sense of being in the scenario
Nodes\\ID Theories\Emerging Non-GBS Methods\Length of Cases	Learner's experience with length of cases
Nodes\\ID Theories\Emerging Non-GBS Methods\Orientation within VP	Knowing where you are and what's ahead.

Codebook Hierarchical Name	Item Description
Nodes\\ID Theories\Emerging Non-GBS Methods\Realism	Experience relative to how real, true to patient characteristics and clinical practice, the intervention is
Nodes\\ID Theories\Emerging Non-GBS Methods\Scaffolding	Providing support on the way to independent and full autonomy in task exploration.
Nodes\\ID Theories\Emerging Non-GBS Methods\Tutorial	Benefits of have an interactive tutorial for a VP to help learner get familiar with how it works.
Nodes\\ID Theories\GBS-Methods	parent node for the collection of GBS methods
Nodes\\ID Theories\GBS-Methods\GBS-Cover Story	The reason for the learner's interaction with the virtual patient. In the present case, the learner is simply a new staff member on the unit receiving a new patient. This is a typical part of a provider's work.
Nodes\\ID Theories\GBS-Methods\GBS-Feedback	Parent node to help identify all the types of feedback and how they are experienced in the Matt Lane, DS-based virtual patient. Feedback is varied and important. This node should be sorted into the different kinds of feedback provided and the learner's experience of them.
Nodes\\ID Theories\GBS-Methods\GBS-Feedback\Kinds of Feedback	Instances of feedback in the VP that may or may not corrospond to orthodox GBS feedback
Nodes\\ID Theories\GBS-Methods\GBS-Feedback\Quality of Feedback	The manner in which feedback is presented. GBS defines 3 modes, more may be appropriate.
Nodes\\ID Theories\GBS-Methods\GBS-Feedback\Score	Quantitative, "how you're doing" measure
Nodes\\ID Theories\GBS-Methods\GBS-Learning Goals (& Objectives)	How learners perceive the VP's learning goals and objectives
Nodes\\ID Theories\GBS-Methods\GBS-Learning Goals (& Objectives)\DecisionSim Authoring Guidance	Document disseminated c 2012 by Decision Simulation for use by VP authors using the DecisionSim platform
Nodes\\ID Theories\GBS-Methods\GBS-Learning Goals (& Objectives)\Narrative Medicine	Goals framed in a narrative medicine approach
Nodes\\ID Theories\GBS-Methods\GBS-Learning Goals (& Objectives)\Patient-centered Care	Refers to the approach to care provision that places the perspective and needs of the patient ahead of objective medical goals
Nodes\\ID Theories\GBS-Methods\GBS-Mission	What the learner is supposed to achieve through working with the virtual patient
Nodes\\ID Theories\GBS-Methods\GBS-Operations (Activities)	What the learner does in working through the virtual patient.Activities may be functional (ex. Listening to the patient and recording his information) or nominal (ex. creating order sets, taking a history)
Nodes\\ID Theories\GBS-Methods\GBS-Operations (Activities)\Clinical Documentation	The reviewing clinical documentation operation
Nodes\\ID Theories\GBS-Methods\GBS-Operations (Activities)\GBS-Multimedia	Relevant of multimedia in the context of GBS

Codebook Hierarchical Name	Item Description
Nodes\\ID Theories\GBS-Methods\GBS-Operations (Activities)\Hand-Off	Learner experience of the hand-off process
Nodes\\ID Theories\GBS-Methods\GBS-Operations (Activities)\History	Parent node
Nodes\\ID Theories\GBS-Methods\GBS-Operations (Activities)\History\Pick List - Known # Right	History-taking presented as a pick list (inquiry node) with the number of "correct" questions known to the learner ahead of time. This is typified by 16a. Past Medical History (Interview)
Nodes\\ID Theories\GBS-Methods\GBS-Operations (Activities)\Listening & Recording	Listening to what the patient says, recording it in objective language. Split this out to differentiate listening to get the prescriptions and listening to understand patient's concerns about baclofen pump. People appreciated these VERY differently. The former more than the latter.
Nodes\\ID Theories\GBS-Methods\GBS-Operations (Activities)\Order Sets	Experience surrounding the activity of creating patient orders
Nodes\\ID Theories\GBS-Methods\GBS-Operations (Activities)\Staging PUs	The operation/activity of staging pressure ulcers
Nodes\\ID Theories\GBS-Methods\GBS-Operations (Activities)\Teamwork	Learner appreciation of how the health care team works together. This is related to handoff, but more generalized.
Nodes\\ID Theories\GBS-Methods\GBS-Resources	Information aids the learner uses to care for the virtual patient -- carry out scenario operations/activities.
Nodes\\ID Theories\GBS-Methods\GBS-Resources\Hyperlinks	Learner experience of hyperlinks
Nodes\\ID Theories\GBS-Methods\GBS-Resources\Online Search	Autonomous searching on the internet to answer questions in doing the VP
Nodes\\ID Theories\GBS-Methods\GBS-Resources\Tech	Using the computer itself to support the intervention, as in taking notes in a Word file.
Nodes\\ID Theories\GBS-Methods\GBS-Role	The role the learner plays in the scenario -- functional (e.g. the person who carries out specific activities) as well as nominal (e.g. the name of the professional whose duties the learner carries out in the scenario)
Nodes\\ID Theories\Situated Learning	Experiences related to Wegner's Situated Learning Theory
Nodes\\Matt Lane	The subject of formative research to develop a theory of virtual patients
Nodes\\Matt Lane\Compared with Other VPs	Particularly DXR Clinician. The PA program uses this VP for learning.
Nodes\\Matt Lane\Compared, Day 1 vs Day 2	How learners feel about Matt Lane Day 1 and Day 2.
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit	The second VP node

Codebook Hierarchical Name	Item Description
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Day 2 Intro	Intro Nodes, Role Selection, Handoff
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Day 2 Intro\57. April 23 - Back in the Hospital	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Day 2 Intro\57.0 Who are you (qm)	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Day 2 Intro\57.1 Handoff	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Day 2 Intro\N1. Welcome & Instructions	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR	The contents of the patient's EMR updated from the previous day
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\156. Review Admission Orders (April 22)	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\25. Physical Exam	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\25. Physical Exam\26. Skin Exam	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\52.8 Specialty Consults	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\58. April 23 - Updates to Matt Lane's EMR	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\59. April 22 Braden Scale	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\59. April 22 Braden Scale\60. Braden Scale QC	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\63. April 23 - Labs	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\63. April 23 - Labs\63.1 PHR Prescription History	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\64. Grand Rounds - Chronic UTIs	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\64. Grand Rounds - Chronic UTIs\63.1. PHR Prescription History	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\65. April 23 - Radiology	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\65. April 23 - Radiology\66. April 23 - Radiology (Review)	DS Node

Codebook Hierarchical Name	Item Description
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\67. April 23 - Progress Notes	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\68. April 23 - ASIA Exam	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\68. April 23 - ASIA Exam\69. April 23 - ASIA Exam (Implications)	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\71. April 22 - Interdisciplinary Nursing Evaluation	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\71. April 22 - Interdisciplinary Nursing Evaluation\72. April 22 - Nursing Evaluation (Review)	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\73. April 22 - Falls Risk Assessment	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\73. April 22 - Falls Risk Assessment\74. Falls Risk Assessment (Review)	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\73.1. April 23 -- Patient's Back on the Unit!	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\FC.0. Patient Care Flow Sheets	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\FC.0. Patient Care Flow Sheets\61. April 22-23 - Patient Care Flowsheet (Night-Day)	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\FC.0. Patient Care Flow Sheets\62. April 22-23 - Flowsheet (Night-Day) Review	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\FC.0. Patient Care Flow Sheets\7. April 22 Patient Care Flowsheet (Day Shift)	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\FC.0. Patient Care Flow Sheets\70. April 22 - Patient Care Flowsheet (Evening)	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History\10. Chief Complaint	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History\12. HX OF PRESENT ILLNESS	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History\17. Surgical History	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History\18. Allergies	DS Node

Codebook Hierarchical Name	Item Description
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History\21. Functional History	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History\22. FAMILY HISTORY	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History\23. Review of Systems	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History\H1. Medications on Admission	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History\H2. PATIENT'S CONCERNS	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History\H3. Past Medical History	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\EMR\H. History\H4. Social History	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Patient's Back on the Unit!	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Patient's Back on the Unit!\74.2. April 23 - PT Session	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Patient's Back on the Unit!\74.3 Family Problem	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Score and Closing	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Score and Closing\80 Sign-Off	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Score and Closing\81 How You Did	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Score and Closing\82.1 Rate this Virtual Patient	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\75. April 23 1452 Visit with Patient	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\AD	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\AD\76. AD Risk	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\AD\76.2. AD Risk - Distended Bladder	DS Node

Codebook Hierarchical Name	Item Description
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\AD\76.2. AD Risk - Distended Bladder\77. SPT Failure Risk	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\AD\76.3. AD Risk - Skin Breakdown	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\AD\76.4. AD Risk - UTI	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\AD\76.4. AD Risk - UTI\74.4.1 UTI Decision	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Bladder	Urinary risk tree
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Bladder\77.1 Past medical Hx - SP Tube	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Bladder\77.3 Wettness	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Bladder\77.3.1. Reason for Wetness	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Bladder\77.4 Tension	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Bladder\77.6. SPT Inspection	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Bladder\77.6. SPT Inspection\77.6.1. Transfer to Inspect SPT	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Bladder\77.6. SPT Inspection\77.6.1. Transfer to Inspect SPT\77.6.2. Inspection of SPT Site	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Bladder\77.8. SPT Status	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Bladder\77.8. SPT Status\77.2 Team Inspection of SPT	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Bladder\77.8. SPT Status\77.7. Urology Consult	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\77.9. BP Down!	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin	DS Node

Codebook Hierarchical Name	Item Description
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.1 Back-of-Head PU Risk Factors	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.1 Back-of-Head PU Risk Factors\78.1star. Back of Head	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.2 Buttocks, Sacrum and IT Risk Factors	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.2 Buttocks, Sacrum and IT Risk Factors\78.2.1 Buttocks, Sacrum, and Ishial Tuberosities	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.2 Buttocks, Sacrum and IT Risk Factors\78.2.1 Buttocks, Sacrum, and Ishial Tuberosities\78.4star. Patient's Feedback	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.5 Heel Breakdown Risk Factors	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.5 Heel Breakdown Risk Factors\78.5.1 Patient's Left Heel	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.5 Heel Breakdown Risk Factors\78.5.2 Patient's Right Heel	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.5 Heel Breakdown Risk Factors\78.5.2star SDTI, Stage II Notes and Orders	DS Node

Codebook Hierarchical Name	Item Description
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.5 Heel Breakdown Risk Factors\78.5.3 Left	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.5 Heel Breakdown Risk Factors\78.5.4 Right	DS Node
Nodes\\Matt Lane\Matt Lane Day 2 on the Unit\Visit with Patient\Skin\78.0 Check Patient's Skin\78.01 Transfer to Inspect Skin\78. Skin Breakdown Risk\78.5 Heel Breakdown Risk Factors\78.5.4star SDTI Notes & Orders	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit	The first VP node -- e.g. Day1
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview -- Part 1 Interactive	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview -- Part 1 Interactive\10. Spasms - April 22	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview -- Part 1 Interactive\12. Hx of Present Illness	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview -- Part 1 Interactive\12a. Keeping Score	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview -- Part 1 Interactive\13. Matt Lane's Current Spasticity Medications	Matt recites his meds, learner writes them down.
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview -- Part 1 Interactive\14. Patient's Other Present Concerns	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview -- Part 1 Interactive\15. Patient's Ambivalence Relative to Spasms	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview -- Part 1 Interactive\15a. Understanding the Full Scope of the Patient's Concern	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview -- Part 1 Interactive\16. Patient's Health Records (Interview)	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview -- Part 1 Interactive\16a. Past Medical History (Interview)	Inquiry node where learner was told how many questions were "correct" to ask the patient. Learners approached this task variously.
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview -- Part 1 Interactive\9. Chief Complaint	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\16b. Complete Patient's History (Interview)	The center of the "star" to complete the patient's history

