Nursing Informatics Competency:
Assimilation into the Sociotechnical Culture on Healthcare Technology and Understanding of Safety Culture

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Chapter 1

Introduction

Healthcare organizations require a high-level of safety and structured management policies towards health information technology (health-IT), including the implementation, adoption, and usage that guide and support healthcare workers as they interact with technology in their clinical workflow. Health information technology broadly encompasses the digitalization of clinical information using hardware, software, and databases to record, store, and securely retrieve data to be accessed by bedside providers and hospital administration to evaluate and perform care (Health-IT, 2021). The overarching goal of health-IT (e.g., electronic health record, telemetry monitors, intravenous infusion pumps etcetera) is to improve the safety, effectiveness, and quality of care to patients. Health-IT has the potential to help nurses manage complex patient conditions by improving access to healthcare information and improved communication among care providers (Wu, 2010). Health-IT is implemented into healthcare organizations comprised of a sociotechnical culture which shapes the interaction between people and their experience with technology to deliver care. To competently perform nursing care at a high level while maintaining patient safety, newly hired graduate nurses need to understand each organization's unique sociotechnical culture and how this culture shapes their nursing behaviors towards health-IT usage and safety competency.

Nursing students during their formative instruction years are exposed to a wide variety of health-IT products while training and little is known about the type of exposure that students experience and their awareness of safe practice in utilizing them (Whitt et al., 2017). Having a formalized nursing informatics course can bolster students' capabilities to understand the usefulness of health-IT towards patient care and how the safety culture of hospital units can have

a powerful influence on their safe usage of health-IT in practice. As students learn to be informatically competent, they need to be able to interact in the sociotechnical culture to learn the complicated usage and limitations of health-IT in the clinical context as a necessary skill. Clinical site training and exposure to the social interaction occurring on hospital units between nurses, physicians, and staff are critical for students to develop the proper knowledge and skills to utilize health-IT safely as they transition from novice to expert nurses.

Students prolonged exposure to the sociotechnical culture of the clinical environment is a means to promote quicker assimilation of the safe use of health-IT as they begin to develop their professional skills and become effective safe practitioners. The purpose of this study will be to explore the link between informatics competency, immersion into complex healthcare systems sociotechnical culture and how these factors shape and influence nursing student's behaviors in using health-IT and their understanding of patient safety.

Health Information Technology (Health-IT)

In today's technology-driven era, it is hard to imagine providing healthcare to patients without the use of health-IT. Within healthcare, integration of health-IT usage such as clinical decision support (CDS), clinical information systems, telehealth applications, and clinical data repositories are used to support interdisciplinary collaboration to coordinate care and guide practice (Locsin, 2005, Health-IT, 2021). Healthcare professionals employ health-IT systems to improve efficiency and communication, but more importantly, to assist providers by improving patient care outcomes in a cost-effective manner (Chang et al., 2011; Eley et al., 2008; McGongile & Masterian, 2015). Healthcare providers need to leverage health-IT not only to function effectively in contemporary healthcare, but also to help transform practice in general. It is imperative for healthcare professionals to possess the skills, attitudes, and information

technology (IT) competencies to operate safely and effectively in today's technology-laden care environments (Eley et al., 2008). Nurses and nursing students need to apply their skills, attitudes, and knowledge regarding health-IT to decrease patient exposure to risks and unnecessary harm (Abdrbo, 2015). Failure by the healthcare professional to develop the necessary health-IT competencies can compromise patient safety and result in ineffective patient care.

Health-IT usage, while considered to be a solution for improvements to patient safety, still has inherent risks associated with its adoption and implementation. Patient safety remains one of the foremost problems facing the U.S. healthcare system, where adverse events (i.e., unintentional harm caused by medical treatment) have been reported to cause more than a million injuries annually and cost $3.5 billion in additional medical costs (Clarke et al., 2014, Kuo et al., 2020). Medical errors have been estimated to cause 251,000 deaths annually in the US making medical errors the third leading cause of death (Anderson & Abrahamson (2017). The goal of health-IT usage is to improve patient safety by eliminating preventable patient harm through an improved healthcare system and find solutions when harm is traditionally considered unpreventable (Hydari et al., 2014). In response to improving patient safety and patient outcomes, hospital systems have begun system-wide improvements aimed at preventing errors and improving efficiencies through the implementation of clinical information systems, specifically using health-IT applications such as clinical decision support systems (CDSS), computerized order entry (CPOE), and bar-code medication administration (BCMA). If adopted properly and when paired with current evidence-based best practices and Just Culture, health-IT is widely believed to not only enhance patient safety, but also improve clinician access to health information, increase efficiencies, and promote positive patient experiences (Clarke et al., 2014; Hydari, 2014). However, failure to optimize interaction with health-IT to integrate it with clinical workflows, processes, and communication

can lead to healthcare system vulnerabilities and result in latent conditions contributing to sentinel safety events (Castro et al., 2016). To help achieve the benefits and alleviate risks associated with health-IT hospital systems need to foster and follow a culture of safety.

Safety Culture

While health-IT usage from a clinical perspective can improve the efficiency of care for patients, having a safety culture in place provides a means to inform the hospital systems of potential safety concerns. Unfortunately, only 10 percent of medical errors are even reported, decreasing the ability for the system to learn from mistakes and to make strategic improvements for improving safety (Anderson & Abrahamson (2017). The concept of safety culture was first established within organizations that conducted complex, hazardous work with minimal adverse events (AHRQ, 2019). The culture of safety contains key elements including a) acknowledgment that the organization provides high-risk activities and is committed to achieving safe operations, b) creation of a non-punitive reporting system of errors or near misses, and c) organizational commitment to allocate resources to address safety concerns (AHRQ, 2019). Extended in the aftermath of devastation caused by the Chernobyl disaster, the concept of safety culture in hospitals is achieved by the shared perception among managers and staff concerning the importance of safety (Shirali et al., 2018). Achieving safety in a system requires understanding that safety is a system property which emerges from assimilation of health-IT components, subsystems, software, hardware, organization, and human behavior and their interactions. Shirali and colleagues (2018) describe safety as something that a system or the organization *does* versus something that a system or organization *has*. Organizational decision-makers need a holistic understanding of all factors that influence the safety and functionality of the health-IT product they select to ensure a comprehensive strategy is used.

One cornerstone of a comprehensive safety culture is to develop a *Fair and Just Culture* in the organization (AHRQ, 2019; Frankel et al., 2006; Mrayyan, 2022). A Fair and Just Culture is often referred to as *Just Culture* and is the notion that everyone contributes to the safety culture, and the organization can only learn and improve by openly identifying its own weaknesses (Frankel et al., 2006). Of critical importance is that healthcare providers feel supported and safe when voicing concerns regarding their own actions or those in the work environment around them. If a Just Culture is to be realized, healthcare workers need to know they will be supported by administration when reporting their actions good or bad and will be defended regardless of whether the health-IT ecosystem is at fault. However, if staff feel they are unfairly penalized by administration when reporting errors or near misses, they may be reluctant to report issues in the future, resulting in lack of awareness of an issue and increasing the risk of safety incidents from a poorly implemented safety climate. It is incumbent upon the entire organization (nursing students included) to understand that everyone is accountable for developing and maintaining an environment that feels psychosocially safe to report safety concerns. Failure by any party to adhere to this ethos will result in an unsafe environment lacking an effective mechanism to improve unsafe practices.

Nursing Informatics Competencies and Curriculum

To ensure public safety, entry into the practice of nursing is regulated by licensing authorities within each of the National Council of State Boards of Nursing (NCSBN) member boards in each state, commonwealth, and territory (NCSBN, 2019). The NCSBN develops a licensure examination, the National Council Licensure Examination for Registered Nurses (NCLEX-RN), that is organized into four major client needs categories that define entry-level actions and competencies for nursing practice, including safe and effective care environments,

health promotion and maintenance, psychosocial integrity, and physiological integrity. For pre-licensure nurses to be successful in passing NCLEX examination, educators need to ensure that nursing informatics competencies are addressed in the curriculum to improve delivery of patient-centered care (Yoon et al., 2009). Students must learn to use health-IT effectively, recognize its benefits and limitations, and integrate the technologies into the care they provide (McGonigle et al., 2018). Failure to effectively use and understand the benefits of health-IT will result in subpar nursing care and increase the likelihood of an adverse safety event (Aoyjai et al., 2021; Koppel et al., 2008). Therefore, students require exposure during clinical education to the concepts of nursing and application of the nursing processes in practice to safely perform in the role.

The American Association of Colleges of Nursing Essentials outline the required curricular content and expected competency for baccalaureate programs (AACN, 2022). The competency-based approach, specifically Domain-8: Informatics and Healthcare Technologies, "requires BSN programs to teach students how to gather clinical data, assimilate information to drive clinical decision making, manage and improve the delivery of safe care" (AACN, 2022). Entry-level competency requires nurses to use health-IT communication tools effectively and be competent in health information literacy used in the care of patients. In addition, students need to demonstrate basic navigation skills and understanding the importance of accurate data entry into the EHR, how to utilize mobile health applications, and demonstrating best practice in the use of social networking applications (AACN, 2022). Of critical importance is Domain 8.3f which "requires students to identify the importance of safe reporting system processes and functional issues (error messages, device malfunctions, poor human computer interfaces etc.) in accordance with organizational policies and procedures" (AACN, 2022). To maximize health-IT's potential benefits to safer nursing care, students need to develop their knowledge regarding the importance

of how a Just Culture is used to report potential adverse safety concerns when utilizing health-IT tools in practice.

To prepare students for competent practice in today's healthcare environment, it is vital for nursing education to develop student informatics competencies to ensure nurses practice to their fullest ability and use information and technology to communicate, mitigate error, and manage healthcare knowledge to ultimately support clinical decision making (Cronenwett et al., 2007; Hebda & Calderone, 2010; IOM, 2003). Nursing curriculum requires students to learn informatics principles, while the hands-on clinical training experience provides the medium to apply those concepts. The clinical training environment provides real-world context with health-IT usage e.g., information extraction through the EHR, interaction with CDSS to make informed clinical decision, and safely administering medication utilizing BCMA tools, coupled with the social interaction with patients and the interdisciplinary team members that help students formulate informatics and nursing skills to deliver safe effective care.

Complex Adaptive Systems

Safe nursing practice requires an understanding of how health-IT usage can benefit the patient but also contribute to adverse events in today's complex healthcare systems. Nursing students as part of their education are trained not only in the classroom but through clinical experiences that expose them to health-IT usage in the hospital systems. Healthcare institutions or hospital systems have been described as socially constructed complex adaptive systems (CAS) (Begun et al., 2003; Rouse, 2008; Sturmberg & Bircher, 2019). Complex adaptive systems provide a framework to help explain the intricate roles individuals, described as agents, interact with each other and within the environment that influences behaviors within a system (Carmichael & Hadzikadic, 2019).

Composed of a wide variety of interacting elements, including people, processes, and procedures, which are *adaptive* through the capacity to alter, change, and learn from their shared experiences, the healthcare system can be conceptualized as *complex*, or a complex adaptive system (CAS). Healthcare systems contain different, yet interrelated elements that can be connected or function independently to accomplish the primary mission of providing healthcare. Healthcare systems are comprised of many interdependent agents, including nurses, physicians, and staff, who are influenced not only by their interaction with each other, but also by a large number of interdependent elements such as patients, families, workflows, standard operating procedures, clinical practice guidelines, health-IT, and governance principles leveraged and organized by agents to provide care. These complex interactions to providing care are non-linear in nature and require emergent behaviors to adjust to the constant state of non-equilibrium in the system. Emergent behaviors can be described as required actions or interventions needed to achieve a positive outcome for patient care e.g., accepting or declining to follow a clinical decision support generated by health-IT based on the healthcare provider's judgment of the situation. Healthcare providers exposed to these fluctuating environments (for example, changes in patient condition) must respond accordingly to achieve stability in the system and patient. Stability is achieved by healthcare provider's (agents) interactions with each other and adaptations of their behaviors within the system, learned over time through self-organization. Learning how this complex process works in practice is critical for nursing students to experience to assist them in developing the necessary skills as a nurse to work in the healthcare environment.

Even with implementation of administrative governance principles to control behaviors in a top-down manner to constrain behaviors in the system, CAS have a strong tendency for staff members to learn, adapt, and self-organize to accomplish patient care from a bottom-up mentality

(Begun et al., 2003; Rouse, 2008; Sturmberg & Bircher, 2019). Taken together, there is a balance between an administration's top-down perspective to limit bottom-up emergent behaviors, and system requirements that demand staff to self-organize behaviors among themselves to bring about needed actions to accomplish care. This complex web of interactions between healthcare team members and interdependent elements (designed to govern behaviors) makes it difficult to delineate specific components into a hierarchical decomposition of CAS. In other words, it is challenging to identify and study complex system components and interpret results to understand how the complete system functions (Sittig & Singh, 2010). To address this, Sittig & Singh (2010) describe a sociotechnical model to study the design, development, use, implementation, and evaluation of health-IT. This model is composed of 'eight-dimensions' viewed sequentially as part of the complex adaptive systems they represent (Sittig & Singh, 2010). As pre-licensure students (or new hires) entering a CAS they need to learn and navigate these unique dynamic behaviors and interacting roles with people, procedures, and health-IT as they assimilate into the sociotechnical care environment to become effective healthcare providers.

Sociotechnical Culture

An additional barrier for nursing students to overcome in learning proper safe use of health-IT in CAS is the relationship between themselves and the clinical staff nurses. As an organization, shared values, norms, and beliefs regarding safety culture and health-IT can influence healthcare workers' behaviors (Mrayyan, 2022). For a cohesive, high functioning healthcare system, each unit in the hospital often develops an informal sociotechnical culture, forming a unique, socially constructed bond among the staff nurses helping them to accomplish tasks together (Leonardi & Barley, 2010, Sittig & Singh, 2010). As nurses work with Health-IT in a CAS they interact with not only the technology but with people, processes, organizational elements, and the external

environment to make clinical decision based on the best information (Castro et al., 2016). This unique social culture self-organizes through creation of unit rules, written or unwritten, specific to each work unit to help perform and navigate system dynamics to accomplish care. These informal rules may include behaviors such as using napkins to record vital signs versus using the approved documentation source (EHR). Unit members may reject new health-IT tools viewed as complicated or too time consuming when speed of delivering an intervention is required and patient care may be jeopardized. These informal sociotechnical aspects are critical for student nurses to experience to begin to apply concepts from the classroom to the bedside.

Nursing education courses are purposefully designed with both a didactic and clinical component to bridge content with practical application. It is through exposure to the clinical complex adaptive systems and exposure to the sociotechnical culture that students are able to view care processes and begin to formulate their own skills, attitudes, and behaviors to care for patients. It is through informatics content that students receive formalized training in the health-IT tools used in care and it is through the clinical experiences where they can learn from the sociotechnical culture to apply them safely. Successfully transitioning from novice nurse to expert nurse takes time, on average up to three years to reach maturation (Benner, 2020). Therefore, this study will explore the link between informatics competency and how clinical exposure to sociotechnical culture shapes pre-licensure students' behaviors in using health-IT and understanding of safety culture.

Sociotechnical Culture: Effects on Work Related Behaviors

Informal rules shared by the sociotechnical cultural result in staff behaviors adopted by the group that are not always consistent with organizationally approved procedures; healthcare agents will creatively and collectively change procedures to accomplish tasks perceived as in the best

interest of the patient. For example, team members may use a workaround behavior to alleviate a block or perceived block in a critical workflow to accomplish a desired task or achieve an intended clinical outcome. As Rouse (2008) relays, staff in CAS are intelligent, self-organized individuals who seek to accomplish tasks by using their collective sociotechnical structure to develop feedback loops to generate change to help navigate and perform their job effectively. As a complex phenomenon, workarounds can be problematic, but understanding employees/agents' intentions and shared strategies via their sociotechnical culture can help inform and benefit organizational policies (Barrett & Stevens, 2017; Ejnefjall & Agerfalk, 2019). However, workarounds or deviations from expected workflow behaviors are risky and have been linked to adverse patient events that jeopardize potential benefits of health-IT usage (Koppel et al., 2008).

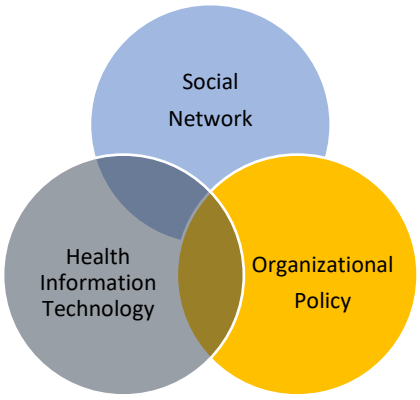
It is important to recognize that workers in CAS will co-construct and create informal sociotechnical networks among themselves to adapt to challenges associated with providing care (Barrett & Stevens, 2017; Rouse, 2008). Therefore, it is incumbent upon all members of the healthcare team from administration, clinicians, staff, and students to understand their unique sociotechnical culture and how it can exert a powerful influence on individual work behaviors. Moreover, organizational decision makers in complex adaptive systems who understand their unit's sociotechnical culture and can leverage the newly developing workflow behaviors are able to influence expected behaviors utilizing and valuing the stakeholder talents. Conversely, traditional management positions that dictate behaviors or policies to control individuals may lead to stakeholder resistance or reluctance to change behaviors or the reporting of issues with care policy (Barret & Stephens, 2017; Rouse, 2008; Sturmberg & Bircher, 2019). Resistance to change (adoption of new health-IT) occurs when the sociotechnical culture is not heard (failure to follow Just Culture) by leadership. Poor communication between the sociotechnical culture and

leadership regarding new clinical workflow recommendations or safety concerns with health-IT can lead to greater practice variability resulting in a missed opportunity to create a safer culture for patients and staff. Students through assimilation in the sociotechnical culture can learn about the procedures, processes, and usage of health-IT and how the sociotechnical culture interaction can either improve patient care or lead to adverse safety events.

Previous evaluations of using health-IT have focused primarily on the system's hardware and software usage, while human factors critical to successful health-IT use in CAS have not been adequately assessed, creating a gap in understanding the sociotechnical factors needed for optimal performance. Successful implementation of health-IT, normally evaluated using adoption rates, acceptance, or quality improvement initiatives, fails to account for complex sociotechnical interactions and contexts across organizations, leaving a limited understanding of health-IT success rates (Yen et al., 2017). Sociotechnical culture is a composite (see Figure 1) of the health-IT (e.g., hardware/software), social network, and non-technical aspects of interactions between human workflows, specifically the organizational policy designed to accomplish tasks (Abdrbo et al., 2009; Singh & Sittig, 2020).

Figure 1

Sociotechnical Culture



An individual's perceptions of the benefits of health-IT usefulness and compatibility with workflow processes are influential factors in facilitating the success or failure of health-IT adoption (Abdrbo et al., 2009; Gagnon et al., 2012). However, health-IT adoption and usage are influenced not only by an individual's perceptions of the usefulness of the technology, but also supported by the organizational sociotechnical culture of CAS. This, in turn, influences how individuals behave and interact with technology (Venkatesh et al., 2003). Shaped by interactions between people, people and procedures, and people and hardware/software components (human-computer interaction), an organization's sociotechnical culture can be a powerful determinant of individual perceptions towards health-IT usage and whether it is being used safely.