Codebook Hierarchical Name	Item Description
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\17 Surgical History (Interview)	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\18. Allergies (Interview)	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\19. Medications (Interview),	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\20. Social History (Interview)	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\21. Functional History (Interview)	Here is where the bit about the footplates is introduced.
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\213. Behind the Scenes	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\22. Family History (Interview)	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\23. Review of Systems (Interview)	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\24. Physical Exam	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\25. Exam Narrative Findings	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\26. Skin Exam	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\27. Positioning and Exam	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Interview Part 2 - Star Branch\44. April 22 - Finish Pateint's Exam	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Intro Nodes	The nodes leading in to Matt Lane: New Patient on the Unit: Overall directions, selection of role, doing a handoff, introduction to the patient. N1, 2, 4, 5, 7, 8, 8R, 8PA, 8NP, 9
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Intro Nodes\1. Welcome to Virtual 2W	This is where the role question is asked. First and only time.
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Intro Nodes\4. Case Presentation	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Intro Nodes\5. Communicating Clearly	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Intro Nodes\7. April 22 Patient Care Flowsheet (Day Shift)	DS Node

Codebook Hierarchical Name	Item Description
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Intro Nodes\8. Meet the Patient	Provides logic for routing the learner to the appropriate role node.
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Intro Nodes\8PA. Introducing Matt Lane, Your Patient	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Intro Nodes\8R. Introducing - Matt Lane, Your New Patient	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Intro Nodes\N1. How to Navigate This Virtual Patient	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\45. Provider's Orders - April 22	Counters for analysis nodes are set here.
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\46. Orders (Dx Information) - April 22	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\46.1. Obstructive Sleep Apnea	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\46-10. Neurogenic Bowel - Bladder	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\46-1000. Spasticity	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\46a. Diagnosis Decision Analysis	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\46Q. Diagnosis Signed Off	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\47. Precautions Orders - April 22	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\47-1. Dysreflexia Precautions	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\47-10. Swallowing - Aspiration Precautions	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\47-1000. Falls Precautions	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\47Q. Precautions Orders Signed Off	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\48. Rehab Program - OT Orders	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\48-1. ROM STRENGTHENING, MOTOR RETRAINING &	DS Node

Codebook Hierarchical Name	Item Description
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\48-10^4 Equipment Assessment	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\48-100. Transfer Training	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\48-1000. TRAIN IN USE OF ORTHOSES - ADAPTIVE EQUIPMENT	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\48Q. OT Orders Signed Off	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\49. Rehab Program - PT Orders April 22	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\49-1. PT ROM Strengthening, Motor Retraining and Coordination Exercise	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\49-10. Sitting, Standing Balance Training	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\49-1000. PT Transfer Training	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\49Q. PT Orders Sign Off	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\50. Nursing Orders - April 22	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\50-10^4. Turning and Bed Positioning	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\50-10^7. Foot Support Boots	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\50-1000. Weight on Admission, Then Every Week	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\50Q. Nursing Orders Signed Off	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\51. Nursing Respiratory Care Orders April 22	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\51Q. Nursing Respiratiory Orders Sign Off	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\52. Consult Orders April 22	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\52-1. Urology	DS Node

Codebook Hierarchical Name	Item Description
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\52Q. Consults Signed Off	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\53. Lab Orders April 22	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\53. Lab Orders April 22\53-10. CBC	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\53-10^4. PRE-ALBUMIN	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\53-1000. Fasting Lipid Profile	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\53Q. Labs Signed Off	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\54. Radiology Orders April 22	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\54-10. Venous Doppler LE	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\54-1000. Renal Ultrasound	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\54Q. Radiology Orders Signed Off	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\55. Medication -Treatment Orders April 22	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\55-1. Diazepam (VALIUM)	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\55-100. Sennosides (SENNA)	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\55Q. Meds Signed Off	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\56. April 22 - Sign-Off	DS Node
Nodes\\Matt Lane\Matt Lane New Patient on the Unit\Order Sets\56Q. APRIL 23RD!	DS Node
Nodes\\Participant	Medical trainees who worked through the virtual patient cases
Nodes\\Participant\AG	Participant coded by initials
Nodes\\Participant\CE	Participant coded by initials

Codebook Hierarchical Name	Item Description
Nodes\\Participant\DF	Participant coded by initials
Nodes\\Participant\EN	Participant coded by initials
Nodes\\Participant\JH	Participant coded by initials
Nodes\\Participant\MM	Participant coded by initials
Nodes\\Participant\RS	Participant coded by initials
Nodes\\Participant\SB	Participant coded by initials
Nodes\\Participant\SL	Participant coded by initials
Nodes\\Participant\ZH	Participant coded by initials
Nodes\\Realizations in Coding	Alternate way of recording impromptu realizations -- versus memoing
Nodes\\Storytelling - Exposition	Parent node coordinating various approaches to telling the patient story
Nodes\\Storytelling - Exposition\Balance of Narrative Text and Video	Pretty much just that
Nodes\\Storytelling - Exposition\Narrative Text	Learner experience with narrative text
Nodes\\Storytelling - Exposition\Text in Objective Language	The patient condition already reduced to objective, medical language. Relies on the clinician who created it to have accurately and completely identified all the issues relevant to the patient condition
Nodes\\Storytelling - Exposition\Video	Learner experience of videos in the VP
Nodes\\Storytelling - Exposition\Video\Slide Show vs Smooth Video	A video made up documentary-style of a succession of stills versus multi-frame -per sec smooth video
Nodes\\Study Limitations	Study limitations noted during analysis
Nodes\\Teaching and Learning	Parent node coordinating the various aspects of teaching and learning brought to light by participants in the study.
Nodes\\Teaching and Learning\Affect	Engagement of the learner's emotions to engage him/her in the narrative

Codebook Hierarchical Name	Item Description
Nodes\\Teaching and Learning\Analytic Processes	Theory (Schank) and evidence from learners
Nodes\\Teaching and Learning\Anticipating Learners' Next Moves	Need for a good grasp of what the learner is expecting --as well as what is correct -- in providing choices for next actions.
Nodes\\Teaching and Learning\Comparing Own Performance to Others'	Learner's interest in how her performance compares to others.' I think, maybe, the earlier students' request for a score hit at some of what's important for Med Students. Are they trained this way? Is what others are doing that central to their learning experience?
Nodes\\Teaching and Learning\Confidence & Familiarity	With the subject matter. This is NOT a measure of confidence generally. So studies of how over-confident physicians tend to be is not relevant.
Nodes\\Teaching and Learning\Content	Parent node coordinating different types of content to which the learner reacted
Nodes\\Teaching and Learning\Content\Evidence-based & Scientific	Learners' perceptions about the science or evidence base on VP content
Nodes\\Teaching and Learning\Content\Improvements Identified	Learner's impressions on how the medical or health care practice content could have been improved. This is not the same as rejection/disconnect which is coded at Resonance & Credibility of Right-Wrong
Nodes\\Teaching and Learning\Content\Medical Art vs Science	Discussion of the equivocal nature of medicine, gray areas in practice
Nodes\\Teaching and Learning\Content\Medical Art vs Science\Professional & Programmatic Variations	Different professions, programs, organizations teach according to a somewhat different take on what's best practice
Nodes\\Teaching and Learning\Content\Resonance & Credibility of Right-Wrong	The "correct" answers and outcomes of actions in the VP have to be credible and resonate with the learner, or s/he is likely to shut down.
Nodes\\Teaching and Learning\Document with Correction	A document completed and them critiqued. Sort of like a worked example.
Nodes\\Teaching and Learning\Engagement-	Phenomenon decreasing learner engagement. Also, segments where learner does not pursue, e.g. looking up a term when it is unknown. This node might just as well be under "storytelling."
Nodes\\Teaching and Learning\Engagement+	Phenomenon increasing learner engagement. This node might be better under "storytelling."
Nodes\\Teaching and Learning\Engagement+\Making it Personal - Matt Lane's 'Presence'	Learners' sense of the patient, Matt Lane himself. How the patient's character could be a component of engagement.
Nodes\\Teaching and Learning\Engagement+\Other Scenario Characters	Engagement with others in the scenario besides the patient himself
Nodes\\Teaching and Learning\Experiential	Learning through observation of a patient case or active decision-making in a patient case
Nodes\\Teaching and Learning\Guidance	Explicit usage of the word "guidance." Learner sense of knowing what to do next in the intervention. Pedagogical sense, versus usability sense.

Codebook Hierarchical Name	Item Description
Nodes\\Teaching and Learning\Impact - Level of Experience	How the learner's level of experience impacts interaction with the virtual patient as currently formulated
Nodes\\Teaching and Learning\Impact - Level of Experience\JIT Knowledge Support Needed	What the learner needs to know to get him/her through the patient to enable other types of learning.
Nodes\\Teaching and Learning\Impact - Level of Experience\Need for Variations	How a learner's prior experience impacts the "coloring" of the perception of the utility of the current patient's characteristics.
Nodes\\Teaching and Learning\Learning In-Scenario Context - Incidental Learning	Learner experience of learning new material -- versus applying explicitly taught knowledge -- in scenario
Nodes\\Teaching and Learning\Learning Through Error	Learners' perception of effect of making mistakes on their learning.
Nodes\\Teaching and Learning\Learning-Explicit	Participant states that she has learned something on query by me, the researcher.
Nodes\\Teaching and Learning\Learning-Implicit	Participant indicates through indirect means, talk-aloud, etc. that she has added to her understanding of how to care for the specific patient. What I, the researcher, see in the learner's interaction with the VP.
Nodes\\Teaching and Learning\Learning-in-Process	Evidence that the participant is learning from the VP, but is in a transitory stage. Learning is expressed, but imperfectly.
Nodes\\Teaching and Learning\Level of Challenge	Demonstration or statement of the difficulty of the subject matter for the learner
Nodes\\Teaching and Learning\Modeling	Presenting a model of practice to the learner. Could be done through resources, feedback, or role.
Nodes\\Teaching and Learning\Modeling\Risk of Feedback Ambiguity	Learner's inability to judge own response against model
Nodes\\Teaching and Learning\Motivation	Parent node coordinating aspects of learner motivation
Nodes\\Teaching and Learning\Motivation\Attention to Detail, Precision	Difference in learners' approach to the VP
Nodes\\Teaching and Learning\Motivation\Extrinsic - Career & Programmatic	e.x. to fulfill a course requirement and get a good grade
Nodes\\Teaching and Learning\Motivation\Intrinsic - Interest & Affect	ex., as a result of personal interest
Nodes\\Teaching and Learning\Motivation\Relevance to Professional Goals	Note this motivator has both extrinsic and intrinsic attributes
Nodes\\Teaching and Learning\Motivation\Success	Learner expresses positive feeling when answer is correct.

Codebook Hierarchical Name	Item Description
Nodes\\Teaching and Learning\Reasoning & Critical Thinking	Demonstrations of reasoning -- deductive or inductive Note -- need to break out reasoning about treating the patient versus navigating and doing WELL in the intervention. Both are important, but different at the same time.
Nodes\\Teaching and Learning\Reasoning & Critical Thinking\Directedness	Navigation path based on reasoning from what is known
Nodes\\Teaching and Learning\Reasoning & Critical Thinking\Sense-Making of the Intervention Presentation	Reasoning about what the point of the learning exercise is versus what's going on with the patient in the scenario
Nodes\\Teaching and Learning\Situational Awareness	Evidence that the learner is aware of what's going on with the patient as she navigates the intervention
Nodes\\Teaching and Learning\Teaching by Indirect Suggestion	Use of indirection to convey a message
Nodes\\Time Spent on Exercises	Time spent on learning exercises
Nodes\\Tone	How the VP intervention "speaks" to the learner during corrective feedback
Nodes\\Usability	Facilitators and barriers to the learner's ability to navigate the virtual patient and understand its content. Parent node, use to aggregate.
Nodes\\Usability\Acronyms	Perceptions, good and bad, of use of acronyms
Nodes\\Usability\Audio Quality	Learner experience impacted by quality (poor) of audio
Nodes\\Usability\Confusion	Parent node -- coordinates various ways the learner expresses confusion from the persective of usability.
Nodes\\Usability\Confusion\Case History Pane	Experience of the DS case history pane used to review previously traversed case nodes
Nodes\\Usability\Confusion\DS Inquiry vs Branch Node Differentiation	Learner experience of distinguishing what is expected at an inquiry versus a branching node. Requires recognition of branching or inquiry icon.
Nodes\\Usability\Confusion\MCQ Node	Incidences of MCQ nodes causing confusion in the learner
Nodes\\Usability\Confusion\Naming & Actual Content	Often, the name of the DS Node has been chosen for "literary" effect. However, if "Meet Your Patient," for example, provides vital signs, on later review, the learner will know that she wants to review Vital Signs. Meet Your Patient won't be an effective guidepost.
Nodes\\Usability\Confusion\Repeating Video to Focus Attention	Using the same video, different segments, to try to focus the learner's attention on specific components of the interaction.