Assimilating Newly Hired Nurses into the Sociotechnical Culture

Healthcare organizations must recognize how their sociotechnical culture contributes to a safe work environment and consider how inexperienced staff members (newly graduated nurses) are assimilated into their culture to ensure provision of safe care. Socialization is a process by which people learn the roles, norms, and skills necessary to form relationships to organize and solve problems cooperatively (Sruthi et al., 2021). In addition, schools of nursing and their faculty who prepare nursing students for work in hospitals and healthcare organizations aim to meet both the educational objectives of the academic program and preparation of nurses for appropriate behaviors in the workplace. However, industry experts agree there is a significant gap between new graduates' abilities when making the transition from the classroom and the demands of registered nurses at the bedside, commonly referred to as the preparation-practice gap (Benner, 2020; Grochow, 2008; Hickerson et al., 2016). Ninety percent of nursing faculty are satisfied with students' progress to make the transition to practice while only 10% of hospital-based nurse administrators convey that new nurses are adequately prepared to care for patients after graduation

(Hickerson et al., 2021). This practice gap has been reported as a possible contributor to high stress levels among novice nurses, as well as increased turnover rates, cost to employers, and patient safety events (Hickerson, 2016). Further complicating the practice gap is the socialization process of nursing student assimilation into the safety culture by adopting the required norms, values, and skills for professional survival (Shruthi et al., 2021).

A study by Walker et al., (2020) found students' scores on Just Culture declined at the end of their program as students perceived error reporting as 'tattling' on others and discouraged each other from using the error reporting systems. It is theorized that declines in positive perceptions of Just Culture behavior result from increased exposure to healthcare's clinical culture. Students' maturation throughout the nursing program becomes assimilated with the experiences of the clinical organization's culture they experience influencing their perceptions.

Receiving a positive introduction to and learning about the existence of the sociotechnical culture is paramount to the success of new graduate nurses and can be a mechanism to help reduce this practice gap through improvement of informatics competency and views on safety culture. Rooyen et al, (2019) stated several factors to smooth the transition from graduate to professional nurse including a supportive and positive organizational culture that values learning, proper matching of preceptors and mentors, and collaboration between healthcare and educational institutions.

Narrowing the transition gap for new nurses depends upon successful assimilation into the sociotechnical culture, allowing new nurses to comfortably ask questions and seek guidance from experienced peers as a mechanism to reduce knowledge deficits and errors by properly performing given tasks when using health-IT. Nurse educators must recognize and prepare future care providers for this pivotal sociotechnical culture and its importance to their success in the nursing

workforce. New graduate nurses must also realize that although the sociotechnical culture exists to support them, negative consequences such as exposure to workarounds or other social structural pressure may lead to learning improper behaviors such as ignoring clinical decision support warnings. Thus, for new nurses, understanding the organization's safety culture and the influence of the sociotechnical culture are key to optimizing health-IT usage and maintaining patient safety when transitioning into the role of the registered nurse. Therefore, increasing the students nurse exposure to the sociotechnical environment is a strategy to improve informatics and safety competency.

Problem Statement

To achieve the goal of a safer healthcare ecosystem for patients, workforce members need to perform informatics competencies at an elevated level. Future nurses depend on nursing faculty to assist them with development of needed skills and attitudes to function effectively upon graduation and transition to practice. It is incumbent upon faculty to teach the necessary informatics competencies and the concept of safety culture required of nurses to care for patients using health-IT. However, learning to apply informatics and safety competency requires proper assimilation and application of these principles in the sociotechnical clinical environments. Therefore, the proposed study will explore the relationship between nursing informatics competencies and how assimilation into the sociotechnical culture may be associated with both informatics and safety competencies (Figure 2).

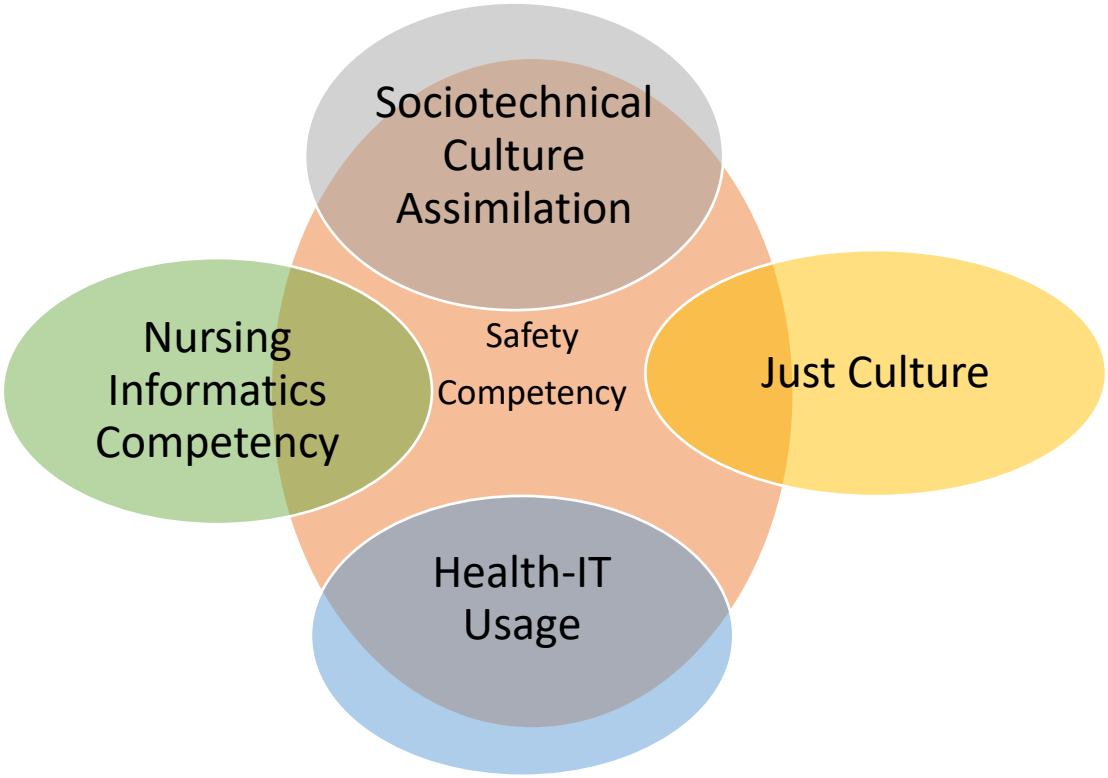
Practical Implications

This study will explore current BSN students informatics competency and whether having a formal informatics course implemented into their education program is associated with a higher level of informatics competency versus having the required informatics competencies weaved into

the overall curriculum. It is theorized that having a formally dedicated informatics course will allow for a deeper understanding of the concepts of health informatics and the necessary competencies required for practice. Nurses trained with the basic skills and abilities in health-IT usage (informatics competency) will likely be associated with promoting safer care practices. In addition, the results of the study can be used by nursing education to advocate for students to seek prelicensure employment to strengthen their informatics and safety competency by spending more professional time in a clinical setting, thereby exposing themselves to the sociotechnical culture to begin the professional clinical maturation process. Healthcare organizations can be informed of how students' exposure to the hospital staff's sociotechnical culture on the clinical units is associated in transitioning prelicensure nurses into practice. Safety competency and informatics competency will be measured, and a predictive model will be developed to inform nursing education regarding the factors that help shape students' perceptions of informatics and safety competency (Figure 4).

Figure 2

Factors in Safety Competency Model

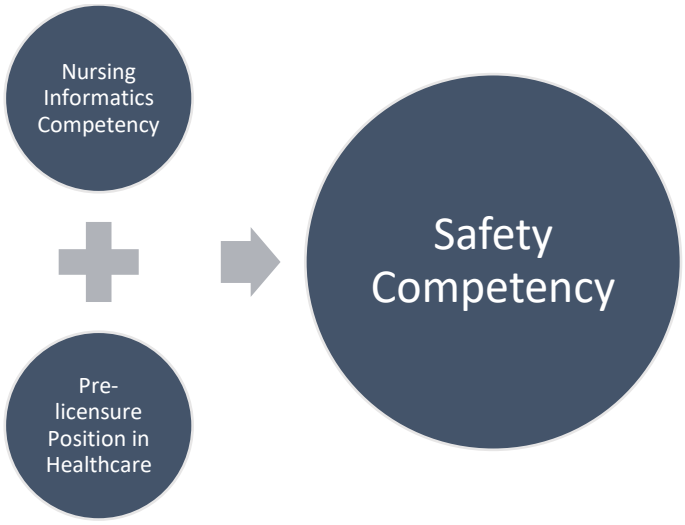


Purpose

The purpose of this cross-sectional study is to explore the relationship between pre-licensure nurses' perceived nursing informatics competencies and increased exposure to the sociotechnical culture, through pre-licensure clinical experience in modern complex adaptive health systems and the association to both informatics and safety competencies scores (Figure 3).

Figure 3

Model of Safety Competency



Research Questions

Research questions (Figure 4) to be answered by this study are as follows:

RQ1: What is the level of nursing informatics competency and safety competency among pre-licensure nursing students?

H1: There will be a difference in scores between nursing informatics competency and safety competency with having a nursing informatics course.

H2: There will be a difference in scores between nursing informatics competency and safety competency with having a pre-licensure position in healthcare.

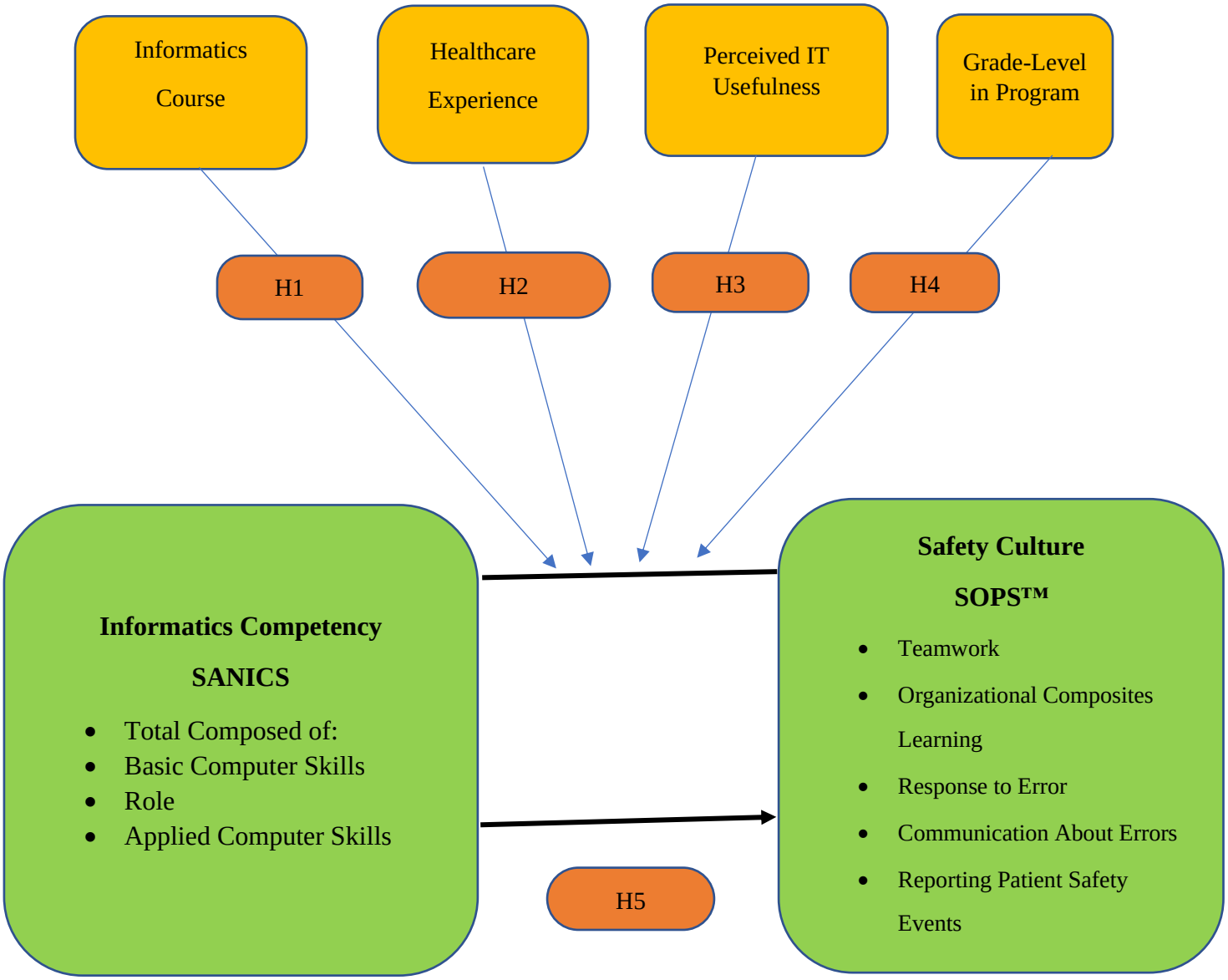
H3: Higher perceived usefulness of information technology will be associated with higher nursing student informatics competency and safety competency.

H4: Higher BSN grade level will be associated with higher nursing student informatics competency and safety competency.

H5: Higher student nurse informatics competency will predict higher nurse safety competency.

Figure 4

Measurement Model for Patient Safety Competencies



Chapter 2

Review of the Literature

Safety Culture and Hospital Safety Culture Survey

As hospital systems continue to strive for patient safety and quality patient care, a culture of safety is needed to meet these goals (AHRQ, 2019). Creating and fostering a culture of safety requires leadership, healthcare workers, and staff to understand the organization's values, beliefs, and norms about appropriate behaviors, attitudes, and expectations to accomplish care. Thus, the Agency for Healthcare Research and Quality (AHRQ, 2019) defined safety culture "as the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management" (p.1). A safety culture places emphasis on patient safety, error prevention, event reporting and fosters a learning environment.

To help hospitals understand the components of compromises to patient safety such as workarounds, AHRQ and the Medical Errors Workgroup of the Quality Interagency Coordination Task Force (QuIC) sponsored development of the *Surveys on Patient Safety Culture Hospital Survey* (SOPS™) *(*AHRQ, 2019). The survey is designed specifically for hospital staff and asks for their opinions about the culture of patient safety in their hospital. The SOPS™ survey (Addendum B) is used by hospital administration to raise staff awareness about patient safety, determine their current patient safety culture, help to understand where improvements may be required to improve patient safety, evaluate longitudinal trends in their patient safety culture, evaluate how new safety initiatives and interventions may be working, and provide benchmarks to make comparisons within and across different hospital systems (AHRQ, 2019). SOPS™ patient safety culture composites are constructed from thirty-two items grouped into ten composite

measures: communication openness, communication about errors, frequency of events reporting, handoffs and transitions, management support for patient safety, response to error, organizational learning (continuous improvement), overall perceptions of patient safety, staffing, supervisor/manger expectations and actions promoting patient safety, teamwork across units, and teamwork within units (AHRQ, 2019). These composites developed under contract from AHRQ used literature reviews, existing surveys, actual medical errors, safety climate and culture surveys, organizational climate, and culture data to define safety culture in hospitals and inform the design of SOPS™.

Safety culture is fundamentally a local problem within different units in hospitals with wide variation in safety culture perception apparent within an organization as healthcare perpetuated a shame and blame culture to hold those at the point of error accountable for years (AHRQ, 2019; Huang et al., 2007; Walker et al., 2020). A poor safety culture has been linked to increased error rates, and the concept of Just Culture has been widely adapted to focus on identifying and correcting system issues that may lead workers to engage in unsafe behaviors (AHRQ, 2019; Spath & Bass, 2011). A Fair and Just Culture is often referred to as Just Culture and is the notion that everyone contributes to the safety culture, and the organization can only learn and improve by openly identifying its own weaknesses (Frankel et al., 2006). Although Just Culture holds individuals accountable for behaviors that are deemed reckless, the culture does afford examination of the system to determine if it leads workers to partake in unintended work behaviors without punitive actions. Once established, sustaining Just Culture can be difficult and requires continuous effort to maintain it by utilizing unit-based safety teams, patient safety executive walk-arounds, and team building to help promote sociotechnical cultural understanding (AHRQ, 2019).

Only through teamwork and proper socialization can a Just Culture be expected to thrive and provide safety benefits for patients.

Health-IT: A Means to Patient Safety

Health information technology (health-IT) can be defined as an all-encompassing term for computer and communication technologies used by healthcare professionals with the overarching goal of improving the safety and overall quality of patient care (Hydari et al., 2016). Examples of health-IT include clinical information systems (CIS), clinical data repositories, clinical decision support (CDS), computerized provider order entry (CPOE), clinical dashboards, and the electronic health record (EHR). One major catalyst for the use of health-IT to improve patient safety was the Institute of Medicine (IOM) publication, *To Err is Human*, which estimated that 100,000 preventable deaths occur annually in America's hospitals. The IOM executive summary emphasized the importance of how "the status quo of healthcare delivery is no longer acceptable, despite cost pressures, resistance to change or other barriers, as it is simply not acceptable for patients to be harmed by the same system that is supposed to heal them" (2000, p. 3). The last several decades have seen investments in health-IT tools and redesigning workflows to improve patient safety for reduction or elimination of preventable medical errors through an improved healthcare delivery system (Wachter, 2012).

Healthcare delivery is a highly complex industry in which no "magic bullet" will alleviate all issues surrounding adverse care events, and solutions will require a multifaceted response (IOM, 2000). Given its potential to transform every aspect of healthcare service, including increasing timely access to patient records, eliminating errors, reducing costs related to duplication of services, decreasing practice variation, and improving patient-centered outcomes, adoption of health-IT into practice is recommended for improving care delivery (Bushelle-

Edghill et al., 2016). To achieve these potential benefits, the U.S. passed the Health Information and Technology Act (HITECH) as part of the American Reinvestment and Recovery Act (ARRA) in 2009, which infused roughly $30 billion in stimulus funds for health-IT infrastructure into healthcare. The HITECH Act provided the Department of Health & Human Services with the authority to establish programs to improve healthcare quality, safety, and efficiency through promotion of health-IT, which included electronic health records (EHRs) along with promoting health information exchanges (HealthIT.gov, 2021).

Classified as a clinical information system (CIS), the EHR is defined as a comprehensive and integrated electronic system that is used to manage clinical aspects of care as the central platform for end users' access (Nelson & Staggers, 2018). The EHR has been leveraged to assist decision-makers/healthcare providers with access to clinical decision support (CDS) tools to help formulate decisions when ambiguities exist in patient assessment by organizing and analyzing information to help make correct clinical or safety recommendations. Clinical decision support aids are a crucial tool in helping to prevent safety-related ordering errors (e.g., warning of a patient allergy prior to administering the medication) or to help make end users aware of clinical parameters (changes in patient condition) needing attention (e.g., sepsis alerts or abnormal laboratory values).

Although there are various strategies for health-IT selection and integration into healthcare systems, the overall aim is to help prevent errors by augmenting healthcare workers' clinical reasoning skills and not simply replacing the value of people's judgment to provide care (Picotty et al., 2015). As humans provide healthcare, there are cognitive limits to the amount of data and information one can process. The balance is knowing when to utilize the recommendation provided by computer-generated clinical support or when to rely on their own

clinical judgement (Nelson & Staggers, 2018). The promise is that a well-designed and well-integrated health-IT ecosystem will help to reduce adverse events by improving access to health information through enhanced decision support features that allow clinicians access to data and information at the point-of-care to make clinical decisions when it is needed the most (Dykes et al., 2007). Effectiveness of health-IT is dependent not only on the quality of the data and algorithms used in information processing, but also the human judgment to act accordingly with the information presented (Nelson & Staggers, 2018).

Error detection associated with using health-IT is dependent on development of a Just Culture to help inform system administrators with the underlying issues and contexts to how and why an error occurred between the user and the technology. While certain errors demand accountability for reckless behavior, a Just Culture helps to focus on health-IT system errors that can lead an end-user to make certain types of errors (AHRQ, 2019). Just Culture identifies different types of errors that humans can make such as slips (non-intentional mistakes e.g., failing to notice a laboratory lab prior to administering a medication), taking shortcuts (e.g., not using the barcode scanner for medication delivery), or ignoring required safety steps in using health-IT in practice (e.g., failing to acknowledge clinical decision support warnings). As areas of concern are identified in health-IT usage through event reporting in a Just Culture it allows for changes to be made to the system design, education, updates to policy and procedures can be implemented to reduce the chance of an adverse event from occurring. Having a strong sociotechnical culture that users feel psychologically safe to report errors through a Just Culture will allow organizational decision makers a mechanism to identify potentially dangerous health-IT system flaws and individual behaviors contributing to adverse events. Once identified health-IT system errors and healthcare care staff's behaviors that contribute to poor safety outcomes can

be reduced or mitigated through changes to system designs, workflow enhancements, or educational initiatives.

Nursing Informatics

With increased health-IT usage to promote safety and complexity of patient care, it is imperative that nurses are equipped with knowledge and skills to succeed in this environment (Chang et al., 2011). It is critical for nurses to understand the impact nursing informatics can have on inter-professional collaboration, patient care settings, strategic planning, patient satisfaction, quality of care, and most importantly, improvements in patient outcomes (McGonigle et al., 2014). Nursing informatics as a discipline has been defined as a specialty that integrates nursing science, computer science, and information science to manage and communicate data, information, knowledge, and wisdom in nursing practice (McGonigle & Mastrian, 2022). The need for this discipline arose as newly developed health-IT made improvements to managing workflow, tracking patient outcomes, and virtually monitoring patients to address safety concerns (McGonigle et al., 2014). Nursing informatics plays a critical role in advocating for patients and nurses who are recipients and stakeholders in the constant evolution of health-IT solutions (HIMSS, 2012).

Nursing Informatics Curriculum and Competencies

Schools of nursing play an important part in helping to develop health-IT and informatics skills and attitudes needed by new graduate nurses upon entering the workforce. Students must learn to use this technology effectively, recognize the benefits and limitations of the technology, and integrate technologies into the care they provide in a safe and effective manner (McGonigle et al. 2014). Failure to instill competent nursing informatics principles to meet the challenge of 21st century health care will result in subpar nursing care.

Entry into nursing practice requires passage of the National Licensure Examination for Registered Nurses (NCLEX-RN). To ensure public protection, candidates for practice are required to meet requirements such as NCLEX-RN passage that measure competencies needed to perform nursing care safely and effectively (NCSBN, 2019). NCLEX-RN assesses the knowledge, skills, and abilities essential for entry-level nursing positions that focus on patient needs requiring the promotion, maintenance, or restoration of health. Specifically related to informatics, entry-level nurses are evaluated on their ability to incorporate communication and electronic records to demonstrate competency to the standards of practice.

To prepare students for practice in today's healthcare environment, it was vital to establish a baseline of informatics competencies in nursing curricula (Hebda & Calderone, 2010). These developed competencies are increasingly viewed as a basic skill that every high performing nurse needs to possess to improve delivery of patient-centered care and be ready for the challenges healthcare can present (Martin & LaVigne, 2016; Yoon et al., 2009). Nursing informatics competencies can be defined as adequate knowledge, skills, and abilities to perform specific informatics tasks, which include use of health-IT products (Hunter et al., 2013). Nursing schools have accreditation bodies that help establish quality standards for nursing education, assist schools with implementation of those standards, influence the nursing profession to improve healthcare, and promote the profession through education, research, and practice (AACN, 2022). As one accreditor, the American Association of Colleges of Nursing (AACN) established the *AACN Essentials* outlining the necessary curriculum content and expected competencies of graduates in baccalaureate, master's, and Doctor of Nursing Practice programs. In 2021, the AACN moved to competency-based education and assessment. This new framework includes ten competency-based domains, including domain eight specifically focused on informatics and healthcare technology.

Therefore, schools of nursing must demonstrate how they are measuring and educating future nurses on informatics and health-IT in their programs to prepare students to not only pass licensure examination, but also to be competent nurses at the bedside.

Evolution of Informatics Competencies and AACN Essentials

One of the earliest attempts to define informatics competencies came from the National League of Nurses in 1988 (Staggers et al., 2002) and was followed by several studies that examined the development of informatics competencies, including the work of the International Medical Informatics Association (IMIA) and the 1998 Pew Commission (Staggers et al., 2002). However, these studies lacked appreciation for nursing contributions and current technology advancements (Chang et al., 2011; Staggers et al., 2002). Substantive work on developing competencies for nursing informatics can be found from Staggers and colleagues (2002), who published a research-based master list of nursing informatics competencies that incorporated skills and knowledge nurses require across multiple sub-specialties within the nursing field.

Building on these foundational competencies, work has flourished establishing current informatics competencies in the literature, such as the Australian Nursing Federation study and Technology Informatics Guiding Educational Reform (TIGER) initiative in the United States (Foster & Bryce, 2009; TIGER, 2009). Incorporating the original informatics competencies proposed by Staggers et al. (2002), the TIGER initiative (2009) used a collaborative approach and approved over one thousand individual competency statements. In 2014, the TIGER initiative was transitioned into the Health Information and Management Systems Society (HIMSS), which is supported by the Clinical Informatics department (Shaw et al., 2020). The transition has allowed for interdisciplinary and interprofessional approach to informatics competencies development. The following informatics competencies are identified by TIGER for

clinical nurses to possess including usage of nursing documentation software, knowledge management skills, understanding data security and protection, understanding ethical use of health-IT for patient care, and use of information communication systems.

In 2009, Chang et al. reexamined the Staggers et al. original competency list of 2002 to determine if these competency lists would be compatible with those in Taiwan. Chang et al. (2011) confirmed the original informatics competency list along with forty-two new informatics competencies to be added. Chang et al. (2011) concluded that because the master list was confirmed in both countries and based on both the TIGER initiative and Staggers et al. (2002) original informatics competencies, the new master list of informatics competencies could be declared an international informatics competency list. The International Medical Informatics Association (IMIA) on Education in Biomedical and Health Informatics has released new recommendations related to informatics competencies, coursework, continuing education and accreditation standards (Bichel-Findlay et al., 2023).

As experts continue to expand the field of nursing informatics competencies, the focus is shifting to measuring and evaluating the informatics competencies of nurses (AACN, 2022; Bichel-Finlay et al., 2023). As AACN sets the standards for nursing education specifically Domain-8: Informatics and Healthcare Technologies, programs must demonstrate their students are meeting the informatics competency to gather clinical data, assimilate information to drive clinical decision making, manage and improve the delivery of safe care (AACN, 2022). As students will soon be entry-level nurses, they will be required to use health-IT communication tools effectively and be competent in health information literacy used in the care of patients. In addition, students will need informatics skills for basic navigation EHR skills and understanding the importance of accurate data entry into the EHR, how to utilize mobile health applications,

and demonstrating best practice in the use of social networking applications (AACN, 2022) Additional competencies center not only around usage of health-IT but how a safe culture is an essential competency. Of critical importance is Domain 8.3f which requires students to identify and understand the importance of using safe reporting system to alleviate potential errors and identifying functionally issues (error messages, device malfunctions, poor human computer interfaces etc.) in accordance with organizational policies and procedures (AACN, 2022). Therefore, given the new *AACN Essentials* competency-based requirements, nurse educators need to measure competency levels of nursing program students and graduates to ensure they meet the demands of nursing positions they will assume (AACN, 2022; Desjardins et al., 2005). The next step is to ensure students graduate with the necessary competencies in informatics to promote safe, evidence-based nursing care (AACN, 2022; Desjardins et al., 2005; McNeil et al, 2005).

SANICS Development

To ensure graduates are equipped with the necessary skills and attitudes to use health-IT, investigators at Columbia University School of Nursing developed a 93-item instrument, the *Self-Assessment of Nursing Informatics Competencies Scale* (SANICS; Yoon et al., 2009). The primary source for scale items was Staggers et al. (2002) Delphi study of informatics competencies (Yoon et al., 2009). Yoon and colleagues (2009) performed psychometric assessment of the instrument and determined that a five-factor, 30-item version of the instrument explained 63.7% of the variance. This study provided preliminary evidence for a 30-item instrument to determine self-reported assessments of informatics competency, but the investigators needed additional diverse samples to further validate the tool (Yoon et al., 2009). Choi & Bakken (2013) repeated psychometrics on SANICS and concluded the instrument to be

psychometrically sound for the use with diverse samples. The investigators noted several limitations of the study: a response rate of 56.3% which increases the potential for nonresponse bias; all subjects from a single northeastern university; and overestimation of competencies as the instrument is self-reported.

Choi (2012) conducted a study to determine and compare informatics competencies among three undergraduate education nursing program tracks: traditional pre-licensure, registered nurse to Bachelor of Science in Nursing (RN-to-BSN) and accelerated BSN. Choi (2012) reported RN-to-BSN students scored significantly higher for informatics competencies than the traditional students. Moreover, RN-to-BSN and accelerated BSN students were more competent in informatics versus traditional students, possibly attributed to RN-to-BSN students already working as RNs at the bedside, affording them experience with informatics principles compared to the other groups (Choi, 2012).

As part of a continuous effort to improve SANICS, Yoon and colleagues (2015) used non-parametric Item Response Theory (IRT) Mokken scaling to refine the original 93-item instrument into an 18-item scale with excellent reliability, reporting a Cronbach's alpha = 0.932. The updated instrument reflects informatics competencies that can now be scaled to include interdisciplinary healthcare professionals on their informatics skills, communication patterns, team-collaboration, and a focus on patient-centered care. In addition, Mokken scaling afforded competency measurement refinement as it provides a hierarchy based on single traits, reliability, and a shorter overall length of 18-items and can be administered to those of varying degrees of experience while measuring competency over time (Yoon et al., 2015). Therefore, this instrument can capture novice pre-licensure nurses' levels of informatics competency throughout their education and as they transition into practice with a high level of reliability.

Based on this review of the literature, there is a continuing need to evaluate and measure nursing informatics competency curriculum among pre-licensure nurses to ensure nurses have the basic knowledge, skills, and attitudes to meet the challenges of today's healthcare environment, especially as new health-IT is constantly being deployed. In addition, educators need a method to determine informatics curriculum deficiencies to help educators prioritize student learning needs and strategize how to deliver content that will lead to competency obtainment (Choi & Jenkins, 2013). SANICS offers a psychometrically tested instrument to assess student informatics competency levels for undergraduate pre-licensure nursing students.

Theoretical Framework

Complex Adaptive Systems

Fundamentally, complex adaptive systems (CAS) can best be described as a framework for studying and explaining how organizational systems function and can be managed (Carmichael & Hadzkadic, 2019). Using this framework as a lens helps explain the intricate roles individuals, described as agents, play through interaction with each other and within the environment that influences behaviors within a system (Carmichael & Hadzikadic, 2019). Complexity science with roots in physics, mathematics, and biology has been expanded to include business organizations or any system of organizations, including healthcare (Begun et al., 2003). According to Begun (2003), complexity science is useful for studying changeable systems to help answer questions regarding the relationships and evolution of complex organizations, especially those with multiple, diverse, and interconnected elements.

Healthcare settings are an ideal example of CAS with diverse, interdisciplinary teams of staff providing care concurrently to ever-changing patient clinical conditions that require the team to organize on an agreed intervention to achieve positive clinical outcomes. Complex

adaptive systems are a dynamic network of interactions, but the behavior of a system may not be predictable according to the individual components (Rouse, 2008). Thus, studying healthcare organizations as living, complex, and adapting systems better represents the reality of the environment versus the machine metaphor when examining healthcare delivery systems.

Complex adaptive systems are comprised of several interconnected components which may interact with each other in unpredictable ways within the system. According to Rouse (2008), CAS can be defined in terms of several characteristics. First, they are nonlinear and dynamic, and when observing them in action, they can appear random and chaotic. Next, through their engagement and interactions in the system, independent agents in CAS, such as people, find their behaviors to be influenced by the physical, psychological, and social experience of the system. As people interact in CAS, they tend to adopt behaviors to resolve conflicts to achieve system goals. After successfully navigating new challenges and interactions, people in the system gain experience and knowledge and learn to adapt by redesigning (self-organizing) the system over time to create new workflows. As adaptation is not static but a continuous process with each new health-IT update, new behavior patterns emerge in the workflow to complete tasks, some positive and some negative (e.g., workarounds). Through unique interactions among elements, CAS feature development of informal collaborative networks of individuals who work together to find solutions to problems in innovative ways (Ellis & Herbert, 2011). As people in CAS develop these adaptive behaviors, they may become unpredictable as adjustments are made and difficult to control from a managerial perspective as issues are solved from a bottom-up perspective. To properly manage individuals in CAS, administration should approach these adaptive behaviors by having a non-punitive reporting mechanism in place to listen to staff concerns and endorse the correct course of action through training and redesign of workflows versus mandating work behavior through a top-down

perspective. Failure to learn from worker concerns leads to resistance and the inability to make corrections, jeopardizing patient safety.

Sociotechnical Culture

An essential element in complex adaptive systems is creation of a sociotechnical culture, which can be understood as the interrelatedness of social and technical aspects of the organization (Castro et al., 2016). Sociotechnical culture plays an integral role in an organization as it influences health-IT work-related behaviors. Failure to account for accepted social norms arising from this group and a sole focus on the physical functional properties of the technology will result in system failure and adverse patient events.

Understanding the role of how social influence drives individual behavior to use and adopt health-IT is paramount to a healthcare organization's success in reaping the benefits of health-IT to decrease adverse events. Leonardi & Barley (2010) argued that technology's effects on an organization are socially constructed: people respond to technology's inherent constraints and affordances, as well as to each other. Therefore, leveraging the social construction process in organizations and how it is woven into the technology's material properties (software/hardware) is a way to help understand differences, strengths, and limitations in recognizing the relationship within sociotechnical cultures (Leonardi & Barley, 2010). To understand the influence of the sociotechnical culture in CAS is to recognize that social and technical systems influence each other. Effective organizations optimize both systems to achieve the benefits of health-IT to improve patient safety.

Recognition of the social interactions of the organization's members in CAS allows for understanding of individuals' assimilation into the sociotechnical culture and how individuals will interact with technology's infrastructure (i.e., computer software and hardware functionality;

(Leonardi & Barley, 2010). Moreover, this information exchange occurring in the sociotechnical culture determines critical medical knowledge to perform care. This medium requires healthcare workers to interact together to develop shared attitudes and social norms and assign value regarding technology's usefulness in helping to ascertain knowledge. To overcome previous models' limitations of health-IT implementation into organizations, Sittig & Singh (2010) developed a new sociotechnical model to evaluate health-IT in CAS or hospital systems. This innovative approach uses an eight-dimensional model to account for the influence and success of health-IT usage in organizations. In keeping with the foundations of CAS, these eight interconnecting properties need to be applied in relation to each other and not separated into individual properties to help understand the intricacies of health-IT usage.

Sociotechnical Model

Given the complexity and multifactorial safety risks associated with health-IT, the sociotechnical model was developed to account for the sociotechnical context in an effort to anticipate risks in a proactive manner (Meeks et al., 2014). The eight-dimensions of the sociotechnical model include: (1) the hardware and software computing infrastructure of the organization; (2) the actual clinical context in which data, information, and user knowledge intermix; (3) the interface allowing access between the end users and the computer (human-computer interface); (4) the actual users themselves (people) who interact within the system; (5) the actual workflow and communication patterns among the users in the system to accomplish care; (6) the organizational structure including policies, procedures, and culture; (7) external regulatory agencies that create laws to facilitate or constrain designs in delivering care; and finally, (8) the monitoring and accountability of the system (Sittig & Singh, 2010). Understanding the properties of CAS in terms of these eight dimensions has helped explain

complexity with using health-IT. Still, Yen et al. (2017) pointed out that adoption is not a static endpoint in health-IT deployment but a process of continuing adaptation and realignment among users. Thus, as new software and hardware upgrades are deployed, users need to realign behaviors (workflows) to optimize the new health-IT implementation by depending on the intricate compilation of their specific organization's sociotechnical culture.

Sociotechnical Culture Assimilation

Sociotechnical culture assimilation is a key factor in understanding the organization's social norms that contribute to the complexities of health-IT implementation and usage. When not properly assimilated into the sociotechnical culture, social norms can hinder usage and adoption of potential health-IT benefits to patient care. Knowledge regarding the importance of social norms and their effects on performance related to health-IT can allow administrators to design strategies aimed at promoting positive adoption processes, especially for new hires. This includes training with a focus on factors affecting social constraints to usage compliance such as placing experienced individuals or super-users with staff to model proper usage during orientation and training periods. In addition, administrators may ensure proper professional socialization and acceptance by assigning mentors and finding a correct match with assigned preceptors to help newly hired nurses learn institutional roles and sociopolitical (e.g., power structure of doctors and nurses) values and norms and develop their professional identity as healthcare providers (Lee & Yang, 2019; Meeks et al., 2014).

Technology Acceptance Model (TAM)

One of the most widely established models for studying information technology (IT) is the Technology Acceptance Model (TAM) (Davis, 1989). The TAM model consistently explains forty percent of intention to use technology by individuals (Venkatesh & Davis, 2003). TAM

theorizes that individual behavior for using IT systems is determined by two mediators: perceived usefulness, defined as the extent to which a person believes that using the system will enhance their job performance; and perceived ease of use, defined as the extent to which a person believes a system is easy to use (Venkatesh & Davis, 2000). Therefore, using the TAM as a predictive measure to help explain technology use provides practical feedback to inform organizations if their staff value the products being incorporated into service (Davis, 1989).

Sociotechnical Culture and Health-IT Usage

When individuals interacting and working in a health-IT ecosystem perceive the inability to complete a given task, they may alter their work performance behavior by deviating from organizational policies and procedures to accomplish that task. Deviation from the normal expected work behavior has been labeled a workaround (Ejnefjall & Agerfalk, 2019; Halbesleben et al., 2013; Westphal et al., 2014). Workarounds usually result from a perceived misfit between the expected work practice behavior and design of the system and have been reported to create hazards and serious patient safety issues when implemented by users utilizing health-IT (Ejnefjall & Agerfalk, 2019; Halesleben et al., 2010). As the sociotechnical model explains, a change in one of the eight dimensions, including a health-IT system change, can have a cascading effect on users and their social interactions to account for the new change.