Codebook Hierarchical Name	Item Description
Nodes\\Usability\Confusion\Thwarted Self-Direction	Experience of learners not being able to take the next step in the VP that they desired to take
Nodes\\Usability\Confusion\Time Orientation Importance	Participant's perception of where she is, chronologically, with in the virtual patient. This sense of time is essential to decision-making.
Nodes\\Usability\Confusion\Video and Narrative Node	Learner experience of video and accompanying narrative.
Nodes\\Usability\Confusion\What To Do Next	Learner experience of confusion over next steps in VP.
Nodes\\Usability\Display	How the learner experiences the DS display, specifically.
Nodes\\Usability\Display\Scrolling	Hunting for information on the screen
Nodes\\Usability\Display\WYSIWG Authoring Area	Learner experience of the wysiwg authoring area
Nodes\\Usability\DS Development Environment	Parent node to coordinate learner experience of various aspects of the DS environment
Nodes\\Usability\DS Development Environment\Analysis Node Network	Learner experience of analysis node networks
Nodes\\Usability\DS Development Environment\Analysis Node Network\Order	Prioritization of feedback
Nodes\\Usability\DS Development Environment\Branching Star Networks	Learner experience of branching star networks
Nodes\\Usability\DS Development Environment\Case History Pane	Learner experience of the case history pane
Nodes\\Usability\DS Development Environment\Counters - Cost, Status, Score	Learner experience of counters
Nodes\\Usability\DS Development Environment\Error Recovery	Learner experience of wanting to change her mind
Nodes\\Usability\DS Development Environment\Inquiry VP Nodes	Learner experience of inquiry nodes. Do inquiry nodes help with making information "sticky"?
Nodes\\Usability\DS Development Environment\MCQ VP Nodes	Learner experience of MCQ nodes
Nodes\\Usability\DS Development Environment\Text Response VP Nodes	Learner experience of text response nodes
Nodes\\Usability\Explicit vs Implicit Navigation Aids	Verbal directions vs., for example, different shapes to indicate inquiry or branching actions inside a node, availability of case history panel
Nodes\\Usability\Formatting	Layout, color choices, etc.

Codebook Hierarchical Name	Item Description
Nodes\\Usability\Frustration	Expression of frustration on the part of the learner or perception of researcher that learner is frustrated.
Nodes\\Usability\Frustration\Expectation Dissonance	When the learner expects one thing and finds another and doesn't receive feedback to resolve the experience of dissonance s/he is experiencing.
Nodes\\Usability\Frustration\Frustration - Information not Found	Learner is frustrated because she needs a piece of information that is not available.
Nodes\\Usability\General Computer or Online Tech	Learner experiences relative to general computer use or online technology
Nodes\\Usability\Implicit Direction	What the learner intuits or reasons about the case author's expectations based on optopms presented
Nodes\\Usability\Interactivity	Learner experience of interactivity in the VP cases
Nodes\\Usability\Reading	Learner experience of reading in the VP
Nodes\\Usability\Scoring	How the learner feels about scoring -- both generally and in specific instances in the VP
Nodes\\Usability\Virtual EMR	Experience with Matt Lane's Virtual EMR, ways it could be improved
Nodes\\VP ID Research Methods	Reflections on the actual process of conducting the study. Memos code here.

Appendix I

Free Text DS-Nodes

In Figure 34, the learner has typed a response in the text box. When the "submit" button is clicked, the learner receives feedback in the form of a model, structured communication, *ISBAR*[36]. An instructor can choose an option in authoring a free text DS-node that will forward the learner's response via e-mail for individualized evaluation.

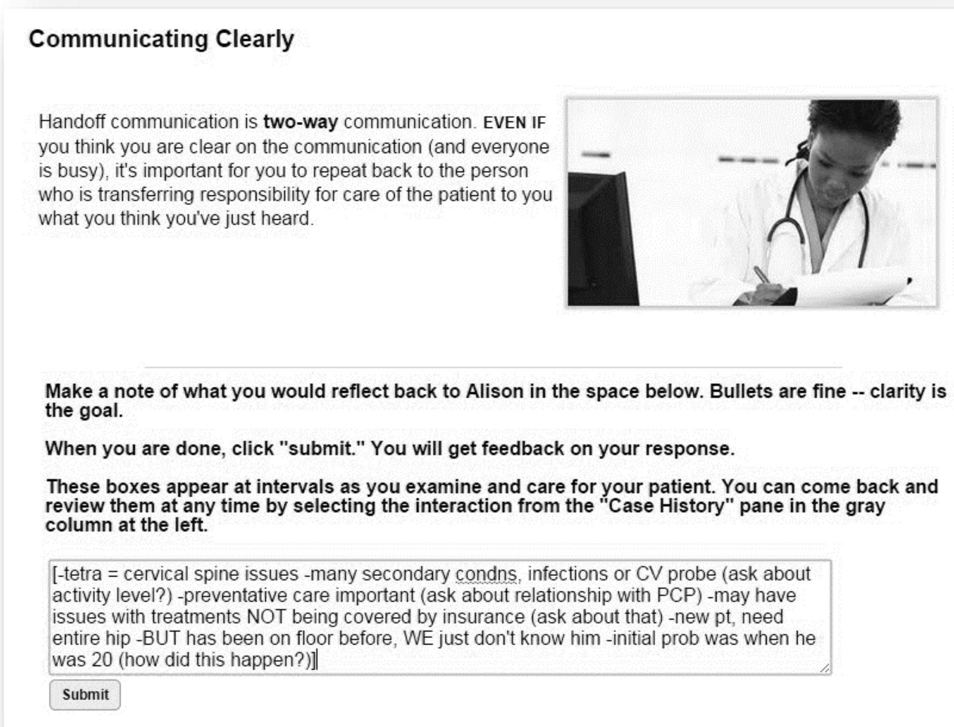
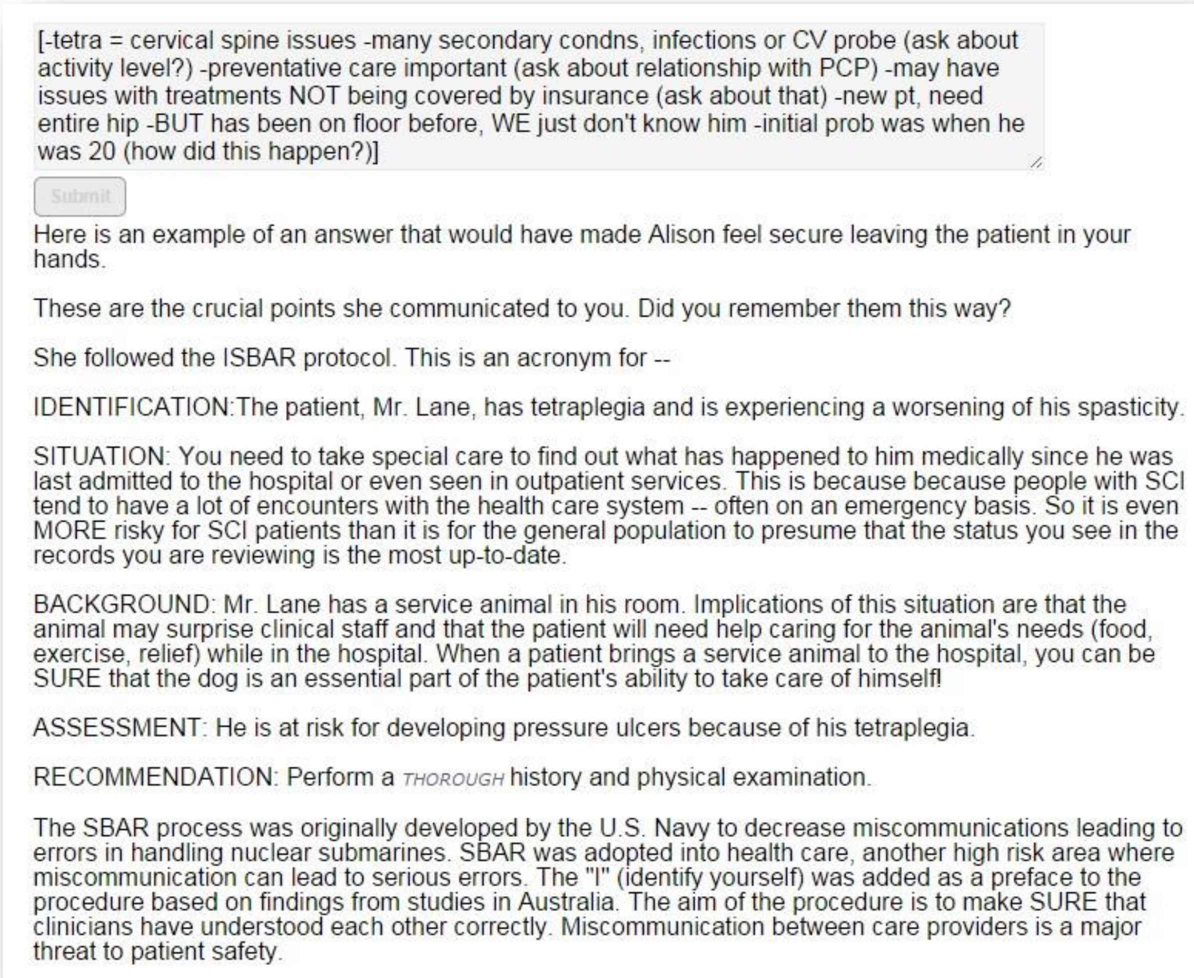


Figure 34. DS-node engaging the learner in practice constructing a handoff communication.

[36] **I**dentification, **S**ituation, **B**ackground, **A**ssessment, **R**ecommendations



[-tetra = cervical spine issues -many secondary condns, infections or CV probe (ask about activity level?) -preventative care important (ask about relationship with PCP) -may have issues with treatments NOT being covered by insurance (ask about that) -new pt, need entire hip -BUT has been on floor before, WE just don't know him -initial prob was when he was 20 (how did this happen?)]

Submit

Here is an example of an answer that would have made Alison feel secure leaving the patient in your hands.

These are the crucial points she communicated to you. Did you remember them this way?

She followed the ISBAR protocol. This is an acronym for --

IDENTIFICATION:The patient, Mr. Lane, has tetraplegia and is experiencing a worsening of his spasticity.

SITUATION: You need to take special care to find out what has happened to him medically since he was last admitted to the hospital or even seen in outpatient services. This is because because people with SCI tend to have a lot of encounters with the health care system -- often on an emergency basis. So it is even MORE risky for SCI patients than it is for the general population to presume that the status you see in the records you are reviewing is the most up-to-date.

BACKGROUND: Mr. Lane has a service animal in his room. Implications of this situation are that the animal may surprise clinical staff and that the patient will need help caring for the animal's needs (food, exercise, relief) while in the hospital. When a patient brings a service animal to the hospital, you can be SURE that the dog is an essential part of the patient's ability to take care of himself!

ASSESSMENT: He is at risk for developing pressure ulcers because of his tetraplegia.

RECOMMENDATION: Perform a THOROUGH history and physical examination.

The SBAR process was originally developed by the U.S. Navy to decrease miscommunications leading to errors in handling nuclear submarines. SBAR was adopted into health care, another high risk area where miscommunication can lead to serious errors. The "I" (identify yourself) was added as a preface to the procedure based on findings from studies in Australia. The aim of the procedure is to make SURE that clinicians have understood each other correctly. Miscommunication between care providers is a major threat to patient safety.