However, researchers have acknowledged that workarounds or innovative approaches to health-IT usage can also be beneficial and in fact necessary when adapting to new workflow changes not anticipated by system designers (Ejnefjall & Agerfalk, 2019; Westphal et al., 2013; Yen at al., 2017). As system upgrades occur or new health-IT measures are deployed, users depend on their sociotechnical cultural network to navigate perceived blocks, seek viable alternatives, and adjust workflows accordingly. For nurses, new health-IT innovative usage is

seen as important problem-solving behaviors to improve efficiency, enhance patient care, or improve processes (Westphal et al., 2013). Proper assimilation into the sociotechnical culture may provide a communication mechanism with a means to discuss alternative actions, decreasing potential hazards of self-developed workarounds which can jeopardize safety. Students in nursing programs will be discouraged from unsanctioned health-IT usage during formal academic clinical experiences and will be taught to follow approved protocols and procedures to ensure safe nursing care. Through continued clinical experience and assimilation, students will begin to learn the informal rules, utilizing peer interaction to help alleviate perceived blocks in care to alleviate or avoid a self-developed workaround that can place the patient's safety at risk. Gaining additional experience (pre-licensure) beyond formal clinical courses will enable students to transition more quickly as they formulate informal relationships with seasoned staff members to learn and develop the necessary health-IT usages behaviors.

Workarounds as unintended consequences of health-IT implementation may provide acceptable solutions, but they typically fail to solve underlying problems (Ejnefjall & Agerfalk, 2019; Westphal et al., 2013). Some workarounds can be mitigated by changing policies or procedures: if an acceptable health-IT usage exists, it may be endorsed and shared among users in CAS to alleviate the block as the sociotechnical model posits. Non-punitive reporting mechanisms (incident reports) to address potential health-IT usage behavior are important to help identify these behaviors and are only possible with a Just Culture in place (AHRQ, 2019). Students need exposure to reporting mechanisms to articulate issues and understand the plan of how they are reported and resolved. Students may not have enough exposure during their limited clinical courses for this skill to be developed; however, with pre-licensure experience, students should have increased exposure to this type of mitigating process.

Barrett & Stephens (2017) studied how coworkers' social influence in the form of feedback and social support resulted in more workarounds while working with the electronic health record (EHR). Their hypothesis focused on linking social information with workarounds and understanding exactly how health-IT usage influences the intended outcome, perceived relative advantage of EHRs, and resistance to change. They concluded that coworker support and feedback influence health-IT usage, a product of social construction resulting from sociotechnical culture interaction. When coworkers engage in these socially constructed workarounds, they are less resistant to the EHR system, perceive the EHR implementation as successful, and clearly see a relative advantage to the EHR. Sociotechnical culture can influence individuals' health-IT usage and ensure safety, highlighting the importance of group influence on safety and improved patient outcomes. Exposing students to this environment will help shape and refine behaviors as they move along the continuum from novice to expert.

Pre-licensure Immersion in Sociotechnical Culture and Health-IT Converge

Based on the Sittig & Singh sociotechnical model for evaluating health IT in complex adaptive healthcare systems (CAS), this research posits that as students engage in the sociotechnical culture of the healthcare agencies they visit during clinical rotations, they will be exposed and influenced by socially constructed behaviors of staff members who comprise the sociotechnical and safety culture. Moreover, students who obtain clinical work experience (nurse tech and nurses aid positions) beyond clinical experience (pre-licensure) provided through academia prior to graduation will increase their exposure to these sociotechnical culture norms, workflow behaviors, workarounds, and health-IT usage. Students with prolonged assimilation to the sociotechnical culture through pre-licensure clinical employment will not only be able to demonstrate higher informatics competencies, but they will also improve their safety awareness

through this same exposure, aiding their transition from student to the role of registered nurse. From the perspective of nursing education, having a formalized informatics course will ensure students are focused on the specific competencies needed for practice.

The American Association of College of Nurses Essentials requires baccalaureate programs to specifically address Domain-8: Informatics and Healthcare Technologies which focuses on being competent to gather clinical data, assimilate information to drive clinical decision making, manage and improve the delivery of safe care (AACN, 2022). Having a formal informatics course coupled with practical experience in the sociotechnical culture clinical settings helps to ensure that entry-level nurses are able to use health-IT communication tools effectively and be competent in health information literacy used in the care of patients. To maximize health-IT's potential benefits to safer nursing care, students need to develop not only their informatics competency but their knowledge regarding the importance of how a Just Culture is used to report potential adverse safety concerns when utilizing health-IT tools in practice.

Solutions for Transition to Practice

Clinical education is an essential component in preparing nursing students to apply theoretical knowledge and practice needed skills to achieve competency to provide care. Clinical training provides context for students by exposure to work in real-world environments and the sociotechnical culture needed for successful assimilation upon graduation. Clinical education can present interpersonal challenges for nursing students during their rotations that may hinder effective transition into the role of a registered nurse when they graduate and join the hospital team. As the sociotechnical model outlines, students need to understand how their interaction with others using health-IT ecosystems can influence their behaviors, leading to either correct decisions or possible workarounds that may contribute to safety lapses.

According to Lee & Yang (2019), many students encounter difficulties during clinical rotations, including negative interpersonal relationships with healthcare professionals, feelings of powerlessness in clinical environments, exclusion from professional groups, and insufficient time in clinical rotations. Moreover, they report the negative impact of nursing professionals' heavy workload on their ability to provide clinical education to students and emotional distress caused by one or any combination of the factors listed above. These factors can disrupt the socialization process for students during their clinical experience and limit their understanding of the sociotechnical culture of specific units and the importance of this culture to developing proper behaviors in practice. A potential solution is gaining experience through pre-licensure work exposure coupled with a formalized informatics course which highlights health-IT usage and safety principles.

This study will help to explore two potential solutions to overcome clinical teaching challenges: 1) are health-IT competency and safety awareness associated with nursing students who have pre-licensure positions in hospitals as nursing technicians and/or patient care aides or 2) with having a formal nursing informatics course in nursing education programs. Findings could strengthen students' ability to learn the rationale behind health-IT usage in the classroom, coupled with practical work experience in clinical areas that expose students to the sociotechnical culture to emphasize basic nursing skills needed for safe care. Obtaining pre-licensure work experience will expose students to the healthcare culture where they can begin the assimilation process. As formal hospital staff members, students with pre-licensure experience can begin to enhance informatics and safety skills required in practice as formal clinical experience may not be ideal or long enough for proper assimilation to occur. Practical pre-licensure hospital work experience helps students begin to develop their professional identity and

understand the roles, status, values, and sociotechnical culture of the institution. To date, no study has measured the association of pre-licensures experience/exposure to sociotechnical assimilation with reducing the practice-preparation gap of new hires by improving their safety and informatics competencies. Therefore, the purpose of this cross-sectional study is to explore the relationship between perceived nursing informatics competencies (measured through SANICS) and increased exposure into the sociotechnical culture through a pre-licensure healthcare position coupled with clinical rotations with safety competencies scores (SOPS™).

Chapter 3

Methods

Review of the literature indicates a tendency for healthcare workers to socially construct norms of behaviors in their respective units to provide care to patients. As sociotechnical culture assimilation is a potential factor to understanding the organization's Just Culture practices exploring this association may contribute to our understanding of the complexities of health-IT implementation, usage, and safety concerns. If individuals are not properly assimilated into the sociotechnical culture, social norms may hinder usage and disrupt the potential health-IT benefits to patient care. Knowledge regarding the importance of social norms and their effects on performance related to health-IT can allow administrators to design strategies aimed at promoting positive adoption processes, especially for new hires. Behavioral norms incorporating health-IT are continuously evolving through interactions within the sociotechnical culture (Sittig & Singh, 2010). Assimilation into this sociotechnical culture provides a network for nurses to help guide safe care practices. Therefore, it is postulated that students who are exposed to sociotechnical culture early in their academic studies which is aligned with coursework will be better prepared to incorporate nursing informatics into practice (e.g., using the EHR or clinical decision support systems), closing the practice gap for safe care. This study used psychometrically evaluated instruments to quantify the degree of association between student informatics competency measured through SANICS and safety competency using the *Surveys on Patient Safety Culture* (SOPS™) *Hospital Survey*. Descriptive statistics, t-tests, and correlational and regression analysis were used to assess the association between subscales and total scores on SOPS™ and total SANICS scores to determine if greater exposure to sociotechnical culture is

associated with higher nursing informatics competency scores and safety competency total scores.

Research Design

This study used a cross-sectional survey design to help provide a quantitative or numerical description of attitudes and opinions of a population (undergraduate nursing students) by studying a sample of that population (Creswell, 2014). The intent was to better understand the association between additional clinical exposure, beyond being a nursing student on informatics competencies and safety competency. Use of a survey provided rapid turnaround and quick access to multiple institutions to understand current practices. The instruments, SANICS (Appendix A) and a modified SOPS™ (Appendix B), were sent digitally using Qualtrics© to schools and colleges of nursing nationally for a cross-sectional survey of student volunteers.

Participants

Subjects who are currently enrolled or recently graduated (pre-licensure) were recruited from traditional Bachelor of Science in Nursing (BSN) programs. According to the American Association of Colleges of Nursing (AACN), as of April 2021, enrollment in baccalaureate-level programs was estimated to be 251,145 students. Exclusion criteria included RN-to-BSN programs as these individuals already hold a registered nurse license and may have previous exposure to sociotechnical culture or previous work history that may bias their scores. A G-power analysis was conducted. Based on a large effect size ($f^2 = 0.15$) and four predictors, 85-92 subjects are required for a power of .80 at an alpha level of 0.05, respectively. Therefore, with 80% power, the study has an 80% chance of detecting an effect that exists.

The potential subject sample was estimated to be 2,000 students based on enrollment data combined across the four nursing schools. Following Kent State University IRB approval

(Number 539), the survey was sent to four U.S. nursing schools that offer BSN programs (three Midwestern universities and one Pacific Northwest university) for distribution via their BSN student listservs. A convenience sample of four nursing program administrators, with whom the investigator has professional ties, were contacted for permission to disseminate the informed consent and survey to each of their respective undergraduate BSN program listservs, targeting only their BSN undergraduate students (estimated to be 2,000 students). Only students enrolled in these four traditional BSN programs were eligible and had the opportunity to complete the survey. The use of a convenience sample was employed for ease of access to the students listservs which are controlled by the various universities. No participating university was identified during the process of data collection. Using school listservs provides an inexpensive and rapid way to improve response rates according to Dillman (2009) as the message comes from a respected leader or authority figure. In addition, listservs are the official line of communication to students, enabling a follow-up request based on reviewing initial survey completion. Limitations to listservs are students may configure their mail system to send listserv emails to a separate mailbox to be viewed at a later point in time delaying recruitment messages resulting in slower response and lower response rates compared to paid recruitment strategies (Dworkin et al, 2016). The survey was pilot tested among 3 Kent State nursing faculty to ensure question mechanics, formatting, skip logic, and question language worked in different browsers.

There were 223 returned responses to the survey. Eighty percent (n=178) completed the survey in its entirety, and those surveys were used for data analysis. Incomplete surveys were rejected and not used for data analysis: 21 failed to complete the survey in its entirety; three failed the attention check-question criteria to accurately respond to the questions; and 21 surveys were removed from the data set as submitted responses were from students in the RN-BSN group

which did not meet inclusion criteria. The overall response rate for the estimated 2,000 sample participants was 11.2% and had a completion rate of 8.9% respectively. This response rate is low but acceptable, as the average response rate for web-based surveys ranges between 5% and 30% with 50% considered excellent (Johnson & Wislar, 2012). Fosnacht et al, (2017) more specifically, demonstrated measures of college students on web-surveys to be reliable under low response rate conditions of 5-10% with at least 500 sampled participants. According to Johnson & Wislar (2012) there is no scientifically proven minimally acceptable response rate, but recognition of the degree to which sampled respondents differ from the population (i.e., nonresponse bias) is central to evaluating the quality of the survey. However, the sample size did satisfy the threshold for the minimum number of respondents (85-92 usable surveys) determined by G-power analysis utilizing four predictors (e.g., informatics Course, healthcare experience, perceived IT usefulness, and grade-level in program) on safety competency.

Procedures

A Qualtrics© survey was open for three weeks (from January 20th to February 3rd, 2023) with two email requests to complete the survey. The first of a two-stage sampling frame request was sent week one, and the second request was sent at the conclusion of week two by university administrators. Students received a description of the survey purpose, risks and benefits, and a link to complete the survey if they agreed to participate. All survey data responses were collected anonymously using Qualtrics© survey software. After data collection, the results were downloaded from Qualtrics© to an Excel spreadsheet to be cleaned and tabulated for placement into linear multiple regression analysis. Statistical Package for the Social Sciences (SPSS Version: 28.0.1.0) was used to analyze the data.

Instrumentation

Informatics Competency (SANICS)

The total 18-item SANICS is composed of three sub-competencies, including (1) basic computer knowledge, (2) roles, and (3) applied computer skills. Questions were assessed using a 5-level Likert-style rating scale (1=Not Competent, 2=Somewhat Competent, 3=Competent, 4=Proficient, and 5=Expert) (Appendix A). Each individual item score in SANICS was weighted, allowing for the survey to be administered and adjusted for varying levels of experience related to informatics competency, i.e., from novice to expert. After adjusting for weight, the total SANICS score ranged from 0 to 44.06. Higher weighted aggregated scores indicated higher self-assessment of informatics competency (Yoon et al., 2015) (see Appendix A for weighted scale). The instrument with the 18-item scale has excellent reliability for students and healthcare professionals with a reported Cronbach's alpha = 0.932 (Yoon et al., 2015).

Safety Competency (SOPS™)

The SOPS™ *Hospital Survey* 2.0, which normally contains 32 items from 10 composite measures, was modified to include only the following five composite measures and 15 corresponding items. The following were selected specifically to focus on dimensions that nursing students were most likely to have experienced during their pre-licensure status: teamwork (3 items), organizational learning-continuous improvement (3 items), response to error (4 items), communication about errors (3 items), and reporting patient safety events (2 items). Additionally, the overall number of safety events reported (1 item) and the overall patient safety rating (1 item) were included from SOPS™. Bartonickova et al, (2022) identified SOPS™ psychometric properties on measuring patient safety culture from the perspective of nursing students and concluded the instrument was suitable for nursing students in regarding face,

content, concurrent and construct validity, internal consistency, and reliability. The Cronbach's alpha = 0.77 when nursing students were evaluated using this instrument on all dimensions, respectively.

Safety Competency (SOPS) Scoring

Each composite item except for communication about errors and reporting patient safety events was assessed using a 5-level rating scale, with a higher number indicating respondent agreement with the statement (1=Strongly Disagree, 2=Disagree, 3=Neither Agree or Disagree, 4=Agree, and 5=Strongly Agree). Communication about errors and reporting errors was assessed using a 6-point rating scale (0=Does not apply or don't know, 1=Never, 2=Rarely, 3=Sometimes, 4=Most of the time, and 5=Always) (Appendix B). The inclusion of "does not apply" properly quantified respondents who may not have experienced communication about errors or reporting of errors items without inflating their composite score, yet accurately captured individuals with these experiences. Overall reporting of patient safety events is a single item question used to assess the frequency of reporting adverse events in the past 12 months with scoring as follows: 0=none, 1=1-2, 2=3-5, 3=6-10, and 4=11 or more reports. Any number scored over 1 in the composite for frequency of reporting patient safety events was considered a positive response. Several composite questions were negatively worded to avoid response set bias by respondents and were subsequently negatively coded prior to administration of the survey in Qualtrics©.

For each composite, a higher score indicated a higher measure of safety related to that composite. The total range of scores for composites of SOPS™ indicated safety rankings in these areas: teamwork composite (3 questions, 0 to 15), organizational learning-continuous improvement (3 questions, 0 to 15), response to error (4 questions, 0 to 20), communication

about errors (3 questions, 0 to 15), reporting patient safety events (2 questions 0 to 10), number of events reported (1 question, 0 to 5), and overall safety rating (1 question, 0 to 5).

Safety Composite (SOPS™) Rationale and Questions

Teamwork as a composite measure is defined as the extent to which staff work together as an effective team, help each other during busy times, and are respectful (Famolaro et al., 2021). These specific questions (See Appendix B) were used to measure teamwork from SOPS™: (A1) In the clinical units you have experienced, did the unit work together as an effective team; (A8) During busy times, staff on clinical units help each other; and (A9) There is a problem with disrespectful behavior by those working in the clinical units. The rationale for selecting these questions was to determine if students recognize and begin to understand teamwork as a concept related to the sociotechnical nature of healthcare. The reliability of the teamwork composite measure demonstrated a Cronbach's alpha= 0.76 (AHRQ, 2019).

Organizational learning-continuous improvement considers whether work processes are regularly reviewed, changes are made to keep mistakes from happening again, and changes are evaluated (Famolaro et al., 2021). These specific questions were used to measure continuous improvement: (A4) The units you have experienced regularly review work processes to determine if changes are needed to improve patient safety; (A12) When considering the units you have experienced, changes to improve patient safety are evaluated to see how well they worked; and (A14) The units you have experienced let the same patient safety problems keep happening. The rationale for selection of this composite measure was to explore students' understanding of the process of learning from each other's mistakes and how organizations make changes for continuous improvement. The reliability of the organizational learning-continuous improvement composite measure demonstrated a Cronbach's alpha= 0.76 (AHRQ, 2019).

Response to error is defined as how administration reacts to an error, how staff are treated when mistakes are made, and if the focus is on learning from the mistake and supporting staff involved in errors or penalizing the individual who made the error (Famolaro et al., 2021). These specific questions were used to measure response to error: (A6) When considering the units, you have experienced, staff feel like their mistakes are held against them; (A7) When considering the units you have experienced, when an event is reported in the unit, it feels like the person is being written up, not the problem; (A10) When considering the units you have experienced, when staff make errors, the unit focuses on learning rather than blaming individuals; and (A13) When considering the units you have experienced, there is a lack of support for staff involved in patient safety errors. The rationale behind selection of this composite measure was to determine if students recognize Just Culture principles when error reporting occurs and if a non-punitive culture exists to have meaningful conversations for improvement when errors occur. The reliability of the response to error composite measure demonstrated a Cronbach's alpha= 0.83 (AHRQ, 2019).

Communication about errors is defined as the extent to which staff are informed when errors occur, discuss ways to prevent errors, and are informed when changes are made (Famolaro et al., 2021). These specific questions were used to measure communication about errors: (C1) How often were you informed about errors that happen in the units you have experienced (C2) When errors happened on the units you have experienced, there were discussions on ways to prevent them from happening again; and (C3) On the units you have experienced, the unit was informed about changes that are made based on event reports. The rationale for inclusion of these questions was to determine if students have been informed about errors and ways to help prevent future errors through an open communication process to help learn and promote safe practices.

The reliability of the communication about errors composite measure demonstrated a Cronbach's alpha= 0.89 (AHRQ, 2019).

Reporting patient safety events is defined as the extent to which mistakes of the following types are reported: (1) mistakes caught and corrected before reaching the patient; and (2) mistakes that could have harmed the patient but did not (Famolaro et al., 2021). These specific questions were used to measure reporting patient safety events: (D1) On the units you have experienced, when a mistake is caught and corrected before reaching the patient, how often this is reported; and (D2) On the units you have experienced, when a mistake reaches the patient and could have harmed the patient but did not, how often is this reported. The reliability of the reporting patient safety events composite measure demonstrated a Cronbach's alpha= 0.75 (AHRQ, 2019). The rationale for these questions was to determine if students had witnessed near-misses and how often mistakes are actually reported. This composite establishes Just Culture in action as failure to report near-misses or actual mistakes could result in future errors. Number of events reported is the actual number of reports the student has filed while in clinical units over the past 12 months (D3); and finally, the patient safety rating asked students how they would rate the units they have experienced on patient safety specifically (E1). The rationale was to determine if students have witnessed a near-miss or mistake and have utilized the reporting system and how they felt in general about how the units they experienced addressed patient safety.

Perceived Usefulness of Technology Measure

Evaluation of an individual's perceptions of the benefits of health-IT usefulness and compatibility with workflow processes is an influential factor for the success or failure of health-IT adoption in healthcare (Abdrbo et al., 2009; Gagnon et al., 2012). To assess the degree to

which an individual believes that using health-IT would enhance their job performance, the following item from Davis's (1989) Technology Acceptance Model (TAM) instrument was included to measure participant's *perceived usefulness* of health-IT. The following item was added to the instrument: Using health-IT (e.g., EHRs) would enhance my clinical effectiveness on the job. The rationale was to capture perceptions of actual usefulness of health-IT versus attitudes towards the implementation of technology and how this component contributes to the sociotechnical model to explain usage. This measure was scored using a 5-level rating (1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4=Agree, and 5=Strongly Agree). The higher the score, the higher the respondent's view that technology would enhance their job effectiveness in practice.

Data Analysis and Interpretation

Step 1: A response rate was reported indicating the number of returned and completed responses compared to the total number of surveys distributed.

Step 2: To ensure that respondents were addressing each question carefully, and to improve the quality of the data, attention check questions were used. If any attention check questions were not answered appropriately, they were removed from the sample. Any incomplete surveys submitted were removed from the final sample.

Step 3: Descriptive analysis was conducted on all data, including means, standard deviations, skewness, and kurtosis. Data collected included gender, race, having a formal informatics course, pre-licensure position in healthcare, grade level in a BSN program, and scores on both SANICS and SOPS™. Tests for normality were conducted using Shapiro-Wilk.

Step 4: Independent *t*-tests were conducted to determine the difference between groups who have pre-licensure experiences versus those who do not have pre-licensure experience on their scores

on SANICS and SOPS™. The following assumptions were confirmed, including measurement of data at the interval or ratio level. To determine homogeneity of variance, a Levine's test was conducted indicating the population sample was from a normal distribution. The alpha value was set at 0.05 for a two-tailed test and a 95% confidence interval conducted for each of the scores. The effect size of the *t*-test was reported as the Cohen *d* to determine the overall effect between the groups.

Step 5: Correlational and linear multiple regression analysis were conducted, including correlational and regression coefficient.

Step 6: SPSS was used to calculate all statistical analysis. Multiple regression analysis was used to determine which predictor variables (e.g., having a formal informatics course, pre-licensure position in healthcare, perceived IT usefulness, and grade level in a BSN program) would best predict SANICS and SOPS™ ™ scores. In addition, regression analysis was used to determine if SANICS was correlated with SOPS™. Those variables significantly correlated with the criterion variable (SANICS and SOPS™ scores) and were entered as predictors into a multiple regression using the standard method. Regression coefficients for the predictor variables were reported. Assumptions tests were conducted, including homoscedasticity to determine if the residuals test the difference between the observed scores and the value predicted by the regression equation. Multicollinearity was checked using the Variable Inflation Factors (VIF) method to determine if variables were highly correlated. A VIF greater than 10 indicates multicollinearity is present and indicates a violation of the assumption.

Step 7: Data analysis was conducted and interpreted to determine the meaning of study findings.

Chapter 4

Results

This chapter presents the results of the data analysis of the study.

Description of Sample

Of the 178 respondents, 84.3% were female, 13.5% were male, 0.6% were non-binary/ third gender, and 1.7% preferred not to say (Table 1). Respondents ranged in age from 18 to 57 with a mean of age of 23.9 years. This sample is representative of the typical student profile for a BSN program with the exception of male participants (13.5% compared to the national average of 12%) (AACN, 2017).

Table 1

Student Characteristics

Student Characteristics	**(*N*=178)**
Age, years, *N* (%)	
18-21	96 (54%)
22-24	41(23%)
25+	41(23%)
Gender, *N* (%)	
Female	150 84.3%)
Male	24 (13.5%)
Non-Binary/Third Gender	1 (0. 6%)
Prefer not to say	3 (1.7%)
Ethnicity, *N* (%)	
American Indians or Alaskan Native	2 (1.1%)
Asian/Pacific Islander	8 (4.5%)
Black or African American	3 (1.7%)
Hispanic	2 (1.1%)
White/Caucasian	156 (87.6%)
Multiple Ethnicity/Other	7 (3.9%)
Grade Level, *N* (%)	
Freshmen	9 (5.1%)
Sophomores	16 (9%)
Juniors	58 (32.6%)
Seniors	87 (48.6%)
Pre-licensure Graduates	8 (4.5%)
Pre-licensure Work Experience, *N* (%)	
None	55(31%)
< 3 months	8(4.5%)

3-9 months	33(18.5%)
≥ 9 months	82(46.1%)
Formal Nursing Informatics Course, *N* (%)	
None	82(46.1%
Completed	96 (53.9%)

The majority of the respondents were seniors (48.6%) and juniors (32.6%) with freshmen (5.1%) and pre-licensure (recent) graduates least represented (Table 1). Given the similarities in skills, knowledge, and attitudes between the educational level of senior students and pre-licensure graduates not currently practicing in the RN role, pre-licensure graduates were combined with senior nursing students for data analysis.

In comparison to the national average (AACN, 2017), nursing students in this sample had a higher proportion of white/Caucasian students (87.6% compared to the national average of 68.5%). The sample underrepresents both Hispanics/Latino students (1.1% compared to the national average of 10.5%) and African American students (1.7% compared to the national average of 10.6%); however, the study had higher representation of American Indian students (1.1% compared to the national average of 0.5%) (Table 1) (AACN, 2017).

Of the respondents, 30.9% (n=55) reported not having additional clinical experience other than clinical coursework, while 69.1% (n=123) indicated pre-licensure clinical experiences beyond clinical coursework. Of the respondents who indicated pre-licensure clinical experience, 4.5% had fewer than 3 months of experience, 18.5% had between 3 to 9 months of experience, and 46.1% had greater than 9 months of clinical experience beyond clinical coursework (Table 1). In addition, 53.9% indicated completion of a formal nursing informatics course as opposed to 46.1% who had not (Table 1).

Data Analysis

SANICS: Measure of Informatics Competency

Descriptive statistics were used to summarize the data obtained from completed surveys, and the Shapiro-Wilk test indicated the data was normally distributed for SANICS responses (p=0.058). The mean score for nursing informatics competency (Total SANICS) (see Table 2) indicates most students ranked their informatics competency at the competent level. As the population parameters are unknown the standard error of the mean was calculated resulting in a CI=26.78-28.4, therefore we are 95% confident that the population means falls within this range, accounting for non-response bias. Interval breakdown of total SANICS scores determined 2.8% of participants were Not Competent, 44.4% were Somewhat Competent, 44.4% were Competent, and 8.4% rated themselves as Proficient and/or Expert. Overall, 52.8% of participants rated themselves as being competent, proficient, or expert for informatics competency (Table 3).

Table 2

Scores of SANICS & SOPS™

	Participants	**Mean Score**	**Std. Dev**	**Min**	**Max**
SANICS Total	178	27.58	5.52	13.78	44.0
SOPS™ Total	178	52.89	9.71	32	79

** Higher mean score indicates higher levels of informatics competency and safety competency*

Table 3

Nursing Informatics (Total SANICS) Competency Rankings

SANICS Score	Number of Participants	Percentage of Total
≤ 17.62 Not Competent	5	2.8%
17.63-26.43 Somewhat Competent	79	44.4%
26.44-35.24 Competent	79	44.4%
35.25+ Proficient/Expert	15	8.4%
Total	178	100%

Hospital Survey on Patient Safety Culture 2.0 (SOPS™)

Respondents also completed survey questions derived from the *Hospital Survey on Patient Safety Culture SOPS™ 2.0* (Appendix B). The survey is designed to help organizations improve and understand the institution's patient safety culture (AHRQ, 2019). The overall modified SOPS™ total score ranges from 0 to 85 with a mean of 52.89 (SD=9.71). The higher the mean score on SOPS™, the higher the overall safety competency the respondent possesses (Table 2). As the population parameters are unknown the standard error of the mean was calculated resulting in a CI=51.46-54.32, therefore we are 95% confident that the population means falls within this range, accounting for non-response bias. The Shapiro-Wilk test indicated the sample was normally distributed (p=0.115). Table 4 reports the individual safety composite scores for respondents. For each composite, a higher score indicates a higher measure of safety related to that composite.

Table 4

*SOPS™ Composite Scores**

SOPS™ Composite	Participants	Mean	Std. Dev.	Min	Max
Teamwork	178	10.77	2.15	4	15
Organizational Learning	178	10.80	1.80	7	15
Response to Errors	178	13.10	2.59	7	20
Communication About Errors	178	9.20	3.51	1	15
Reporting Errors	178	4.26	3.50	0	10
Number of Reported Errors	178	1.35	0.64	0	5
Overall Safety Rating	178	3.35	0.75	1	5

*A higher score indicates a higher level of safety.

Perceived Usefulness of Technology

The mean perceived usefulness of technology score was 3.79 (SD = 0.70). With a range of 1-5, a higher score indicates higher usefulness of technology. This score suggests most participants agreed that using health-IT would enhance clinical effectiveness on the job.

Research Questions Analysis

Research Question 1 (RQ1)

RQ1: What is the level of nursing informatics competency and safety competency in pre-licensure nursing students.

Students' mean score on the SANICS representing their overall informatics competency was 27.58 (SD = 5.52) (see Table 2). Adjusting for weight, the mean score for SANICS indicated the majority of students (52.8%) ranked themselves as competent, proficient, or expert in regard

to informatics competency, while 44.4% ranked themselves as somewhat proficient in informatics competencies (Table 3).

The students' mean score on the SOPS™ was 52.89 (SD = 9.71) out of a total of 85. A higher overall and/or individual composite score indicated a higher overall safety competency rating or composite measure respectively when trying to make between group comparisons on safety competency. The mean safety composite scores for SOPS™ reported in Table 4 indicated higher mean scores for response to errors, organizational learning, and teamwork compared to reporting errors and number of reported errors.

Hypothesis 1 (H1)

H1: There will be a difference in scores between nursing informatics competency and safety competency with having a nursing informatics course. Independent *t*-tests were conducted to determine the difference between groups who have had a formal informatics course versus those who have not had a formal informatics course on their scores on SANICS and SOPS™. We reject H1 as having a formal informatics course was not associated with an increase in informatics (SANICS) or safety competency (Total SOPS™ score) and SOPS™ composite scores (see Table 5).

Table 5

Results of an Informatics Course (IC) on SANICS, SOPS™, and SOPS™ Composites

	IC		No IC		*t*(176)	*p*	Cohen's *d*
	M	***SD***	***M***	***SD***			
SANICS total score	27.78	5.56	27.34	5.49	-0.53	.59	5.53
SOPS™ total score	52.57	9.60	53.27	9.88	0.48	.64	9.73
†Organizational learning	10.71	1.76	11.00	1.85	1.0	.30	1.80
†Response to error	12.98	2.54	13.23	2.65	0.62	.54	2.59
†Communication about errors	9.21	3.28	9.20	3.78	-0.02	.98	3.52
†Reporting errors	4.08	3.40	4.47	3.60	0.75	.46	3.49
†Teamwork	10.75	1.98	10.79	2.34	0.13	.90	2.15

Note: † = Composite

Hypothesis 2 (H2)

H2: There will be a difference in scores between nursing informatics competency and safety competency with having a pre-licensure position in healthcare. Independent *t*-tests were conducted to determine the difference between groups who have pre-licensure experiences versus those who do not have pre-licensure experience on their scores on SANICS and SOPS™. We partially accept the hypothesis in that the safety composites (SOPS™ composite) of organizational learning, response to error, and teamwork were not significantly associated with having pre-licensure experience. However, the results indicated that students with pre-licensure positions in healthcare reported higher scores on informatics competency through the total

SANICS score, as well as safety competency through the total SOPS™ score and the SOPS™ composite scores of communication about errors and reporting errors (see Table 6).

Table 6

Results of a Pre-licensure Position (PP) on SANICS, SOPS™ and SOPS™ Composites

	PP		No PP		*t*(176)	*p*	Cohen's *d*
	M	***SD***	***M***	***SD***			
SANICS total score	28.45	5.79	25.66	4.29	-3.57	.001***	5.38
SOPS™ total score	54.01	9.67	50.40	9.43	-2.32	0.02**	9.59
†Organizational learning	10.87	1.89	10.80	1.59	-0.24	0.81	1.81
†Response to error	12.99	2.73	13.34	2.22	0.84	0.40	2.59
†Communication about errors	9.934	3.09	7.60	3.87	-3.94	.001***	3.35
†Reporting errors	4.66	3.42	3.38	3.52	-2.28	0.02**	3.45
†Teamwork	10.80	2.22	10.80	1.99	0.13	0.90	2.15

Note: † = Safety composite, significant at *p<.05; ** p<.01; ***p<.001

Hypothesis 3 (H3)

H3: Higher perceived usefulness of information technology will be associated with higher nursing student informatics competency and safety competency. Correlational analysis was used to evaluate if respondents' perceived usefulness of information technology predicted higher informatics and safety competency scores. We partially support H3, as a higher perceived usefulness of information technology score was weakly but significantly correlated with a higher informatics competency score (SANICS) (see Table 7). There was not a significant correlation

between a higher perceived usefulness of information technology score and higher safety competency (total SOPS™ score or SOPS™ composites scores).

Table 7

Correlations of Perceived Usefulness of IT with SANICS, SOPS™, and SOPS™ Composites (2-tailed)

Variable	n	1	2	3	4	5	6	7
1. PUT	178	-						
2.SANICS	178	.176**	-					
3. SOPS™	178	.113	.359***	-				
4. TCS	178	.040	.228***	.615***	-			
5. OLCS	178	.114	.224***	.669***	.538***	-		
6. RTECS	178	.081	.091	.584***	.436***	.459***	-	
7. CECS	178	.055	.315***	.754***	.236***	.301***	.167**	-
8. RECS	178	.053	.293***	.707***	.158**	.253***	.104	.585***

Note: PUT = Perceived usefulness of Technology, TCS = Teamwork Composite Score, OLCS = Organizational Learning Composite Score, RTECS = Response to Errors Composite Score, CECS = Communication About Errors Composite Score, RECS = Reporting Errors Composite Score.

Significant at *p<.05; ** p<.01; ***p<.001

Hypothesis 4 (H4)

H4: Higher BSN grade level will be associated with nursing student informatics competency and safety competency. Linear regression was used to test if higher student BSN grade level predicted higher informatics competency (total SANICS score). We partially accept H4, as a higher BSN grade level did significantly predict an increase in student informatics competency. However, BSN grade level was not a significant predictor of increases in safety competency. The following model (see Table 8) shows BSN level explained 6.1% of the variance in informatics competency

(R^2 = .061, F(1, 176) = 11.38, p< .001). Higher levels of college education significantly predicted higher levels of informatics competency.

A multiple regression was conducted to determine the effect of adding both BSN grade level and perceived usefulness of technology as predictors of informatics competency (SANICS). Regression results indicated the overall model significantly predicts informatics competency (R^2 = .074, F(2, 175) = 6.944, p < .001). With the addition of perceived usefulness of technology and BSN grade level, the model accounted for 7.4% of the variance in informatics competency, while the adjusted R-squared indicated only 6.3% of variance with the additional of perceived usefulness as a predictor in the model (see Table 9).

A third regression was used to test if higher student BSN grade level predicted higher safety competency (SOPS™ score). The following model shows BSN grade level explained 0.4% of the variance in safety competency (R^2 = .004, F(1, 176) = .739, p = .391. A higher grade level in a BSN program was not a significant predictor of safety competency.

Table 8

BSN Grade Level as a Predictor of Informatics Competency (SANICS)

Predictor Variable	B	SE	β	t	p-value
BSN Grade level	1.50	.447	.246	3.37	.001***

Significant at *p<.05; ** p<.01; ***p<.001

Table 9

BSN Grade Level and Perceived Usefulness as a Predictor of Informatics Competency (SANICS)

Predictor Variables	**B**	**SE**	**β**	**t**	***p*-value**
BSN Grade Level	1.31	.463	.214	2.83	.005**
Perceived Usefulness	.934	.602	.118	1.55	.122

Significant at *p<.05; ** p<.01; ***p<.001

Hypothesis 5 (H5)

H5: Higher student nurse informatics competency will predict higher nurse safety competency. A simple linear regression was used to test if nurse informatics competency (total SANICS) predicted higher nurse safety competency (total SOPS™). We support H5, as nurse informatics competency predicted a higher nurse safety competency. The overall regression was statistically significant (R^2 = 0.129, F(1, 176) = 26.04, p < .001). Informatics competency significantly predicted safety competency (β = .359, t(176) = 5.10, p < .001), and accounted for 12.9% of the variance in safety competency (see Table 10). No adjustment was made for students who had no clinical experience.

A multiple regression was conducted to determine the effect of adding BSN grade level and perceived usefulness, in addition to SANICS, to the model. The SANICS model with the addition of perceived usefulness of technology and BSN grade level accounted for (13.3%) of the variance in safety competency (R^2 = 0.133, F(3, 174) = 8.88, p < .001). With the addition of these additional predictors, the model's adjusted R-squared accounted for 11.8% of the variance in the model. Regression results indicated that SANICS was found to be a significant predictor of

safety competency (see Table 11). Therefore, H5 was supported, and the results are discussed in the following chapter.

Table 10

Informatics Competency (SANICS) as a Predictor of Safety Competency (SOPS™)

Predictor Variable	**B**	**SE**	**β**	**t**	***p*-value**
SANICS total	.632	.124	.359	5.10	.001***

Significant at *p<.05; ** p<.01; ***p<.001

Table 11

Informatics (SANICS), Perceived Usefulness of Technology, and BSN Grade Level as Predictors of Safety Competency (SOPS™)

Predictor Variables	**B**	**SE**	**β**	**t**	***p*-value**
BSN Grade Level	-.434	.81	-.040	-.537	.592
Perceived Usefulness	.855	1.03	.061	.827	.409
SANICS	.630	.129	.358	4.88	.001***

Significant at *p<.05; ** p<.01; ***p<.001

Results Summary

The findings reveal that pre-licensure work experience was associated with an increase in nursing informatics and safety competency when compared to students without pre-licensure work experience. There was a positive correlation between perceived usefulness of technology and nursing informatics competency, but this correlation was not associated with safety competency. Higher BSN grade level was a predictor of higher nursing informatics competency but not a predictor for safety competency. Nursing informatics competency as measured by SANICS was a predictor of higher safety scores, explaining 12.9% of the variance in SOPS™.