Figure 35. Free text DS-node response. The learner's response remains displayed for comparison with the model provided.

Appendix J

Matt Lane's YouTube Channel

Video resources used in *Matt Lane* were housed on YouTube and imported to DecisionSim™ via hyperlink. It is public and continues to be available to the public as Matt Lane's YouTube Channel. The views logged in the video thumbnails in the tables below are as of this writing and demonstrate interest beyond the perusal of students who participated in the effort recounted in this report to develop and instructional design theory of VPs.

Table 48

Matt Lane's YouTube Channel Part I, January 25, 2015

Tune-Up
55 views • 1 year ago

http://youtu.be/PkmMVrn-xK4

What Brought the Patient to the Hospital
127 views • 1 year ago

http://youtu.be/nVsAJf0Nqn0

Matt Lane's Usual Medications
82 views • 1 year ago

http://youtu.be/8z2-DeVLL2s

Spasms
2,106 views • 1 year ago

http://youtu.be/xi8Ao5astCg

Table 49

Matt Lane's YouTube Channel Part II, January 25, 2015

Concern 1
221 views • 1 year ago
http://youtu.be/67V_lt5FisI

Concern 2
60 views • 1 year ago
http://youtu.be/RXIyxCw-qns

Concern 3
69 views • 1 year ago
http://youtu.be/LabdbINngrA

Exam of Buttocks, ITs, & Sacrum
641 views • 1 year ago
http://youtu.be/3lBtQY6fhnQ

Status of pressure-relieving surface for bed
194 views • 1 year ago
http://youtu.be/eSxtV1ypHpY

Gilly
50 views • 1 year ago
http://youtu.be/AScQdmUZoHw

Table 50

Matt Lane's YouTube Channel Part III, January 25, 2015

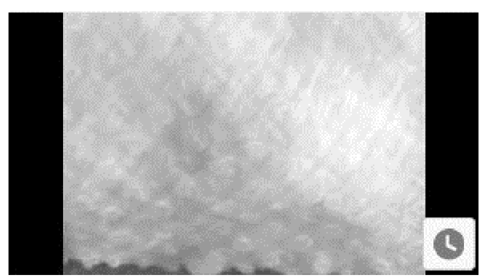
Transfer
652 views • 1 year ago
http://youtu.be/Ed8g4YNhEOA

Spasms
714 views • 1 year ago
http://youtu.be/wKTTIJIyTm0

Shear
74 views • 1 year ago
http://youtu.be/PDQoTAID9Ow

Moisture
77 views • 1 year ago
http://youtu.be/0mvqtLHklFM

MysterySolved!
49 views • 1 year ago
http://youtu.be/JrJa_YbE6Dk



Mystery Solved!
42 views • 1 year ago
http://youtu.be/iwKctwEBw9E

Table 51

Matt Lane's YouTube Channel Part IV, January 25, 2015

Equipment

35 views • 1 year ago

http://youtu.be/W9mHaslFego

Communication from PT

248 views • 1 year ago

http://youtu.be/QHkUaqkSALE

Boots

114 views • 1 year ago

http://youtu.be/0tkSJMqKk0s

How it went... and Riverboat

53 views • 1 year ago

http://youtu.be/LlxOZ20mot0

Appendix K

Video and Text-based Narrative DS-Nodes

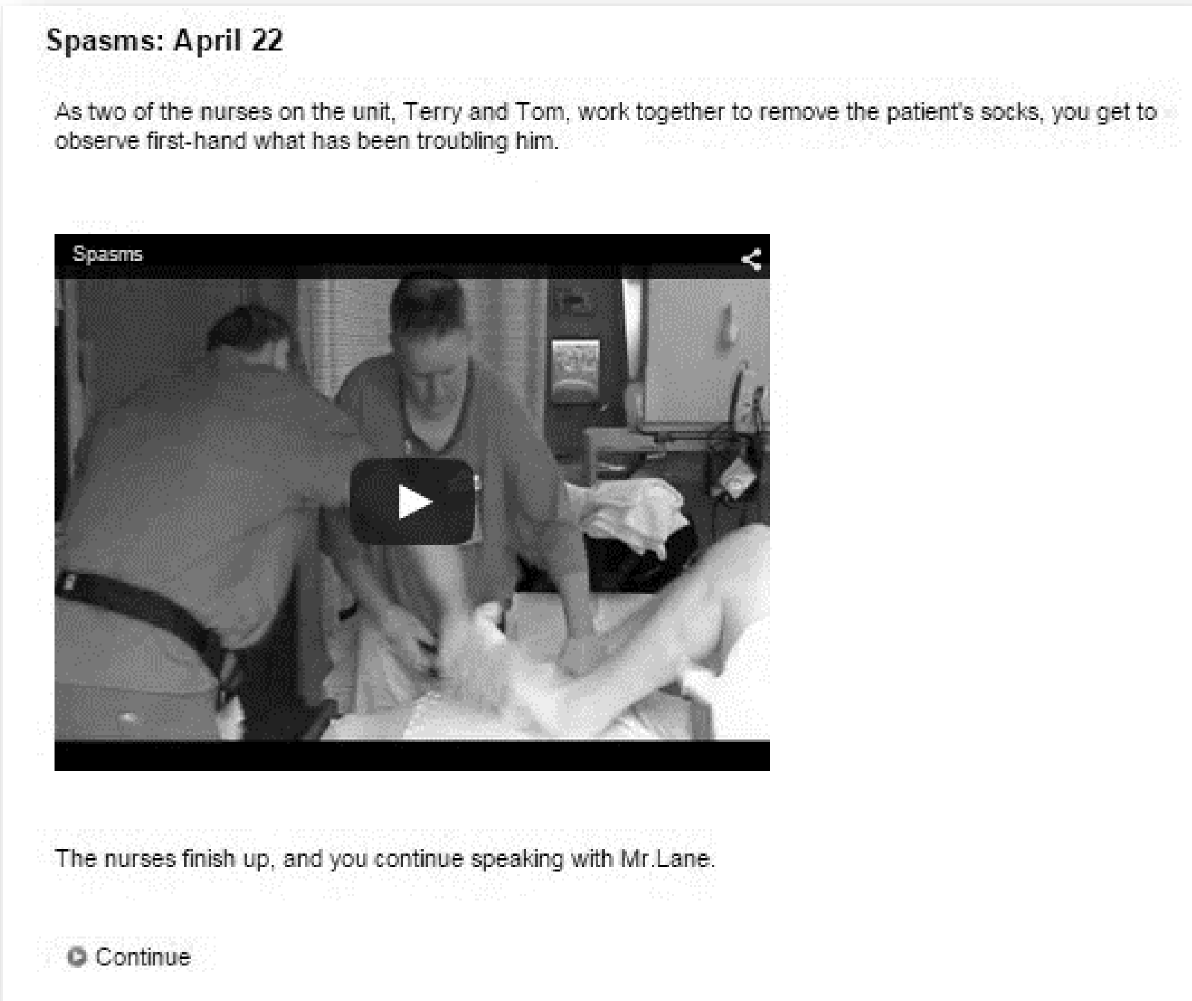


Figure 36. Spasms: April 22 is a narrative, DS-node that contains video content showing Matt Lane's experience of spasms and his interaction with nursing staff over the problem. It provides an example of how video is used in Matt Lane to advance the story and provide the learner opportunities to document the patient status and identify risks through observation.

Social History (Interview)

You: "Could you tell me a little about your living situation?"

Patient: "I live independently. I have a condominium that I live in. I have care givers come in in the morning and the evening -- 2 hours approximately in the morning and 2-3 hours in the evening -- sometimes longer."

You: "Do you use alcohol or tobacco?"

Patient: "Yeah, I do smoke. I've been smoking for about 10 years, I try to keep it to 2 cigarettes a day. Alcohol is variable. Mostly when I go out with people."

You: "You mentioned before that you're working.."

Patient: "Yep. Full-time."

You: : "And your level of education?"

Patient: "I have a Master's Degree in Educational Technology and I currently work as an engineer for the Department of Education. We do Section 504 and Section 508 of the Rehabilitation Act .. basically we test websites and software to make sure they're accessible to people with disabilities like me or people that are blind or low vision. I've been doing this work for about 8 years."

You: "That's wonderful."

Patient: "Yeah, It's been a great experience. I meet a lot of interesting people. (searches on his phone for a moment) Here's a pic of me and Senator Tom Harkin from Iowa - champion of civil rights for people with disabilities. This was taken at one of the ADAPT actions here in D.C. I called his office the day before so his aide could dress him in tune with my apparel for the pic. Purple pals on a parallel plane."

You: "That must have been fun! (Patient smiles.)

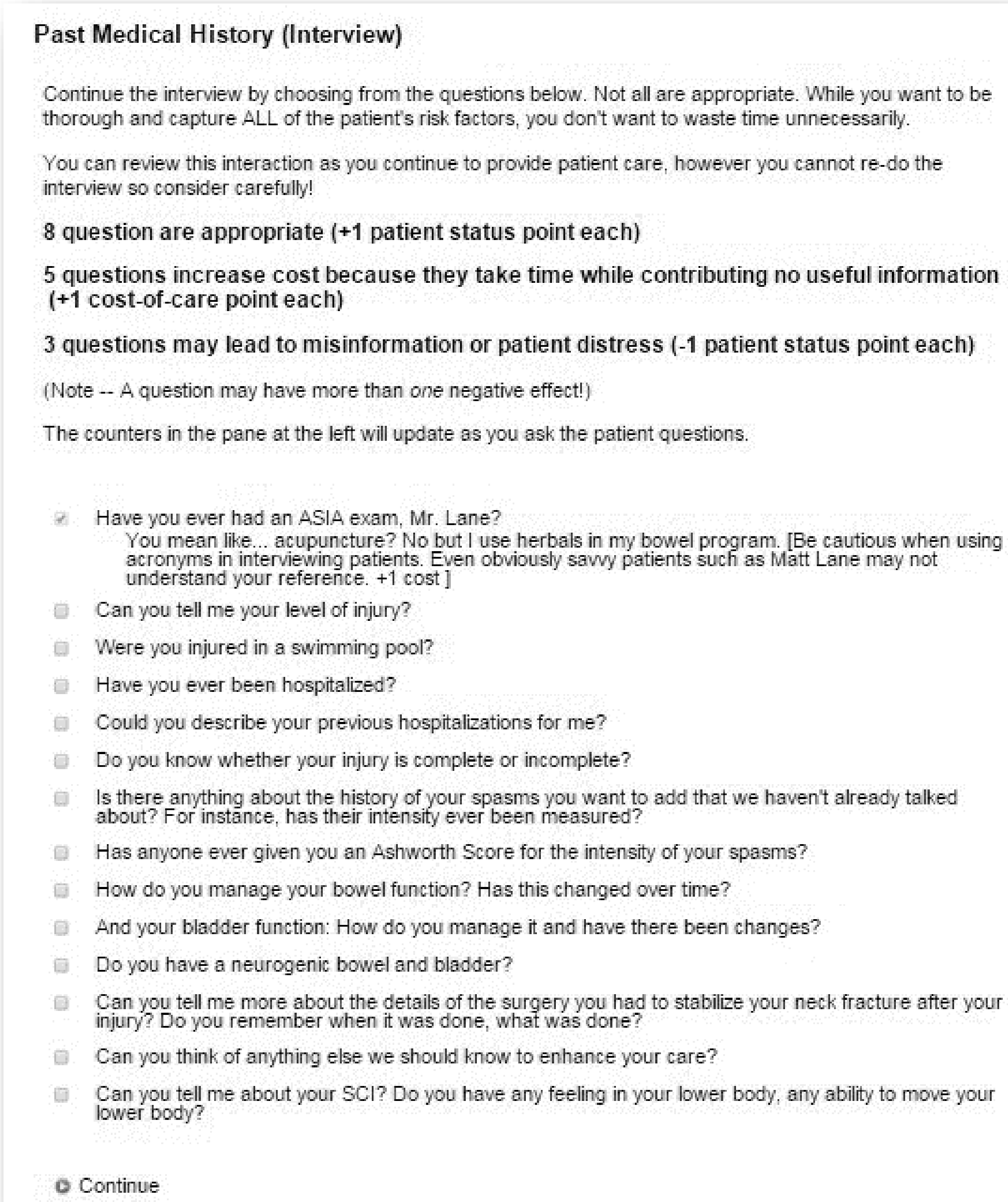
Patient" "You know I'm kidding? It was a total coincidence." (You smile and nod.)

Figure 37. Social History (Interview) is a narrative, DS-node that contains text simulating dialog between the clinician (learner) and the patient. It provides naturalistic dialog for the learner to peruse for salient factors impacting the patient's well-being and document them, in objective language, in his medical record.

Appendix L

The DS Inquiry Node

The activity of getting the patient's past medical history was modeled as a DS inquiry node in *Matt Lane.* The learner chooses questions to ask the patient that elicit important information from the patient to build his history. Some are appropriate and some are not appropriate. Some are efficient and others are not. Learners receive a score based on how well they have identified key information while keeping cost of care (e.g. time) low. See Figure 38.



Past Medical History (Interview)

Continue the interview by choosing from the questions below. Not all are appropriate. While you want to be thorough and capture ALL of the patient's risk factors, you don't want to waste time unnecessarily.

You can review this interaction as you continue to provide patient care, however you cannot re-do the interview so consider carefully!

8 question are appropriate (+1 patient status point each)

5 questions increase cost because they take time while contributing no useful information (+1 cost-of-care point each)

3 questions may lead to misinformation or patient distress (-1 patient status point each)

(Note -- A question may have more than *one* negative effect!)

The counters in the pane at the left will update as you ask the patient questions.

- [x] Have you ever had an ASIA exam, Mr. Lane?
  You mean like... acupuncture? No but I use herbals in my bowel program. [Be cautious when using acronyms in interviewing patients. Even obviously savvy patients such as Matt Lane may not understand your reference. +1 cost]
- [ ] Can you tell me your level of injury?
- [ ] Were you injured in a swimming pool?
- [ ] Have you ever been hospitalized?
- [ ] Could you describe your previous hospitalizations for me?
- [ ] Do you know whether your injury is complete or incomplete?
- [ ] Is there anything about the history of your spasms you want to add that we haven't already talked about? For instance, has their intensity ever been measured?
- [ ] Has anyone ever given you an Ashworth Score for the intensity of your spasms?
- [ ] How do you manage your bowel function? Has this changed over time?
- [ ] And your bladder function: How do you manage it and have there been changes?
- [ ] Do you have a neurogenic bowel and bladder?
- [ ] Can you tell me more about the details of the surgery you had to stabilize your neck fracture after your injury? Do you remember when it was done, what was done?
- [ ] Can you think of anything else we should know to enhance your care?
- [ ] Can you tell me about your SCI? Do you have any feeling in your lower body, any ability to move your lower body?

Continue

Figure 38. The DS inquiry node displayed above permits insertion of text or other media at the top. Subsequently, the leaner chooses items and receives feedback on the appropriateness of those choices. Several tallies can be actuated based on choices to provide the learner a score or to direct the learner to different parts of the virtual patient depending on performance across the items.

Appendix M

The DS MCQ (Multiple Choice Question) Node

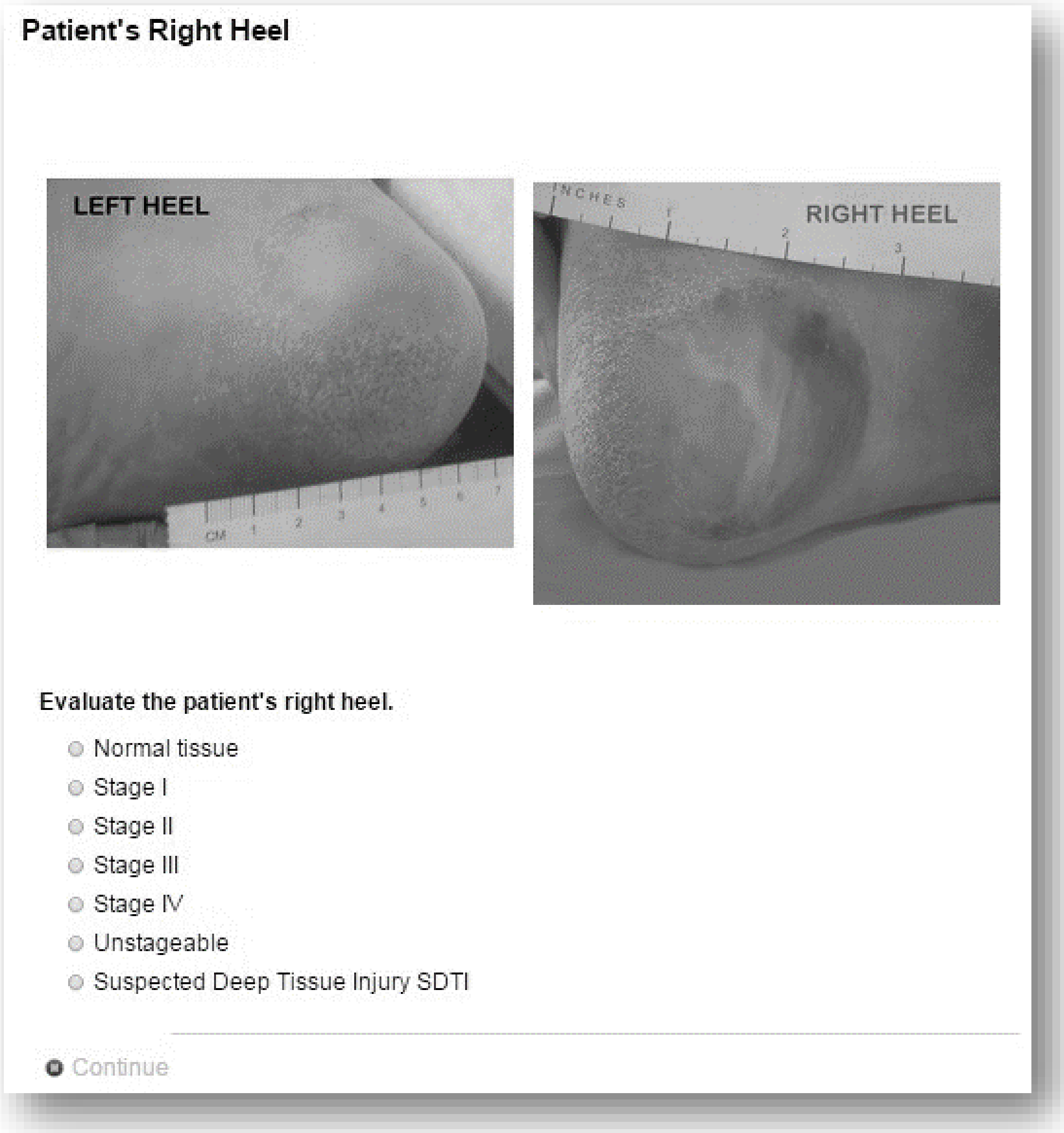
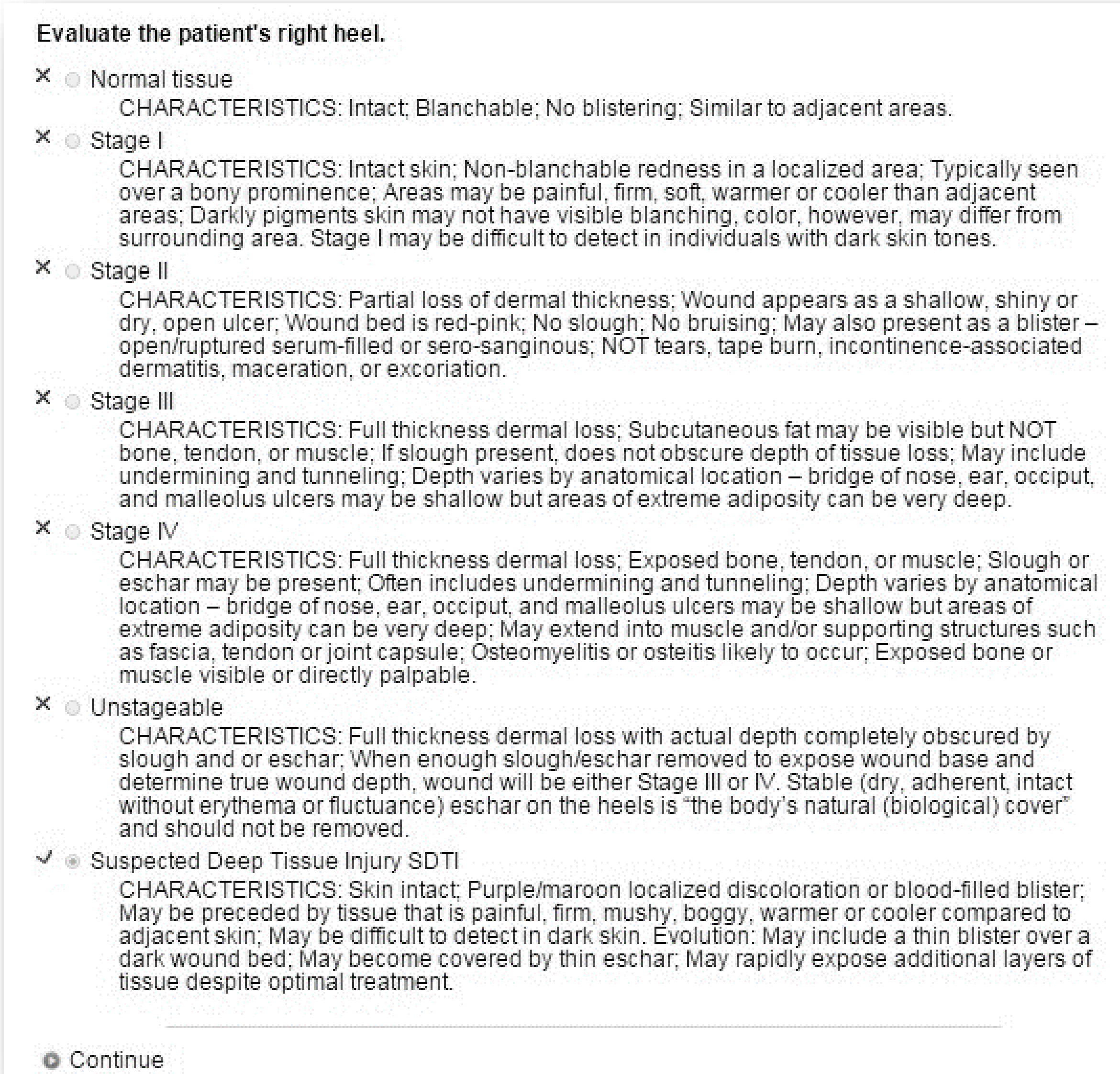


Figure 39. DS MCQ Node employed in a pressure ulcer grading activity. Learner compares bilateral anatomical images and stages the condition of the tissue on the side indicated.



Evaluate the patient's right heel.

✕ ○ Normal tissue
CHARACTERISTICS: Intact; Blanchable; No blistering; Similar to adjacent areas.

✕ ○ Stage I
CHARACTERISTICS: Intact skin; Non-blanchable redness in a localized area; Typically seen over a bony prominence; Areas may be painful, firm, soft, warmer or cooler than adjacent areas; Darkly pigments skin may not have visible blanching, color, however, may differ from surrounding area. Stage I may be difficult to detect in individuals with dark skin tones.

✕ ○ Stage II
CHARACTERISTICS: Partial loss of dermal thickness; Wound appears as a shallow, shiny or dry, open ulcer; Wound bed is red-pink; No slough; No bruising; May also present as a blister – open/ruptured serum-filled or sero-sanginous; NOT tears, tape burn, incontinence-associated dermatitis, maceration, or excoriation.

✕ ○ Stage III
CHARACTERISTICS: Full thickness dermal loss; Subcutaneous fat may be visible but NOT bone, tendon, or muscle; If slough present, does not obscure depth of tissue loss; May include undermining and tunneling; Depth varies by anatomical location – bridge of nose, ear, occiput, and malleolus ulcers may be shallow but areas of extreme adiposity can be very deep.