Having a nursing informatics course was not associated with improving overall nursing informatics competency or safety competency.

Chapter 5

Discussion

The goal of this cross-sectional study was to explore the relationship between pre-licensure nurses' perceived nursing informatics competencies and increased exposure to the sociotechnical culture through pre-licensure clinical experience in modern complex adaptive health systems and the association with both informatics and safety competencies scores. Research questions to be answered by this study are as follows:

RQ1: What is the level of nursing informatics competency and safety competency in pre-licensure nursing students?

H1: There will be a difference in scores between nursing informatics competency and safety competency with having a nursing informatics course.

H2: There will be a difference in scores between nursing informatics competency and safety competency with having a pre-licensure position in healthcare.

H3: Higher perceived usefulness of information technology will be associated with higher nursing student informatics competency and safety competency.

H4: Higher BSN grade level will be associated with higher nursing student informatics competency and safety competency.

H5: Higher student nurse informatics competency will predict higher nurse safety competency.

In this chapter, I discuss and interpret major research findings and implications of these findings for nursing education, the preparation-practice gap, healthcare administration, informatics, and safety. In addition, I outline limitations of this study and suggestions for future research.

Interpretation of the Findings

Informatics Competency

The results of students' self-reported informatics competency using SANICS indicated their overall nursing informatics competency to be at the level of competent, proficient, or expert (52.8%) in their use of informatics principles. It is concerning that 48.2% ranked themselves as somewhat proficient (44.4%) or not competent (2.8%) in their informatics competency, given the importance of how health-IT is utilized in today's healthcare systems. Despite the belief that students today are skilled with technology (e.g., searching the internet and using social media platforms), many are deficient regarding information literacy skills such as critically evaluating sources of information and competently integrating clinical information into their care practices (Bove, 2019). Bove and Saur (2022) reported that graduates of nursing programs need to have at least a proficient competency level in informatics to understand the health-IT they will be using to provide optimal care. These results indicate a need to further understand why these subjects reported such a low level of confidence regarding informatics competency and how nursing education can improve this competency.

Based on this study's findings, it is recommended that BSN education focuses on applying informatics competencies. Students should have the ability to use an EHR, interact with clinical decision support systems, and understand how accurate data entry is essential to patient safety. Particular attention should be given to having students extract data from clinical data sets, identify, evaluate, and apply the most relevant information. Health-IT safety can be jeopardized by the notion suggested by Nelson & Staggers, (2018) of the phenomena related to 'garbage in garbage out' (GIGO) resulting from inaccurate data entry into the EHR. The notion of GIGO would emphasize to students how data entry has grave patient consequences if patient

assessment data is entered inaccurately into the EHR. Inaccurate data can trigger CDS recommendations that may not be needed, potentially resulting in errors such as duplication of services or unwarranted treatment regiments to patients. Additional recommendations include applying and evaluating patient monitoring systems when providing care to aid in understanding physical assessment cues to improve response rates and initiation of interventions to reduce safety related events (e.g., bed alarms, telemetry alarms, IV infusion therapy pump alarms etc.). These specific recommendations focus on practical application of informatics principles to augment didactic content to develop the necessary skills needed to confidently function in today's healthcare environment.

New nurses entering the workforce need to be competent in using health-IT not only to function effectively in contemporary healthcare, but also to deliver safer care. The goal of health-IT is for users to leverage these tools in the provision of care to improve healthcare efficiencies, bolster communication between providers and patients, and assist users in augmenting their clinical decision-making process to ultimately improve health and safely manage health conditions (AACN, 2022). Health-IT is regarded as a means to transform the healthcare system by improving safety through technology utilization, so it is incumbent upon healthcare providers to be equipped with the knowledge, skills, and attitudes to use the technology competently to meet this challenge. Results of this study indicate that nursing educators need to enhance nursing students' confidence in using health-IT competently to care for patients in today's complex healthcare systems.

Informatics Coursework Influence

In this section, we examined the influence of formal informatics course completion and the association with nursing student informatics competency. Schools of nursing play an

important role in helping to develop health-IT awareness in students and ensuring that informatics is used safely by new graduate nurses entering the workforce. Students must learn to use health-IT effectively, recognize the benefits and limitations of the technology, and integrate technologies into the care they provide in a safe and effective manner (McGonigle et al., 2014). In its quest to develop highly skilled practitioners, nursing education has developed an extensive competency-based curriculum specifically designed to teach informatics as a domain in and throughout the nursing program (AACN, 2022). However, as nurse education has made improvements by adding competency-based informatics as a curriculum domain, barriers such as lack of faculty competency and the necessary time in BSN programs to teach informatics remains a problem (Bove, 2019).

The results indicated no significant difference between students having a formal informatics course compared to those who have not had an independent or formal course. While these findings were not expected, one explanation may involve the American Association of Colleges of Nursing (AACN) accreditation standards for BSN programs. To be accredited by AACN, BSN program must demonstrate how Domain-8 (*Informatics and Healthcare Technologies)* is taught in the nursing curriculum and how this domain is measured (AACN, 2022). Domain-8 advocates for entry-level users to be able use information and communication technology to gather data, create information, and use informatics processes to deliver safe nursing care (AACN, 2022). Even if a program does not have a formal informatics course dedicated solely to nursing informatics competencies in a BSN program, informatics content and healthcare technologies competencies needs to be woven into the curricular plan to meet accreditation standards. Thus, informatics competencies can be embedded in other BSN courses to meet the criteria of Domain-8.

The results are compelling: current curriculum is meeting standards set forth by AACN regarding informatics competency whether presented in a formal course or simply woven into the curriculum. Of the four schools of nursing surveyed, three schools provided a formal nursing informatics course. However, for both nursing programs offering a formal course and those using the woven-in approach, results indicate that faculty should facilitate the use of a more robust, practical, hands-on experience for learners regarding informatics principles such use of an EHRs during nursing interactive simulation training in laboratories (Bove, 2019; Khezri & Abdekhoda, 2019). Clinical experiences for students can vary in terms of settings, preceptors, and overall learning opportunities. Per Lee & Yang (2019), students may encounter difficulties during clinical rotations, including negative interpersonal relationships with healthcare professionals, feelings of powerlessness in clinical environments, exclusion from professional groups, and insufficient time in clinical rotations. Being aware of these limitations of clinical training nursing educators can use simulation laboratory experiences to teach and develop the necessary skills to safely use health-IT products to augment traditional didactic lectures of informatics content. Experiential learning techniques such as interactive simulation allow students the ability to apply informatics principles in context, helping them extract needed information to develop valuable health information literacy skills by using health-IT products in safe learning environments. As the use of health-IT will undoubtedly continue to grow, it is recommended to continue to support faculty to develop and enhance informatics competency to promote safe usage of health-IT in nursing education programs. The results of this study provide an opportunity to enlighten nursing educators about the importance of improving formal course offerings to bolster the content surrounding informatics usage in healthcare. Another recommendation would be to use SANICS

survey as a verifiable way to measure future changes made to the informatics curriculum and provides a gauge to assess current confidence levels of their students' informatics competency.

Pre-Licensure Work Experience Influences

In comparing students with pre-licensure clinical experience beyond clinical coursework (nurse aid or nurse tech positions) to those who do not have this additional clinical experience, those with pre-licensure experience scored significantly higher on informatics and safety competencies. Students with pre-licensure experience had a significantly higher mean average on informatics competency compared to students without additional clinical experience. In addition, students with pre-licensure experience scored a higher mean average on safety competency compared to students without additional clinical experience. These findings lend support to the role that early and prolonged assimilation of these students into the sociotechnical culture of the nursing workforce can enhance their understanding of safety principles and informatics usage in the clinical environment.

Pre-licensure students who work in the hospital system have an opportunity to work with health-IT products and have deep interactions with professional nurses during their shifts, providing context and application within the sociotechnical culture. Part of pre-licensure clinical work responsibilities can include obtaining vital signs and documentation in the EHR while communicating to nursing staff and patients. This additional practice of data entry and retrieval coupled with communication with professional nurses allows students to develop information literacy regarding information extraction from health-IT using the nursing process. Results of this study indicate that informatics competency is associated with hands-on usage of health-IT in pre-licensure positions, teaching nursing students the affordances and constraints of technology in real-life situations.

Compared to students who only had traditional faculty-led clinical experience, pre-licensure work experience students were associated with the added benefit of developing a higher level of safety competency. Students with pre-licensure work experience reported a higher level of safety competency. Having additional time to assimilate into the healthcare setting and its associated sociotechnical culture benefited their knowledge about safety, noted by their observations of communication about errors or error reporting mechanisms in hospital systems through socialization and interaction with nurses. This association is logical, as students with pre-licensure experience may be able to increase practice time in the usage of health-IT, coupled with exposure to Just Culture through this interaction with healthcare professionals.

Learning through formal and informal communication between staff and management regarding safety issues is more likely to occur as an employee versus a student on the clinical unit, as demonstrated by the study's findings. Students with pre-licensure experiences were more likely to report a safety event and report being aware of communication about safety-related issues compared to students without pre-licensure work experience. Students with pre-licensure work experience begin the assimilation process into the sociotechnical culture by learning the roles, norms, and skills necessary to form relationships to organize with co-workers to collectively solve problems (Sruthi et al., 2021). Pre-licensure positions facilitate student exposure to not only safety events but also the reporting mechanisms (non-punitive error reporting systems) healthcare institutions have in place, helping students learn about safety reporting systems and experience how a safe Just Culture should function.

The difference between these groups, those with pre-licensure work experience compared to those without, points to the importance of the amount of time these respondents with pre-licensure experiences spent embedded in the sociotechnical culture. Through exposure and

engagement, this increased time allowed students to socially partake in the construction of behaviors in CAS to influence and shape their attitudes, behaviors, and skills related to safety and informatics competencies. While the SOPS™ composites of organizational learning and response to errors was not significant, the overall safety (Total SOPS™) and composite scores of communication about errors and response to errors scores were significantly different between those with pre-licensure experience and those without. These results indicate that all students, regardless of pre-licensure employment, are still learning the value and key aspects of the safety composites while attending formal clinical rotations. However, students with pre-licensure work experience obtain a more profound understanding of the composites and overall safety principles.

Hospitals want to be good stewards when students arrive on their units. Safety-related issues and associated faults and vulnerabilities may not be openly discussed with outside employees such as students. Despite trying to create positive experiences during their clinical time, student experiences in hospital units can be fraught with incivility, negative interpersonal relationships with healthcare professionals, powerlessness in clinical environments, and insufficient time on clinical units (Lee & Yang, 2019; Keller et al., 2020). Therefore, students whose only pre-licensure work experiences are clinical rotations aligned with their schooling lack opportunities for informal conversations and assimilation with staff to learn the complete role of the nurse and the relationship of that role to the sociotechnical culture of the unit. Students without additional hospital experience beyond formal courses miss these opportunities and limit their understanding of informatics and safety competency in practice.

New nurses must develop skills to ensure patient safety by recognizing unsafe health-IT practices and using mechanisms in place to alert and inform the healthcare system. Shirali and

colleagues (2018) describe safety as something a system *does* versus something a system *has*. Achieving safety in the system requires constant vigilance to ensure safety is maintained on all subsystems, software, hardware, human-computer interaction, and human-to-human interaction. Achieving and maintaining safety requires a human-centered perspective on working in complex adaptive systems such as healthcare organizations. As Sittig and Singh's (2010) sociotechnical model explains, changes in one dimension have a ripple effect that can change the dynamics in an entire system. Therefore, as previously outlined, a cornerstone to achieving safety is the notion of Just Culture.

Maintaining a positive safety culture is necessary to inform the system, hospital, and unit staff members of near-misses or errors in patient care so the system can learn and evolve to continue to meet safety standards (AHRQ, 2019; Spath & Bass, 2011). Just Culture holds individuals accountable for reckless behaviors but uses a non-punitive reporting mechanism to help identify system hazards that may lead to safety issues (Walker et al., 2020). Left unchecked or underreported, potential safety issues within the system can lead to catastrophic errors and patient harm. Safety event reporting is regarded as a significant factor when assessing a healthcare system's patient safety culture as it provides a tool to promote safety and quality (Abuosi et al., 2022). Thus, students with increased exposure to the sociotechnical norms, workflow behaviors, health-IT usage, and communication about safety concerns through pre-licensure work experience in healthcare systems have the underlying knowledge needed to embrace a Just Culture and help improve the system as newly hired nurses. Therefore, it is recommended to encourage nursing students to seek out employment options in healthcare settings early in their BSN program to benefit from the interaction in the sociotechnical culture and Just Culture to enhance their informatics and safety competency.

Perceived Usefulness of Technology Influence

Using the *perceived usefulness of technology* item adopted from the Technology Acceptance Model (TAM), this study examined students' perceived usefulness of health-IT and how it will enhance their informatics competency. The results indicated a positive correlation between *perceived usefulness of technology* and student informatics competency. Specifically, a higher *perceived usefulness of technology* score was weakly correlated with a higher informatics competency, accounting for 31% of the variance explained. From a curricular perspective, it is necessary to ensure that students understand and value the usefulness of health-IT and make the connection that computer skills are necessary to augment clinical decision-making to enhance informatics competency and develop necessary skills to care for patients (Abdrbo, 2015). If students fail to see value in the health-IT ecosystem, the promise of a safer healthcare system through health-IT utilization and the investments made toward health-IT will not be realized.

From a safety perspective, *perceived usefulness of technology* was not found to be significantly related to higher scores on safety competency. While the results do not directly correlate with safety competency, a limitation may be only using one item to assess perceived usefulness of technology. However, this study's results indicate that improving students' perception of the usefulness of health-IT enhances their informatics competency and nursing informatics competency is a predictor of higher safety competency.

BSN Grade Level Assessment of Informatics and Safety Competency

Using linear regression, lower levels of college education were significantly associated with lower levels of informatics competency. These findings indicate that as students progress through a BSN program, they are associated with beginning to learn the necessary informatics concepts required in practice. Coursework coupled with clinical training can be a means to help

students develop the necessary knowledge, skills, and attitudes to obtain informatics competency by their senior year. Students in freshmen and sophomore level nursing courses have only begun learning about the concepts of informatics, and limited time spent in clinical areas have not provided enough time in the hospital's sociotechnical culture to apply informatics concepts fully. These students require additional assimilation time to begin the professional maturation process from novice to expert nurse (Benner, 2020).

Results comparing BSN grade level as a predictor of safety competency failed to indicate significance. These results can be explained by the nature of how nursing education programs teach the necessary informatics skills and safety competency in practice. Students in clinical rotations are governed by the clinical faculty instructor and primary nurse assigned to the patient, who oversee the actions of student nurses in the clinical environment to teach and ensure patient safety is not jeopardized during the leaning process. Students are beholden to the clinical instructor's and primary nurse's clinical judgement and are limited in their ability to independently act until they have demonstrated competency in the required clinical skills or have passed licensure examination. As students progress in the nursing program, they build on a foundation based on performing nursing care for patients, i.e., assessments, medication administration, medical procedures, etc. and learn to incorporate skill with health-IT tools to enhance clinical judgement to provide safe care.

As students develop their nursing skills, they simultaneously begin to accrue the necessary informatics competencies from health-IT usage. It takes time for students to assimilate into the sociotechnical culture to develop their own informatics competency and understand safety implications. However, depending on the quality and amount of time spent in clinical training, the potential exists that this assimilation and learning process can be hindered and

disrupted (Lee & Yang, 2019). Findings from this study suggest that encouraging students to pursue pre-licensure positions earlier in the BSN program will strengthen informatics and safety competencies sooner. This finding has implications for BSN nursing curriculum planning to recommend that students seek pre-licensure employment. These roles allow students in hospital settings to begin the assimilation process through hands-on patient care roles to help them observe and contribute to patient care.

Informatics Role in Safety

Competency in informatics contributes to improving safety competency among nursing students. Informatics competency was a significant predictor of safety competency, accounting for 12.9% of the variance in safety competency. The overall aim of health-IT is to help prevent errors by augmenting healthcare workers' clinical reasoning by using computer-generated clinical support tools to reduce cognitive load for healthcare staff (Piscotty et al., 2015). Effectiveness of health-IT is not only dependent on the quality of system data, but also how users access and extract the necessary data to make appropriate care interventions (information literacy) (Nelson & Staggers, 2018). Investment in health-IT and re-designs to clinical workflows have been implemented to reduce or eliminate medical errors and improve patient safety (Wachter, 2012). Therefore, students who have an understanding of the role of Just Culture will feel confident to report health-IT system errors or issues to help hospital systems identify latent conditions that may lead or contribute to adverse patient events. A recommendation for nursing education is to institute a Just Culture within the nursing programs to aid students in error recognition that may occur during clinical, simulation, or laboratory experiences. Having an adverse event reporting mechanism at the educational level will afford students the ability to use an event reporting system and begin to develop their skills to evaluate

clinical systems and potential health-IT system errors during their formative years. Results of the Model of Safety Competency (see Figure 3) indicate that students who obtain additional pre-licensure work experience coupled with higher understanding of informatics competency are in a stronger position to be safer nurses. This model confirms the need to continue to push for informatics competency and safety culture competency in nursing education programs as a vital initiative to move healthcare toward safer practice regarding health-IT usage.

Solutions to Practice-Gap Inequalities

Clinical education is essential to preparing students to apply theoretical knowledge and practice the needed skills to transition into the role of the registered nurse. At the same time, immersion into the sociotechnical culture through work experience in a healthcare setting (obtaining a position as a nurse's aide or patient care assistant) enables students to model social norms and behaviors necessary to leverage the complexity of the health-IT ecosystem (Barrett & Stephens, 2017). Challenges to formal coursework clinical training include lack of time and opportunities at clinical sites, and educators can't guarantee all students experience the same patient care opportunities. Furthermore, staff nurses may not be able to fully engage with students (socialization) because of the heavy workload nurses face in providing care affecting nursing students' assimilation into the sociotechnical culture of the nursing unit and the interactions of Just Culture to occur. Keller and colleagues (2020) reported that less experienced nurses and nursing students are more likely to be targeted for incivility. Incivility is defined as behaviors that break typical norms of respect for one's colleagues that is an ambiguous intent to harm (lateral violence or bullying) linked to decreased safety culture (Keller et al., 2020; Smith et al., 2018). Taken as a whole, these challenges limit students' exposure to the very skills they will need when they transition into the nurse role. Clinical experiences not only vary but can

cause emotional distress to students, affecting the quality of the educational experience (Lee & Yang, 2019). It can be challenging for students to interact with the healthcare team under highly stressful situations that arise. Unlicensed students typically rely on the clinical instructor to help them with communication and application of safe nursing care when the assigned primary nurse is not willing to assist.