✕ ○ Stage IV
CHARACTERISTICS: Full thickness dermal loss; Exposed bone, tendon, or muscle; Slough or eschar may be present; Often includes undermining and tunneling; Depth varies by anatomical location – bridge of nose, ear, occiput, and malleolus ulcers may be shallow but areas of extreme adiposity can be very deep; May extend into muscle and/or supporting structures such as fascia, tendon or joint capsule; Osteomyelitis or osteitis likely to occur; Exposed bone or muscle visible or directly palpable.

✕ ○ Unstageable
CHARACTERISTICS: Full thickness dermal loss with actual depth completely obscured by slough and or eschar; When enough slough/eschar removed to expose wound base and determine true wound depth, wound will be either Stage III or IV. Stable (dry, adherent, intact without erythema or fluctuance) eschar on the heels is "the body's natural (biological) cover" and should not be removed.

✓ ◉ Suspected Deep Tissue Injury SDTI
CHARACTERISTICS: Skin intact; Purple/maroon localized discoloration or blood-filled blister; May be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler compared to adjacent skin; May be difficult to detect in dark skin. Evolution: May include a thin blister over a dark wound bed; May become covered by thin eschar; May rapidly expose additional layers of tissue despite optimal treatment.

Continue

Figure 40. View of the DS MCQ Node after learner has made a selection. Correct answers are indicated by a green check mark; incorrect answers are preceded by a red "x." The author can optionally set the node to have all answers appear after the learner's initial choice or have them appear one by one, allowing the learner multiple tries to arrive at the correct answer.

Appendix N

Extended Free Text DS-Node

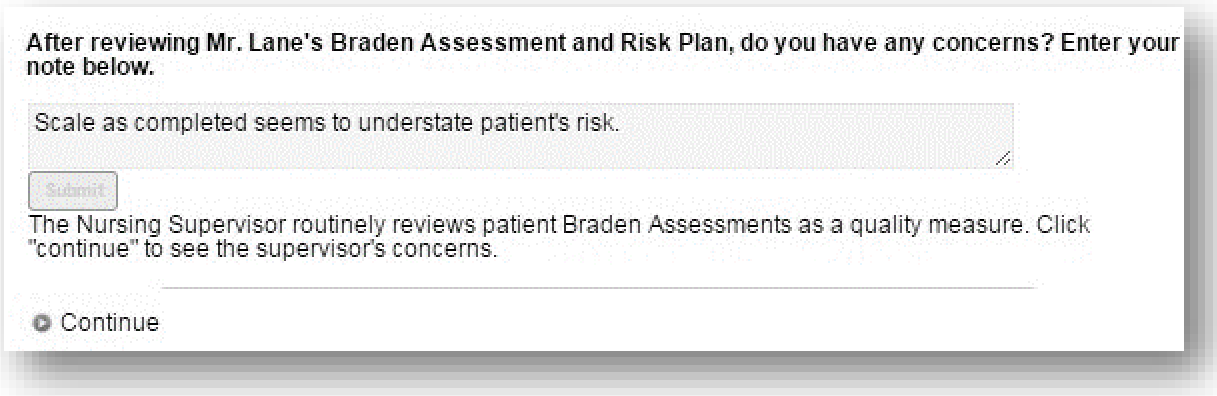


Figure 41. Modified use of DS free text node. Learners enter their response and click "submit." Feedback refers learners to a fresh DS-node to receive more intensive feedback, including media and hyperlinked resources, than the standard, text only, feedback box of the DS-node accommodates. See Figure 42 for an example of the extended feedback linked from this free text DS-node.

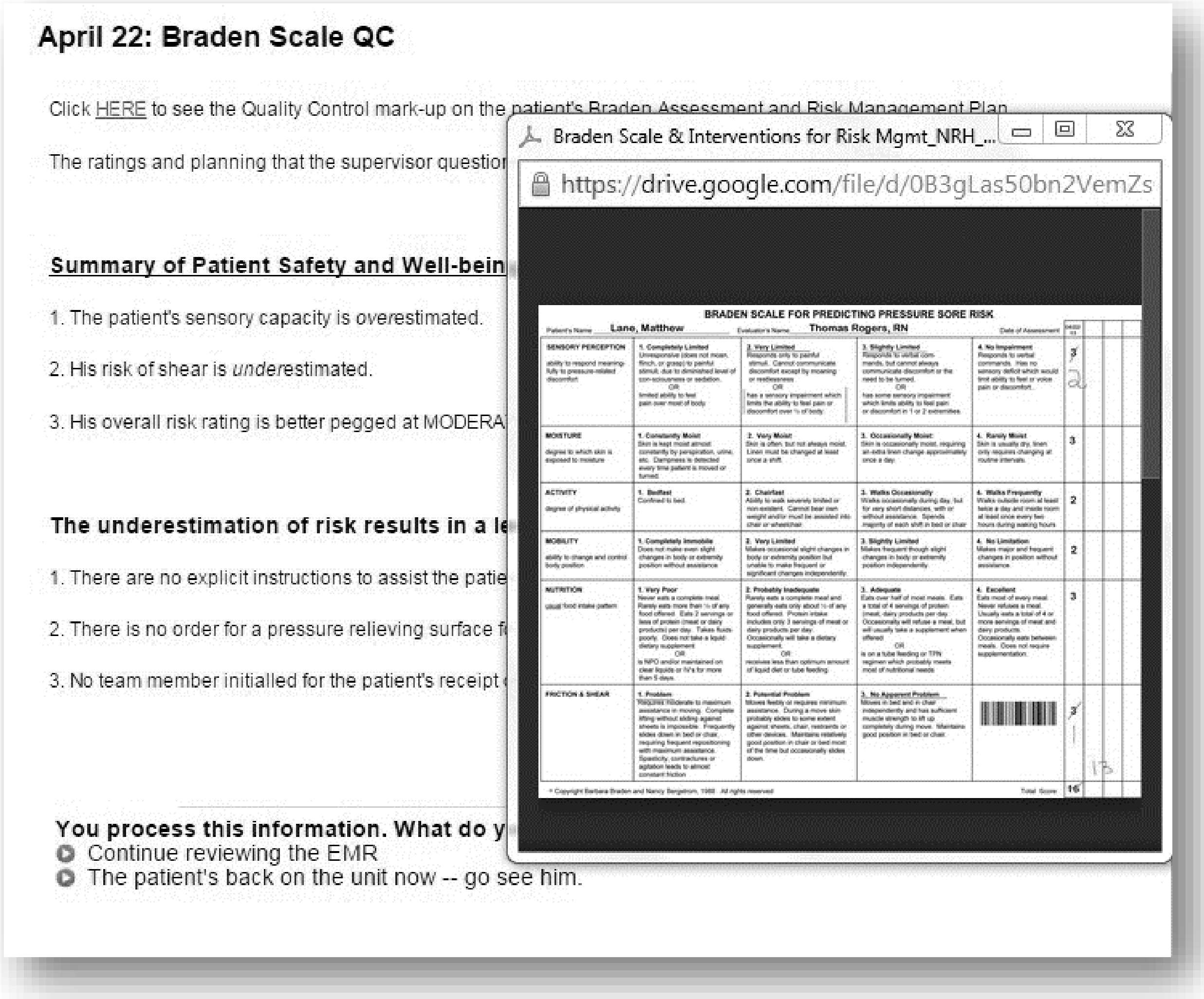


Figure 42. Feedback and resources linked to DS free text node displayed in Figure 41. Learners receive a detailed, model response to the question asked in the parent DS node (Figure 41). The Braden Scale with errors marked up in red (pop out) is provided as a hyperlink ("Click HERE") from the extended feedback node.

Appendix O

Branching Logic DS-Nodes

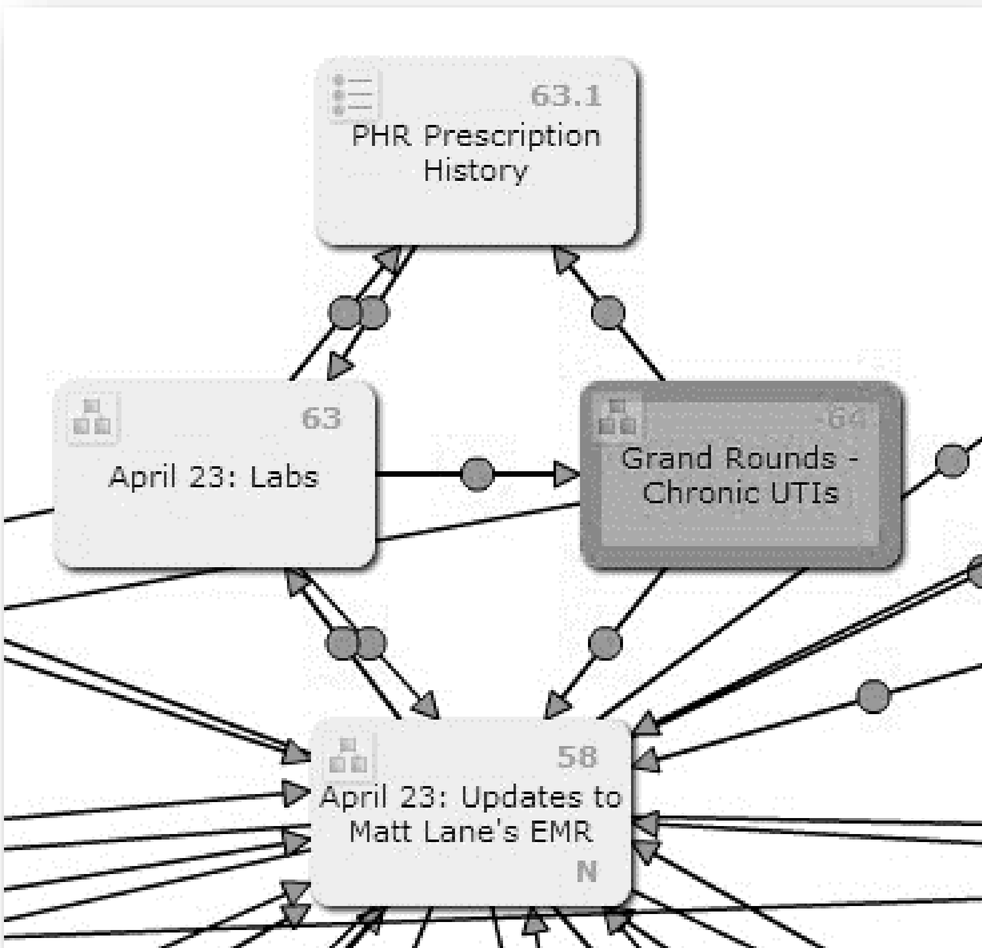


Figure 43. Case map view of the exemplar, DS branching logic node, *Grand Rounds – Chronic UTIs* (64). This node is reached from *April 23: Labs* (63), and provides the learner the choice of reviewing the patient's *PHR (personal health record) Prescription History* (63.1) to explore prior treatment of urinary tract infections by care providers outside of the care system where he is currently admitted. The learner can also go directly back to reviewing the patient record at *April 23: Updates to Matt Lane's EMR*.