The solution to improving the new hire practice-gap is for students to obtain additional exposure beyond the clinical coursework in the curriculum. The sooner students begin learning the sociotechnical culture and informal behavioral norms associated in maintaining not only a Just Culture but the usage of health-IT to provide safe healthcare, the quicker they will develop the necessary skills to thrive in this challenging environment. As Benner (2020) observes, it takes years to learn and mature into the role of the registered nurse. It is beneficial to advocate for students to seek additional learning opportunities through pre-licensure employment as nurse technicians or patient aids, or through nurse residency programs or internships/externships if available. It is through prolonged immersion in clinical care areas that nursing students experience and begin to create professional identities and behaviors. This study provides evidence to support an association between increased exposure to clinical settings through pre-licensure work experience enhances students' awareness of informatics in practice and recognition of safe practice behaviors.

In the sociotechnical model, Sittig & Singh (2010) explain that the people dimension (represented by nurses in CAS) is important as health-IT usage is influenced by the way people think through automated, computer-driven clinical decision support tools; how users feel about interaction with this technology is dependent on their social interactions with coworkers and the design of the human computer interface forming the sociotechnical culture. This relationship

between new hires and their coworkers' sociotechnical culture may explain the reason for the preparation-practice gap or lack of skill application with health-IT after graduation as students transition from the role of student to professional nurse. The preparation-practice gap is the assessment by hospital administrations and nursing educators of new hire/graduate readiness for nursing practice. This gap can be narrowed by additional exposure to pre-licensure work experience (Benner, 2020; Grochow, 2008; Hickerson et al., 2016). In support of Benner's (2020) advocacy for the theory of novice to expert, new graduates lacking pre-licensure work experience will eventually learn and transition into the role of the nurse effectively; however, it will take more time to assimilate. The sooner students begin to interact in the sociotechnical culture and develop the necessary attitudes, behaviors, and skills, the more competent they will become with safely using health-IT. Rooyen and colleagues (2019) advocate smoothing the transition from graduate to professional nurse through a supportive and positive organizational culture that values learning, proper matching of preceptors and mentors, and collaboration between healthcare and educational institutions. Narrowing the preparation-practice gap for new nurses depends upon successful assimilation into the sociotechnical culture, which includes allowing new nurses to comfortably ask questions and seek guidance from experienced peers as one mechanism to reduce knowledge deficits and errors by properly performing given tasks when using health-IT.

Implications for Practice and Research

Exposure to the sociotechnical culture beyond clinical rotations through pre-licensure work roles provides individuals with the opportunity to develop a greater understanding of informatics and safety competencies. The study highlighted the phenomenon of assimilation and the practical effects that previous studies have demonstrated regarding how informal

communication in healthcare units can influence both informatics and safety competency understanding and behaviors (Barrett & Stevens, 2017; Rouse, 2008). Recommendations for hospital nursing administration would be to advocate for hiring nursing students as patient aides or nurse technicians or justify creation of externships to bring potential future hires into their units sooner to begin their transition from student to nurse expert. Recommendations for nurse educators include encouraging students to seek pre-licensure work experiences after completing their first clinical course to begin assimilation and transition to the nursing role in their formative years to enhance and apply theoretical nursing concepts. Aligned with these recommendations, it may be important to encourage students to seek opportunities for nurse residency programs after graduation to help gain further experience and promote assimilation into the practice environment.

Future Research

Future research should examine sociotechnical socialization factors in greater depth for pre-licensure nursing students work experiences and understanding the healthcare worker's sociotechnical culture. Examining the influence of increased assimilation time through pre-licensure experience in the sociotechnical culture may help with understanding the organizational work culture as it relates to both patient safety and incivility among coworkers. There is a need to develop a sociotechnical culture instrument to help hospital administrators measure their hospital staff's sociotechnical culture and Just Culture interaction specifically related to the safe usage of health-IT behaviors and factors that compromise patient safety. A positive work environment lowers incivility, which can lead to acceptance into the workforce's sociotechnical culture that can help newly hired nurses begin the transition from student to the role of registered nurse (Smith et al., 2018). Understanding the sociotechnical culture aspects of

pre-licensure employment would allow nurse educators to replicate components or address factors missing from the current teaching model to improve student transition to the role of registered nurse. Future research should examine the transition from pre-licensure student to expert nurse to determine the amount of time to achieve competency for both informatics and safety competency. In addition, conducting a follow-up study that analyzes data from the full population through recruitment and expanding on the number of BSN programs and comparing these results to the initial study's findings is recommended.

Limitations

Limitations of using cross-sectional and correlational research strategies include inability to determine whether one variable causes another. While correlational research can help determine if variables co-vary, it cannot establish time precedence, provide alternative explanations for any of the relationships found, or determine causal inference. Potential limitations also include use of a convenience sample of nurse administrators to secure permission to deploy the single-stage sample survey, as well as a low survey response rate (11.2%) and completion rate (8.9%). Another limitation was the inability to access the student listservs to obtain an accurate sample population number, which limited an accurate response rate using the American Association for Public Opinion Research (AAPOR) standards. In addition, a standard error of the mean was unable to be calculated which would have helped to estimate the effect of error related to non-response bias, however without having an exact population sample limited this ability. The inability to compare and evaluate non-response bias by lack of access to the listserv members was a limitation. Lack of access prevented the ability to contact members to

conduct interviews regarding the study's key measures towards initial non-responders from the study's listserv population and/or compare early versus late respondents to the survey.

Although the response rate was low, the sample provided reliable data for the study's concepts as the response rate was similar to previous research regarding the use of college students in general when using web-based surveys (Fosnacht et al, 2017). The low response rate could have been due to survey fatigue given students' hectic schedules or the length of the survey (estimated completion time of 15 minutes with less than 10 minutes as ideal), the short length of deployment (only 3 weeks), lack of incentive, and inability to access the listserv personally to follow-up with multiple reminders. The self-reported nature of surveys is a limitation as respondents over or underestimate both their safety and informatics competency as there was no direct observable informatics or safety behaviors observed or recorded. Another limitation was modification of the SOPS™ survey, which prevented the ability to benchmark scores to other hospital systems safety results. Using only perceived usefulness from the Technology Acceptance Model limited analysis and explanatory understanding of the findings derived from this instrument. The racial make-up of the study was predominately white/Caucasian females which under-represented black/African American populations and over-represented the number of males in comparison to typical racial/gender make-ups of BSN programs. The low response rate and the demographic make-up of the sample population limit the generalizability of the study's results based on non-response bias given the disproportion of responders influencing the study's findings.

Conclusion

This study was conducted to explore the relationship between pre-licensure nurses' perceived nursing informatics competency and the association of increased exposure to the

sociotechnical culture in modern complex adaptive health systems and the relationship to both informatics and safety competencies. In addition, the study examined nursing informatics competency as a predictor for safety competency. The findings indicate that pre-licensure experience was associated with higher students' nursing informatics and safety competencies scores. Nursing informatics was positively associated with improvements in safety competency as well. Therefore, it is incumbent upon all members of the healthcare team, including administration, students, faculty, and staff, to understand the importance of exposure to the sociotechnical culture through pre-licensure work experiences on patient safety. Nursing and clinical educators need to continue to develop students' understanding of safety culture to improve patient care. These findings should help stimulate discussion for nursing educators about improving access for students to pre-licensure experience in healthcare environments, as well as continuing to strengthen the importance of informatics concepts in nursing curriculum as an important contributor to improved patient safety.

Appendix A

Self-Assessment of Informatics Competency Scale for Health Professionals (SANICS)

For each statement, indicate your current level of competency on the scale of 0 to 4, where:

0 = Not competent, 1 = Somewhat competent, 2 = Competent, 3 = Proficient, and 4 = Expert

Basic computer skills	1. Demonstrate basic technology skills (e.g., turn computer off and on, load paper, change toner, remove paper jams, print documents)	0	1	2	3	4
	2. Use e-mail	0	1	2	3	4
	3. Conduct on-line literature searches (e.g., PubMed)	0	1	2	3	4
	4. Use applications to manage aggregated data (e.g., excel, database, statistical software)	0	1	2	3	4
Role	5. Recognize that the computer is only a tool to provide better nursing care and that there are human functions that cannot be performed by computer	0	1	2	3	4
	6. Recognize the value of clinician involvement in the design, selection, implementation, and evaluation of applications, systems in health care	0	1	2	3	4
Applied computer skills : Clinical Informatics	7. Extract data from clinical data sets (e.g., Clinical data warehouse, Minimum Data Set)	0	1	2	3	4
	8. Incorporate structured languages into practice (e.g., ICD9 or 10 codes, CPT codes, diagnoses codes)	0	1	2	3	4
	9. Describe ways to protect data	0	1	2	3	4
	10. Assess accuracy of health information on the Internet	0	1	2	3	4
	11. Identify, evaluate, and apply the most relevant information	0	1	2	3	4
	12. Use application to document patient care	0	1	2	3	4
	13. Identify, evaluate, and use electronic patient education materials appropriate to language and literacy level at the point of care	0	1	2	3	4
	14. Use decision support systems, expert systems, and aids for differential diagnosis	0	1	2	3	4
	15. Act as an advocate of system users including patients and colleagues	0	1	2	3	4

	16. Participate as a content expert to evaluate information and assist others in developing information structures and systems to promote their area of nursing practice	0	1	2	3	4
	17. Applies monitoring system appropriately according to the data needed	0	1	2	3	4
	18. Describe general applications/systems to support clinical care	0	1	2	3	4

Use and Scoring

Please enter your discipline name in item 5 and 16 prior to use. Total score ranges from 0 to 44.064 using the following weight. Each subscale score can be calculated separately. Because it measures the level of self-confidence, absolute number varies by target population. The best use of the tool may be to apply it before and after your intervention and compare the results. Please properly cite for the use.

Item	Score weight
1	0.344
2	0.377
3	0.378
4	0.409
5	0.410
6	0.430
7	0.492
8	0.505
9	0.528
10	0.528
11	0.549
12	0.553
13	0.573
14	0.578
15	0.586
16	0.593
17	0.606
18	0.612

Reference

Yoon, S., Yen, P. Y., & Bakken, S. (2009). Psychometric properties of the self-assessment of nursing informatics competencies scale. *Studies in Health Technology and Informatics*, *146*, 546-50. PMID: 19592902. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2858312/

Appendix B

Hospital Survey on Patient Safety (Version 2.0) (SOPS™)

Instructions

This survey asks for your opinions about patient safety issues, medical error, and event reporting in your hospital and will take about 10-15 minutes to complete. If a question does not apply to you or your hospital or you don't know the answer, please select "Does Not Apply or Don't Know."

- ***"Patient safety"*** *is defined as the avoidance and prevention of patient injuries or adverse events resulting from the processes of healthcare delivery.*
- ***A "patient safety event"*** *is defined as any type of healthcare-related error, mistake, or incident, regardless of whether or not it results in patient harm.*

Your Staff Position

1. **What is your position in this hospital?**

   Select ONE answer.

   Nursing
   - ☐1 Advanced Practice Nurse (NP, CRNA, CNS, CNM)
   - ☐2 Licensed Vocational Nurse (LVN), Licensed Practical Nurse (LPN)
   - ☐3 Patient Care Aide, Hospital Aide, Nursing Assistant
   - ☐4 Registered Nurse (RN)

   Medical
   - ☐5 Physician Assistant
   - ☐6 Resident, Intern
   - ☐7 Physician, Attending, Hospitalist

   Other Clinical Position
   - ☐8 Dietitian
   - ☐9 Pharmacist, Pharmacy Technician

   Supervisor, Manager, Clinical Leader, Senior Leader
   - ☐15 Supervisor, Manager, Department Manager, Clinical Leader, Administrator, Director
   - ☐16 Senior Leader, Executive, C-Suite

   Support
   - ☐17 Facilities
   - ☐18 Food Services
   - ☐19 Housekeeping, Environmental Services
   - ☐20 Information Technology, Health Information Services, Clinical Informatics
   - ☐21 Security
   - ☐22 Transporter

☐10 Physical, Occupational, or Speech Therapist
☐11 Psychologist
☐12 Respiratory Therapist
☐13 Social Worker
☐14 Technologist, Technician (e.g., EKG, Lab, Radiology)
☐23 Unit Clerk, Secretary, Receptionist, Office Staff

Other
☐24 Other, please specify:

Your Unit/Work Area

2. Think of your "unit" as the work area, department, or clinical area of the hospital where you spend *most* of your work time. What is your primary unit or work area in this hospital?

Select ONE answer.

Multiple Units, No specific unit

☐1 Many different hospital units, No specific unit

Medical/Surgical Units

☐2 Combined Medical/Surgical Unit

☐3 Medical Unit (Non-Surgical)

☐4 Surgical Unit

Patient Care Units

☐5 Cardiology

☐6 Emergency Department, Observation, Short Stay

☐7 Gastroenterology

☐8 ICU (all adult types)

☐9 Labor & Delivery, Obstetrics & Gynecology

☐10 Oncology, Hematology

☐11 Pediatrics (including NICU, PICU)

☐12 Psychiatry, Behavioral Health

☐13 Pulmonology

☐14 Rehabilitation, Physical Medicine

☐15 Telemetry

Surgical Services

☐16 Anesthesiology

☐17 Endoscopy, Colonoscopy

☐18 Pre Op, Operating Room/Suite, PACU/Post Op, Peri Op

Clinical Services

☐19 Pathology, Lab

☐20 Pharmacy

☐21 Radiology, Imaging

☐22 Respiratory Therapy

☐23 Social Services, Case Management, Discharge Planning

Administration/Management

☐24 Administration, Management

☐25 Financial Services, Billing

☐26 Human Resources, Training

☐27 Information Technology, Health Information Management, Clinical Informatics

☐28 Quality, Risk Management, Patient Safety

Support Services

☐29 Admitting/Registration

☐30 Food Services, Dietary

☐31 Housekeeping, Environmental Services, Facilities

☐32 Security Services

☐33 Transport

Other

☐34 Other, please specify:

SECTION A: Your Unit/Work Area

How much do you agree or disagree with the following statements about your unit/work area?

Think about your unit/work area:	Strongly Disagree ▼	Disagree ▼	Neither Agree nor Disagree ▼	Agree ▼	Strongly Agree ▼	Does Not Apply or Don't Know ▼
1. In this unit, we work together as an effective team.....	☐1	☐2	☐3	☐4	☐5	☐9
2. In this unit, we have enough staff to handle the workload.....	☐1	☐2	☐3	☐4	☐5	☐9
3. Staff in this unit work longer hours than is best for patient care	☐1	☐2	☐3	☐4	☐5	☐9
4. This unit regularly reviews work processes to determine if changes are needed to improve patient safety	☐1	☐2	☐3	☐4	☐5	☐9
5. This unit relies too much on temporary, float, or PRN staff.....	☐1	☐2	☐3	☐4	☐5	☐9
6. In this unit, staff feel like their mistakes are held against them	☐1	☐2	☐3	☐4	☐5	☐9
7. When an event is reported in this unit, it feels like the person is being written up, not the problem	☐1	☐2	☐3	☐4	☐5	☐9
8. During busy times, staff in this unit help each other.....	☐1	☐2	☐3	☐4	☐5	☐9
9. There is a problem with disrespectful behavior by those working in this unit...	☐1	☐2	☐3	☐4	☐5	☐9
10. When staff make errors, this unit focuses on learning rather than blaming individuals.....	☐1	☐2	☐3	☐4	☐5	☐9
11. The work pace in this unit is so rushed that it negatively affects patient safety...	☐1	☐2	☐3	☐4	☐5	☐9
12. In this unit, changes to improve patient safety are evaluated to see how well they worked.....	☐1	☐2	☐3	☐4	☐5	☐9

13. In this unit, there is a lack of support for staff involved in patient safety errors	☐1	☐2	☐3	☐4	☐5	☐9
14. This unit lets the same patient safety problems keep happening	☐1	☐2	☐3	☐4	☐5	☐9

SECTION B: Your Supervisor, Manager, or Clinical Leader

How much do you agree or disagree with the following statements about your immediate supervisor, manager, or clinical leader?

	Strongly Disagree ▼	Disagree ▼	Neither Agree nor Disagree ▼	Agree ▼	Strongly Agree ▼	Does Not Apply or Don't Know ▼
1. My supervisor, manager, or clinical leader seriously considers staff suggestions for improving patient safety	☐1	☐2	☐3	☐4	☐5	☐9
2. My supervisor, manager, or clinical leader wants us to work faster during busy times, even if it means taking shortcuts	☐1	☐2	☐3	☐4	☐5	☐9
3. My supervisor, manager, or clinical leader takes action to address patient safety concerns that are brought to their attention	☐1	☐2	☐3	☐4	☐5	☐9

SECTION C: Communication

How often do the following things happen in your unit/work area?

Think about your unit/work area:	Never ▼	Rarely ▼	Some-times ▼	Most of the time ▼	Always ▼	Does Not Apply or Don't Know ▼

1. We are informed about errors that happen in this unit	☐1	☐2	☐3	☐4	☐5	☐9
2. When errors happen in this unit, we discuss ways to prevent them from happening again	☐1	☐2	☐3	☐4	☐5	☐9
3. In this unit, we are informed about changes that are made based on event reports	☐1	☐2	☐3	☐4	☐5	☐9
4. In this unit, staff speak up if they see something that may negatively affect patient care	☐1	☐2	☐3	☐4	☐5	☐9
5. When staff in this unit see someone with more authority doing something unsafe for patients, they speak up	☐1	☐2	☐3	☐4	☐5	☐9
6. When staff in this unit speak up, those with more authority are open to their patient safety concerns	☐1	☐2	☐3	☐4	☐5	☐9
7. In this unit, staff are afraid to ask questions when something does not seem right.....	☐1	☐2	☐3	☐4	☐5	☐9

SECTION D: Reporting Patient Safety Events

Think about your unit/work area:	Never ▼	Rarely ▼	Some-times ▼	Most of the time ▼	Always ▼	Does Not Apply or Don't Know ▼
1. When a mistake is caught and corrected before reaching the patient, how often is this reported?	☐1	☐2	☐3	☐4	☐5	☐9
2. When a mistake reaches the patient and could have harmed the patient, but did not, how often is this reported?	☐1	☐2	☐3	☐4	☐5	☐9

3. In the past 12 months, how many patient safety events have you reported?

☐a. None
☐b. 1 to 2
☐c. 3 to 5
☐d. 6 to 10
☐e. 11 or more

SECTION E: Patient Safety Rating

1. How would you rate your unit/work area on patient safety?

Poor ▼	Fair ▼	Good ▼	Very Good ▼	Excellent ▼
☐1	☐2	☐3	☐4	☐5

SECTION F: Your Hospital

How much do you agree or disagree with the following statements about your hospital?