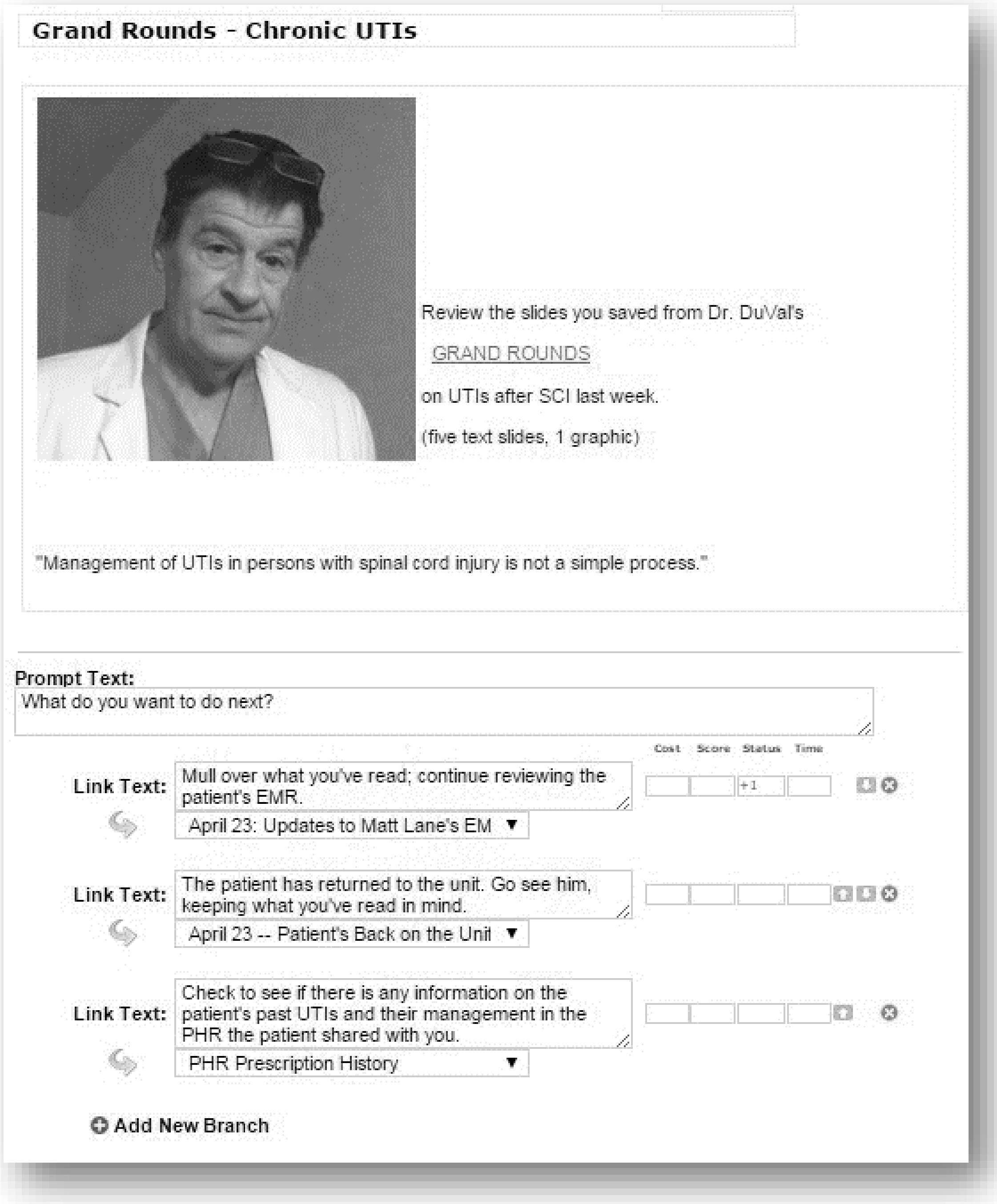


Figure 44. Under-the-hood view of Grand Rounds – Chronic UTIs. Learners earn an additional point for continuing to review the patient record. If learners choose to gather more information by visiting *PHR Prescription History*, additional points are assigned within that node's activities.

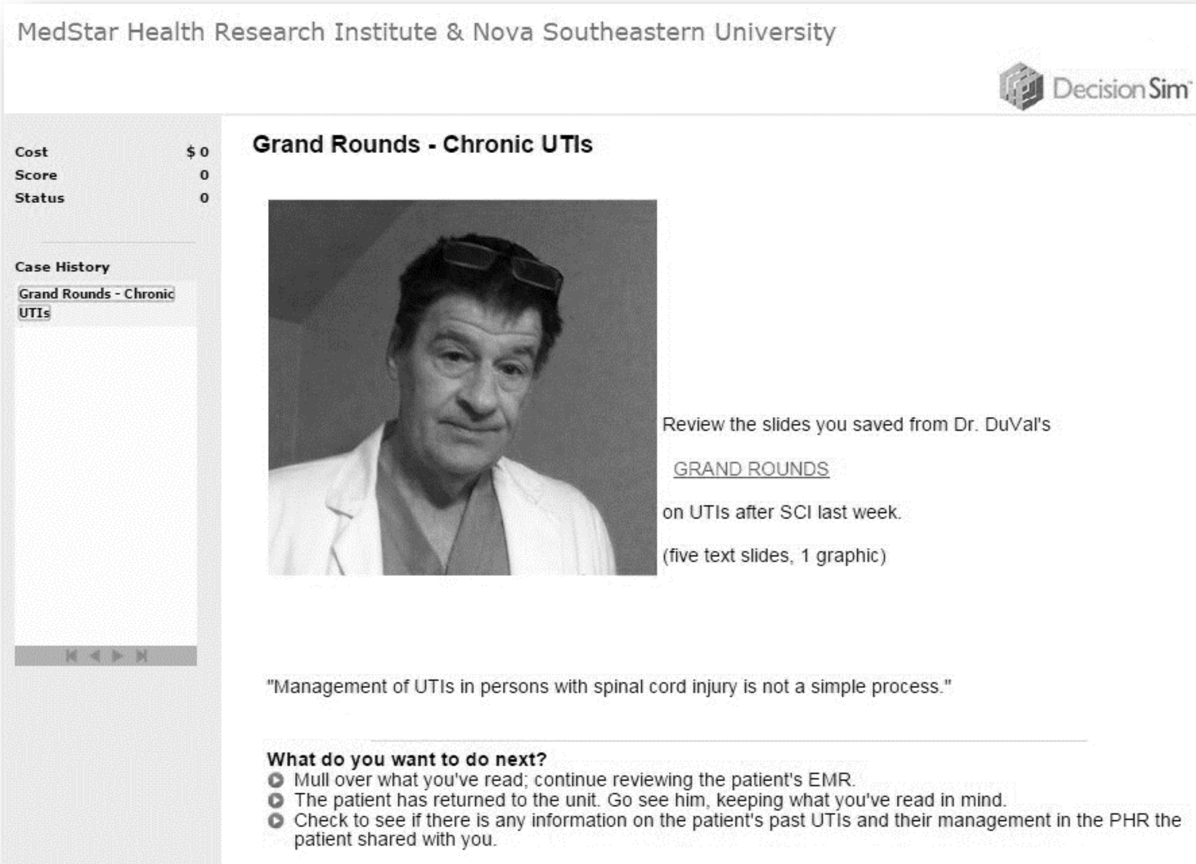
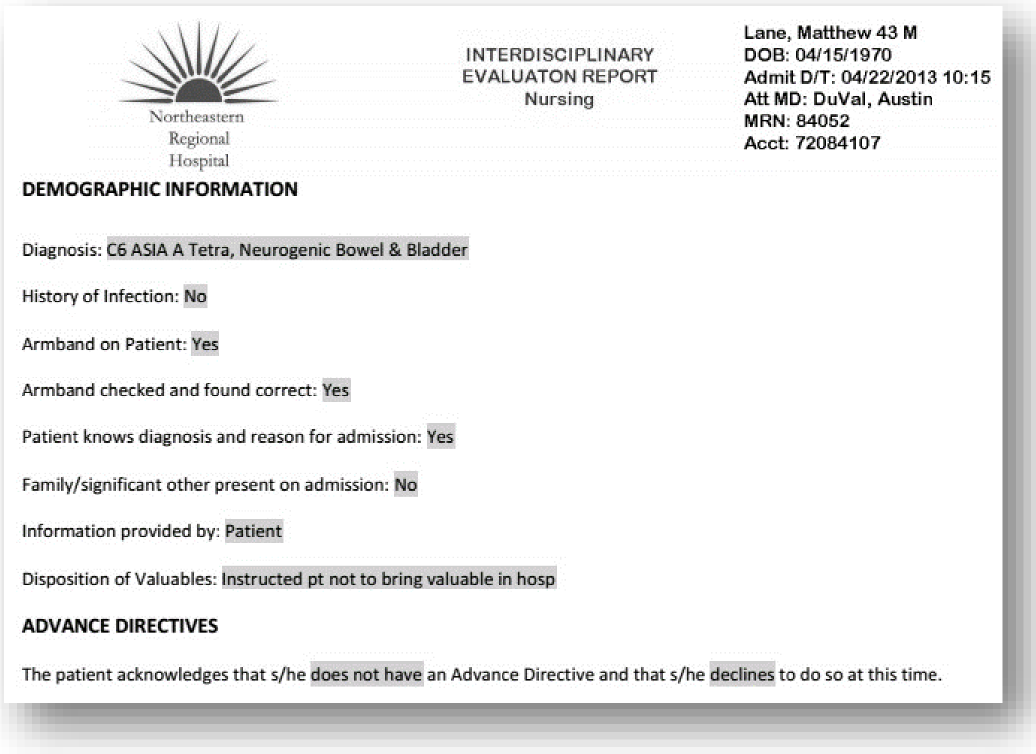


Figure 45. Grand Rounds – Chronic UTIs branching logic node learner view. Learners select from three possible next actions by clicking on the choices, indicated by green arrows, presented at the bottom of the display.

Appendix P

Sample Documents Constructed for the *Matt Lane* VP from Authentic Clinical Artifacts



Northeastern Regional Hospital

INTERDISCIPLINARY EVALUATON REPORT
Nursing

Lane, Matthew 43 M
DOB: 04/15/1970
Admit D/T: 04/22/2013 10:15
Att MD: DuVal, Austin
MRN: 84052
Acct: 72084107

DEMOGRAPHIC INFORMATION

Diagnosis: C6 ASIA A Tetra, Neurogenic Bowel & Bladder

History of Infection: No

Armband on Patient: Yes

Armband checked and found correct: Yes

Patient knows diagnosis and reason for admission: Yes

Family/significant other present on admission: No

Information provided by: Patient

Disposition of Valuables: Instructed pt not to bring valuable in hosp

ADVANCE DIRECTIVES

The patient acknowledges that s/he does not have an Advance Directive and that s/he declines to do so at this time.

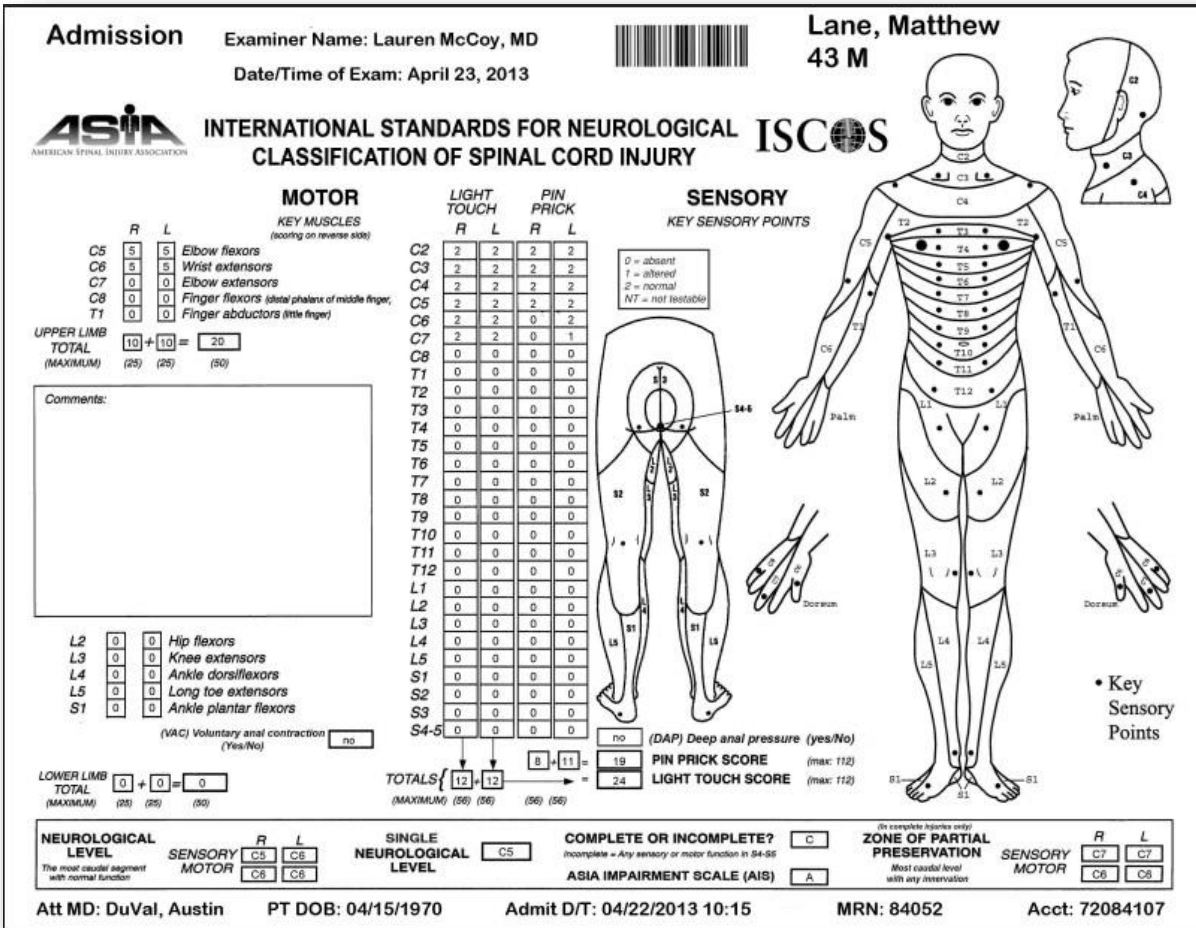
Figure 46. Interdisciplinary Evaluation Report replicating the authentic report from which information content for the Matt Lane VP was drawn.

BRADEN SCALE FOR PREDICTING PRESSURE SORE RISK

Patient's Name **Lane, Matthew** Evaluator's Name **Thomas Rogers, RN** Date of Assessment

					04/22/13			
SENSORY PERCEPTION ability to respond meaning-fully to pressure-related discomfort	**1. Completely Limited** Unresponsive (does not moan, flinch, or grasp) to painful stimuli, due to diminished level of con-sciousness or sedation. OR limited ability to feel pain over most of body	**2. Very Limited** Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness OR has a sensory impairment which limits the ability to feel pain or discomfort over ½ of body.	**3. Slightly Limited** Responds to verbal com-mands, but cannot always communicate discomfort or the need to be turned. OR has some sensory impairment which limits ability to feel pain or discomfort in 1 or 2 extremities.	**4. No Impairment** Responds to verbal commands. Has no sensory deficit which would limit ability to feel or voice pain or discomfort..	**3**			
MOISTURE degree to which skin is exposed to moisture	**1. Constantly Moist** Skin is kept moist almost constantly by perspiration, urine, etc. Dampness is detected every time patient is moved or turned.	**2. Very Moist** Skin is often, but not always moist. Linen must be changed at least once a shift.	**3. Occasionally Moist:** Skin is occasionally moist, requiring an extra linen change approximately once a day.	**4. Rarely Moist** Skin is usually dry, linen only requires changing at routine intervals.	**3**			
ACTIVITY degree of physical activity	**1. Bedfast** Confined to bed.	**2. Chairfast** Ability to walk severely limited or non-existent. Cannot bear own weight and/or must be assisted into chair or wheelchair.	**3. Walks Occasionally** Walks occasionally during day, but for very short distances, with or without assistance. Spends majority of each shift in bed or chair	**4. Walks Frequently** Walks outside room at least twice a day and inside room at least once every two hours during waking hours	**2**			
MOBILITY ability to change and control body position	**1. Completely Immobile** Does not make even slight changes in body or extremity position without assistance	**2. Very Limited** Makes occasional slight changes in body or extremity position but unable to make frequent or significant changes independently.	**3. Slightly Limited** Makes frequent though slight changes in body or extremity position independently.	**4. No Limitation** Makes major and frequent changes in position without assistance.	**2**			
NUTRITION usual food intake pattern	**1. Very Poor** Never eats a complete meal. Rarely eats more than ⅓ of any food offered. Eats 2 servings or less of protein (meat or dairy products) per day. Takes fluids poorly. Does not take a liquid dietary supplement OR is NPO and/or maintained on clear liquids or IV's for more than 5 days.	**2. Probably Inadequate** Rarely eats a complete meal and generally eats only about ½ of any food offered. Protein intake includes only 3 servings of meat or dairy products per day. Occasionally will take a dietary supplement. OR receives less than optimum amount of liquid diet or tube feeding	**3. Adequate** Eats over half of most meals. Eats a total of 4 servings of protein (meat, dairy products per day. Occasionally will refuse a meal, but will usually take a supplement when offered OR is on a tube feeding or TPN regimen which probably meets most of nutritional needs	**4. Excellent** Eats most of every meal. Never refuses a meal. Usually eats a total of 4 or more servings of meat and dairy products. Occasionally eats between meals. Does not require supplementation.	**3**			
FRICTION & SHEAR	**1. Problem** Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity, contractures or agitation leads to almost constant friction	**2. Potential Problem** Moves feebly or requires minimum assistance. During a move skin probably slides to some extent against sheets, chair, restraints or other devices. Maintains relatively good position in chair or bed most of the time but occasionally slides down.	**3. No Apparent Problem** Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair.		**3**			
				Total Score	**16**			

Figure 47. Braden Scale evaluating a patient for pressure ulcer risk. This artifact is reproduced exactly from the medical record of the patient on whom Matt Lane was modeled. The completing RN is pseudomized.



Admission Examiner Name: Lauren McCoy, MD
Date/Time of Exam: April 23, 2013
Lane, Matthew
43 M

ASIA — American Spinal Injury Association

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY ISCOS

MOTOR KEY MUSCLES (scoring on reverse side)

	R	L	
C5	5	5	Elbow flexors
C6	5	5	Wrist extensors
C7	0	0	Elbow extensors
C8	0	0	Finger flexors (distal phalanx of middle finger)
T1	0	0	Finger abductors (little finger)

UPPER LIMB TOTAL (MAXIMUM): 10 (25) + 10 (25) = 20 (50)

Comments:

	R	L	
L2	0	0	Hip flexors
L3	0	0	Knee extensors
L4	0	0	Ankle dorsiflexors
L5	0	0	Long toe extensors
S1	0	0	Ankle plantar flexors

(VAC) Voluntary anal contraction (Yes/No): no

LOWER LIMB TOTAL (MAXIMUM): 0 (25) + 0 (25) = 0 (50)

SENSORY KEY SENSORY POINTS

0 = absent
1 = altered
2 = normal
NT = not testable

	Light Touch R	Light Touch L	Pin Prick R	Pin Prick L
C2	2	2	2	2
C3	2	2	2	2
C4	2	2	2	2
C5	2	2	2	2
C6	2	2	0	2
C7	2	2	0	1
C8	0	0	0	0
T1	0	0	0	0
T2	0	0	0	0
T3	0	0	0	0
T4	0	0	0	0
T5	0	0	0	0
T6	0	0	0	0
T7	0	0	0	0
T8	0	0	0	0
T9	0	0	0	0
T10	0	0	0	0
T11	0	0	0	0
T12	0	0	0	0
L1	0	0	0	0
L2	0	0	0	0
L3	0	0	0	0
L4	0	0	0	0
L5	0	0	0	0
S1	0	0	0	0
S2	0	0	0	0
S3	0	0	0	0
S4-5	0	0	0	0
TOTALS (MAXIMUM)	12 (56)	12 (56)	8 (56)	11 (56)

(DAP) Deep anal pressure (yes/No): no
PIN PRICK SCORE (max: 112): 19
LIGHT TOUCH SCORE (max: 112): 24

• Key Sensory Points

NEUROLOGICAL LEVEL (The most caudal segment with normal function): SENSORY R C5, L C6; MOTOR R C6, L C6
SINGLE NEUROLOGICAL LEVEL: C5
COMPLETE OR INCOMPLETE? (Incomplete = Any sensory or motor function in S4-S5): C
ASIA IMPAIRMENT SCALE (AIS): A
ZONE OF PARTIAL PRESERVATION (In complete injuries only; Most caudal level with any innervation): SENSORY R C7, L C7; MOTOR R C6, L C6

Att MD: DuVal, Austin PT DOB: 04/15/1970 Admit D/T: 04/22/2013 10:15 MRN: 84052 Acct: 72084107

Figure 48. ASIA neuro-assessment of the patient on whom Matt Lane was modeled reproduced for the VP. The completing physician is pseudomized.

Appendix Q

Learner Desktop While Interacting with *Matt Lane*

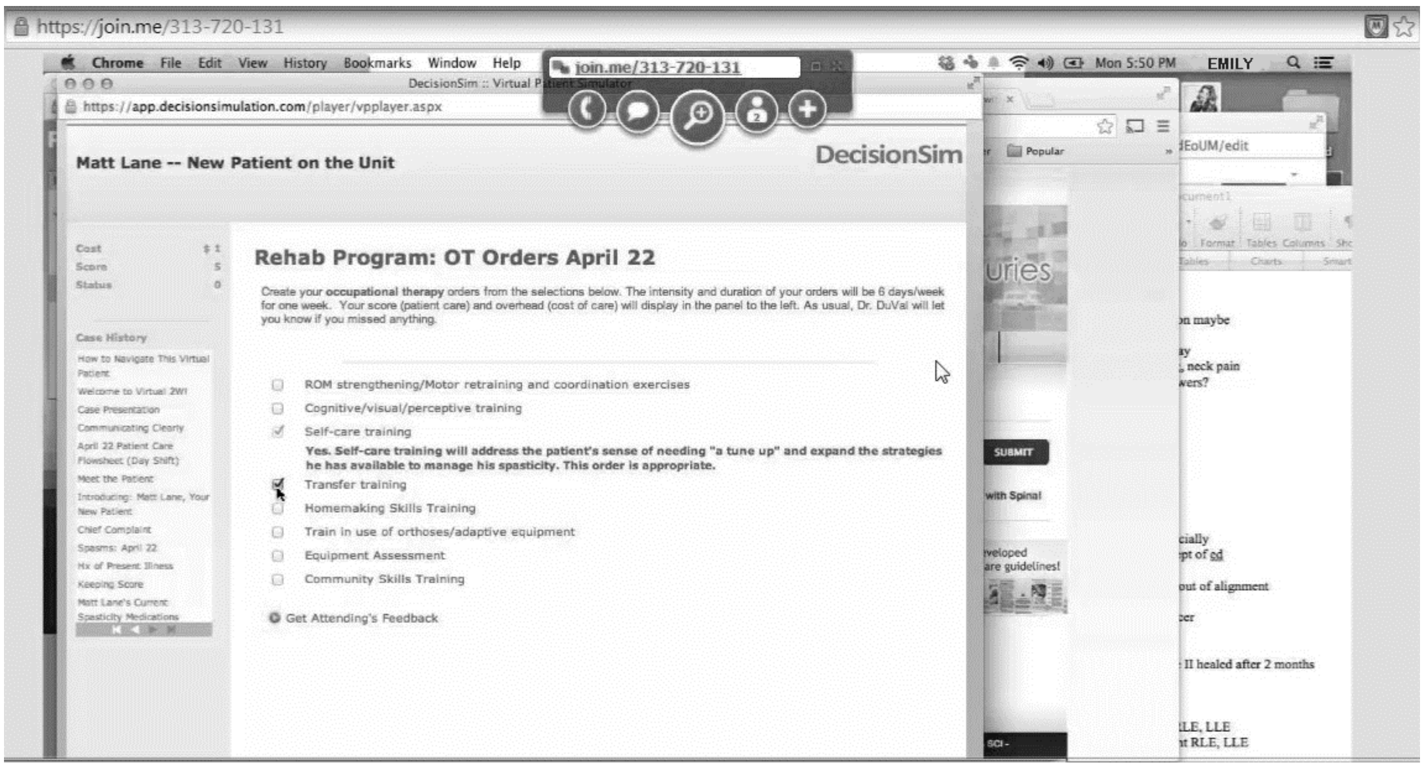


Figure 49. Learner windows top to bottom: 1) current Matt Lane activity, 2) hyperlinked lecture retrieved from last DS-note visited, 3) word-processing application with learner's notes on Matt Lane, 4) activity learner was engaged in before pulling up the VP, 5) learner's Mac desktop

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