Think about your hospital:	Strongly Disagree ▼	Disagree ▼	Neither Agree nor Disagree ▼	Agree ▼	Strongly Agree ▼	Does Not Apply or Don't Know ▼
1. The actions of hospital management show that patient safety is a top priority	☐1	☐2	☐3	☐4	☐5	☐9

2. Hospital management provides adequate resources to improve patient safety	☐1	☐2	☐3	☐4	☐5	☐9
3. Hospital management seems interested in patient safety only after an adverse event happens.....	☐1	☐2	☐3	☐4	☐5	☐9
4. When transferring patients from one unit to another, important information is often left out.....	☐1	☐2	☐3	☐4	☐5	☐9
5. During shift changes, important patient care information is often left out	☐1	☐2	☐3	☐4	☐5	☐9
6. During shift changes, there is adequate time to exchange all key patient care information	☐1	☐2	☐3	☐4	☐5	☐9

Background Questions

1. How long have you worked in this <u>hospital</u>?

☐a. Less than 1 year
☐b. 1 to 5 years
☐c. 6 to 10 years
☐d. 11 or more years

2. In this hospital, how long have you worked in your current <u>unit/work area</u>?

☐a. Less than 1 year
☐b. 1 to 5 years
☐c. 6 to 10 years
☐d. 11 or more years

3. Typically, how many hours per week do you work in this <u>hospital</u>?

☐a. Less than 30 hours per week
☐b. 30 to 40 hours per week
☐c. More than 40 hours per week

4. In your staff position, do you typically have direct interaction or contact with patients?

☐a. YES, I typically have direct interaction or contact with patients
☐b. NO, I typically do NOT have direct interaction or contact with patients

Your Comments

Please feel free to provide any comments about how things are done or could be done in your hospital that might affect patient safety.

Thank you for completing this survey.

Appendix C

Consent to Participate in a Research Study

Study Title: Nursing informatics competency: Assimilation into the sociotechnical culture on healthcare technology and understanding of safety culture

Principal Investigators: Jeremy Jarzembak (Doctoral Candidate) & Dr. Rebecca Meehan

You are being invited to participate in a research study. This consent form will provide you with information on the research project, what you will need to do, and the associated risks and benefits of the research. Your participation is voluntary. Please read this form carefully. It is important that you ask questions and fully understand the research in order to make an informed decision.

Purpose

The purpose of this study is to explore the relationship between pre-licensure nurses' perceived informatics competencies and how increased exposure to healthcare systems can help inform nurse educators in improving both students' informatics and safety competencies.

Procedures

The survey is anonymous and will take 7-10 minutes to complete. There are no follow-up requirements, and you may revoke your consent at any time. The survey will ask you about your experiences with safety in the clinical units you have visited and your assessment of your familiarity with nursing informatics.

Benefits

This research will not benefit you directly. However, your participation will help us better understand student nursing informatic and safety competencies.

Risks and Discomforts

There are no anticipated risks beyond those encountered in everyday life.

Confidentiality

We will keep your information confidential within the limits of the law, but due to the nature of the internet there is a chance that someone could access information that may identify you without permission. No personal information will be collected.

Future Research

Your de-identified information will not be used or shared with other researchers.

Voluntary

Participation in this study is voluntary. You may discontinue participation at any time without penalty or loss of benefits. Your participation or non-participation will not affect your grades.

If you have any questions or concerns about this research, you may contact Jeremy Jarzembak at 330-672-8781 or jjarzemb@kent.edu. This project has been approved by the Kent State University Institutional Review Board. If you have any questions about your rights as a research participant or complaints about the research, you may call the IRB at 330-672-2704.

To participate click the button below. If you do not want to participate, exit the window.

Informatics & Safety Survey

Hello, I am doctoral student at Kent State University. I am conducting a study among nursing students and the relationship between informatics and safety in healthcare. Please complete this 7–10-minute survey. Your responses are anonymous. Thank you for your participation.

Q1. Please select your program of study

- Traditional BSN (1)
- Accelerated BSN (2)
- RN-BSN (3)
- Associate degree (4)
- Diploma (5)

Q.2 Have you completed a nursing informatics course?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Have you completed a nursing informatics course? = Yes

Q3. Indicate how many credit hours of nursing informatics course work you have taken.

- ○ 1 credit hour (1)
- ○ 2 credit hours (2)
- ○ 3 credit hours (3)
- ○ Greater than 3 credit hours (4)

Q4. Do you have healthcare work experience besides clinical course work?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Do you have healthcare work experience besides clinical course work? = Yes

Q5. Please select the response below that best represents your healthcare work history besides clinical courses

- ○ 3 months or less (1)
- ○ 3 to 9 months (2)
- ○ 9 months or greater (3)

Q6. Have you heard of the term “Just Culture” or “Safety Culture” in a work setting?

- ○ Yes (1)
- ○ No (2)

Q7. Select the response that best represents your current education level

- ○ Freshman (1st-year) (1)
- ○ Sophomore(second-year) (2)
- ○ Junior (3rd-year) (3)
- ○ Senior (4th-year) (4)
- ○ Graduated (Pre-licensure) (5)

For each of the following items please indicate your current level of competency related to computer usage and skills.

Q8. Demonstrate basic technology skills (e.g., turn computer off and on, load paper, change toner, remove paper jams, print documents)

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q9. Use e-mail

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q10. Conduct on-line literature searches (e.g., PubMed)

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q11. Use applications to manage aggregated data (e.g., excel, database, statistical software)

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q12. Recognize that the computer is only a tool to provide better nursing care and that there are human functions that cannot be performed by computer

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q13. Please select ‘expert’ to show you are paying attention to this question.

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q14. Recognize the value of clinician involvement in the design, selection, implementation, and evaluation of applications, systems in health care

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Page Break

Q15. Extract data from clinical data sets (e.g., Clinical data warehouse, Minimum Data Set)

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q16. Incorporate structured languages into practice (e.g., ICD9 or 10 codes, CPT codes, diagnoses codes)

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q17 Describe ways to protect data

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q18 Assess accuracy of health information on the Internet

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q19. Identify, evaluate, and apply the most relevant information

- Not competent (1)
- Somewhat competent (2)
- Competent (3)
- Proficient (4)
- Expert (5)

Q20. Use application (apps) to document patient care

- Not competent (1)
- Somewhat competent (2)
- Competent (3)
- Proficient (4)
- Expert (5)

Page Break

Q21. Identify, evaluate, and use electronic patient education materials appropriate to language and literacy level at the point of care

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q22. Use decision support systems, expert systems, and aids for differential diagnosis

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q23. Act as an advocate of system users including patients and colleagues

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q24. Participate as a content expert to evaluate information and assist others in developing information structures and systems to promote their area of nursing practice

- ○ Not competent (1)
- ○ Somewhat competent (2)
- ○ Competent (3)
- ○ Proficient (4)
- ○ Expert (5)

Q25. Applies monitoring (telemetry) system appropriately according to the data needed

- Not competent (1)
- Somewhat competent (2)
- Competent (3)
- Proficient (4)
- Expert (5)

Q26. Describe general applications/systems to support clinical care

- Not competent (1)
- Somewhat competent (2)
- Competent (3)
- Proficient (4)
- Expert (5)

Page Break

For the next set of questions please consider the clinical units you have experienced when making your selection.

Q27. In the clinical units you have experienced did the unit work together as an effective team

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree or Disagree (3)
- Agree (4)
- Strongly Agree (5)

Q28. During busy times, staff on clinical units help each other

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree or Disagree (3)
- Agree (4)
- Strongly Agree (5)

Q29. There is a problem with disrespectful behavior by those working in the clinical units

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree or Disagree (3)
- Agree (4)
- Strongly Agree (5)

Page Break

Q30. The units you have experienced regularly review work processes to determine if changes are needed to improve patient safety

- ○ Strongly Disagree (1)
- ○ Disagree (2)
- ○ Neither Agree or Disagree (3)
- ○ Agree (4)
- ○ Strongly Agree (5)

Q31. When considering the units you have experienced, changes to improve patient safety are evaluated to see how well they worked

- ○ Strongly Disagree (1)
- ○ Disagree (2)
- ○ Neither Agree or Disagree (3)
- ○ Agree (4)
- ○ Strongly Agree (5)

Q32. The units you have experienced let the same patient safety problems keep happening

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree or Disagree (3)
- Agree (4)
- Strongly Agree (5)

Page Break

Q33. When considering the units you have experienced, staff feel like their mistakes are held against them

- ○ Strongly Disagree (1)
- ○ Disagree (2)
- ○ Neither Agree or Disagree (3)
- ○ Agree (4)
- ○ Strongly Agree (5)

Q34. When considering the units you have experienced, when an event is reported in the unit, it feels like the person is being written up, not the problem

- ○ Strongly Disagree (1)
- ○ Disagree (2)
- ○ Neither Agree or Disagree (3)
- ○ Agree (4)
- ○ Strongly Agree (5)

Q35. When considering the units you have experienced, when staff make errors, the unit focuses on learning rather than blaming individuals

- ○ Strongly Disagree (1)
- ○ Disagree (2)
- ○ Neither Agree or Disagree (3)
- ○ Agree (4)
- ○ Strongly Agree (5)

Q36. When considering the units you have experienced, there is a lack of support for staff involved in patient safety errors

- ○ Strongly Disagree (1)
- ○ Disagree (2)
- ○ Neither Agree or Disagree (3)
- ○ Agree (4)
- ○ Strongly Agree (5)

Page Break

Q37. How often were you informed about errors that happen in the units you have experienced?

- ○ Never (1)
- ○ Rarely (2)
- ○ Sometimes (3)
- ○ Most of the time (4)
- ○ Always (5)

Q38. When errors happened on the units you have experienced, there were discussions on ways to prevent them from happening again

- ○ Never (1)
- ○ Rarely (2)
- ○ Sometimes (3)
- ○ Most of the time (4)
- ○ Always (5)
- ○ Does not apply or don’t know (6)

Q39. On the units you have experienced the unit was informed about changes that are made based on event reports (incident reports)

- ○ Never (1)
- ○ Rarely (2)
- ○ Sometimes (3)
- ○ Most of the time (4)
- ○ Always (5)
- ○ Does not know or Don’t know (6)

Page Break

Q40. On the units you have experienced when a mistake is caught and corrected before reaching the patient how often is this reported?

- ○ Never (1)
- ○ Rarely (2)
- ○ Sometimes (3)
- ○ Most of the time (4)
- ○ Always (5)
- ○ Does not apply or don't know (6)

Q41. On the units you have experienced when a mistake reaches the patient and could have harmed the patient, but did not, how often is this reported?

- ○ Never (1)
- ○ Rarely (2)
- ○ Sometimes (3)
- ○ Most of the time (4)
- ○ Always (5)
- ○ Does not apply or don't know (6)

Q42. In the past 12 months, how many patient safety events have you reported?

- ○ None (1)
- ○ 1 to 2 (2)
- ○ 3 to 5 (3)
- ○ 6 to 10 (4)
- ○ 11 or more (5)

Page Break

Q43. Overall how would you rate the units you have experienced on patient safety

- ○ Poor (1)
- ○ Fair (2)
- ○ Good (3)
- ○ Very Good (4)
- ○ Excellent (5)

Q44. Using health-IT (e.g., EHRs) would enhance my clinical effectiveness on the job.

- ○ Strongly Disagree (1)
- ○ Disagree (2)
- ○ Neither Agree or Disagree (3)
- ○ Agree (4)
- ○ Strongly Agree (5)

Q45 What is your current age

_____

Q46 How you do you identify yourself

- ○ Male (1)
- ○ Female (2)
- ○ Other (3)

Q47 Which race or ethnicity best describes you? (Please choose only one.)

- o American Indian or Alaskan Native (1)
- o Asian / Pacific Islander (2)
- o Black or African American (3)
- o Hispanic (4)
- o White / Caucasian (5)
- o Multiple ethnicity/ Other (6)

Q48 Any additional comments

_____

REFERENCES

Abuosi, A.A., Poku, C.A., Attafuah, P. Y.A., Anaba, E.A., Abor, A.A., Setordji, A., & Netiah-Amponsah, E. (2022). Safety culture and adverse event reporting in Ghanaian healthcare facilities: Implications for patient safety. PLOS ONE, https://doi.org/10.1371/journal.pone.0275606

Adler-Milstein, J., Everson, J., & Shoou-Yih, L. (2014). Sequencing of EHR adoption among US Hospitals and the impact of meaningful use. *Journal of the American Medical Informatics Association, 21*(6), 984-991. doi.10.1136/amiajnl-2014-002708

Agarwal, R., Gao, R., DesRoches, C., & Jha, A. K. (2010). The digital transformation of healthcare: Current status and the road ahead. *Information Systems Research, 21*(4), 796-808. https://www.jstor.org/stable/23015646

Agency for Healthcare Research and Quality (AHRQ) (2019). *Culture of safety*. https://psnet.ahrq.gov/primer/culture-safety

Aoyjai, M., Patrician, P. A., & Andres, A. (2021). Nurse burnout syndrome and work environment impact patient safety guide. *Journal of Nursing Care Quality*, 37(1):87-93. doi.10.1097/NCQ.0000000000000574

American Association of Colleges of Nursing (AACN). *About AACN*. (2022). https://www.aacnnursing.org/About-AACN

American Association of Colleges of Nursing (AACN). *About AACN*. (2022). : https://www.aacnnursing.org/Essentials/Domains

American Association of Colleges of Nursing (AACN) (2017). The changing landscape: Nursing student diversity on the rise. Retrieved from: https://www.aacnnursing.org/Portals/42/Diversity/Student-Diversity.pdf

American Hospital Association. (2017). *Study: HITECH act drove large gains in hospital EHR adoption*. https://www.aha.org/news/headline/2017-08-08-study-hitech-act-drove-large-gains-hospital-ehr-adoption

Anderson, J.G. & Abrahamson, K. (2017). Your Health Care May Kill You: Medical Errors. *Stud Health Technol Inform*. 234, 3-17. PMID: 28186008.

Apathy, N. C., Holmgren, A. J., & Adler-Milstein, J. (2021). A decade post-HITECH: Critical access hospitals have electronic health records but struggle to keep up with advanced functions. *Journal of the American Medical Informatics Association*, *28*(9), 1947-1954. https://doi.org/10.1093/jamia/ocab102

Barrett, A. K., & Stephens, K. K. (2017). Making electronic health records (EHRs) work: Informal talk and workarounds in healthcare organizations. *Health Communication*, *32*(8), 1004-1013. https://doi.org/10.1080/10410236.2016.1196422

Bartonickova, D., Kohanova, D., & Ziahova, K. (2022). Measuring patient safety from the perspective of nursing students a literature review. *Central European Journal of Nursing and Midwifery*, 14(1), 839-849. Doi: 10.15452/CEJNM.2022.13.0015

Bates, D. (2007). Preventing medication errors: A summary. *American Journal of Health Systems 64*(14), 3-9. doi.10.2146/ajhp070190

Benner, P. (2020). *From novice to expert*. https://nursing-theory.org/nursing-theorists/Patricia-Benner.php

Bichel-Findlay, J., Koch, S., Mantas, J., Abdul, S.S., Al-Shorbaji, N., Ammenwerth, E., Baum, A., Borycki, E.M., Demiris, G., Hasman, A., Hersh, W., Hovenga, E., Huebner, E.H., Huesing, E.S., Kushniruk, A., Hwa Lee, K., Lehmann, C.U., Lillehaug, S., Marin, H.F., Marschollek, M., Martin-Sanchez, F., Merolli, M., Nishimwe, A., Saranto, K., Sent, D.,

Shachak, A., Ganesh Udayasankaran, J., Were, M.C., & Wright, G. (2023). Recommendations of the International Medical Informatics Association (IMIA) on Education in Biomedical and Health Informatics: Second Revision. *International Journal of Medical Informatics,* 170, 1386-5056, https://doi.org/10.1016/j.ijmedinf.2022.104908.

Bove, A. (2019). Integration of informatics content in baccalaureate and graduate nursing education. *Nurse Educator*, 45(4), 206-209. DOI: 10.1097/NNE.0000000000000734

Bove, A. L. & Sauer, P. (2022). Assessing Nurse Educator Student Informatics Competencies. *Online Journal of Nursing Informatics*. 2022;26(2):2-12. https://search-ebscohostcom.proxy.library.kent.edu/login.aspx?direct=true&AuthType=ip&db=rzh&AN=160005563&site=eds-live&scope=site

Bushelle-Edghill, J., Brown, J. L., & Dong, S. (2016). An examination of EHR implementation impacts on patient-flow. *Health Policy and Technology*, *6*(1), 114-120. https://doi.org/10.1016/j.hlpt.2016.11.005

Carmichael, T. Collins, A. J. Hazinakis, M. (2019). *Complex adaptive systems: Views from the physical, natural, and social sciences*. Springer. https://search-ebscohost-com.proxy.library.kent.edu/login.aspx?direct=true&AuthType=ip&db=cat02507a&AN=ohiolink.b40461028&site=eds-live&scope=site.

Castro, M., Buczkowski, M. S., & Hafner, J. M. (2016). The contribution of sociotechnical factors to health information technology-related sentinel events. *The Joint Commission Journal on Quality and Patient Safety*, 42(2), 70-76. https://doi.org/10.1016/S1553-7250(16)42008-8

Chang, J., Poynton, M. R., Gassert, C. A., & Staggers, N. (2011). Nursing informatics

competencies required of nurses in Taiwan. *International Journal of Medical Informatics*, 80, 332-340. doi.10.1016/j.ijmedinf.2011.01.011

Choi, J. (2012). Comparative assessment of informatics competencies in three undergraduate programs. *Online Journal of Nursing Informaitcs (OJNI), 16(*2). http://ojni.org/issues/?p=1700

Choi, J., & Bakken, S. (2013). Validation of the self-assessment of nursing informatics competencies scale among undergraduate and graduate nursing students. *Journal of Nursing Education*, *52*(5), 275-282. doi.10.3928/01484834-20130412-01

Choi, J., & DeMartins, J. E. (2013). Nursing informatics competencies: Assessment of undergraduate and graduate nursing students. *Journal of Clinical Nursing, 22*(13-14), 1970-1976. http://works.bepress.com/jeungok_choi/8/

CMS. (2021). Centers for Medicare & Medicaid Services. *Promoting interoperability program*s. https://www.cms.gov/regulations-and-guidance/legislation/ehrincentiveprograms?redirect=/ehrincentiveprograms

CMS. (2022). Centers for Medicare & Medicaid Services. *2022 Medicare promoting interoperability program requirements*. https://www.cms.gov/regulations-guidance/promoting-interoperability/2022-medicare-promoting-interoperability-program-requirements

Cronenwett, L., Barnsteiner, J., & Sullivan, D. T. (2007). Quality and safety education for nurses. *Nursing Outlook*, *55*(3), 122-131. https://www.nursingoutlook.org/article/S0029-6554%2807%2900062-0/fulltext

Creswell, J. W. (2014). The selection of research approach. In *Research design, qualitative, quantitative, and mixed methods approaches* (4th ed., p.14), SAGE.

Curran, C. (2001). The glue and the grease in radical organizational change. *Nursing Economics, 19*(5), 197.

Davis, F. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-340. doi.10.2307/249008

Dillman, D. A. (2000). *Mail and Internet surveys: The tailored design method, Second edition*. New York: John Wiley and Sons.

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2009). *Mail and Internet Surveys: The Tailored Design Method, Third edition*. New York: John Wiley and Sons.

Desjardins, K. S., Sheets-Cook, S., Jenkins, M., & Bakken, S. (2005). Effect of an informatics for evidence-based practice curriculum on nursing informatics competencies. *Journal of Medical Informatics, 74*(11-12), 1012-1020. doi.10.1016/j.ijmedinf.2005.07.001

Dworkin, J., Hessel, H., Gliske, K., & Rudi, J.H. (2016). A Comparison of Three Online Recruitment Strategies for Engaging Parents. *Family Relations*, 65(4): 550-561. doi: 10.1111/fare.12206. Epub 2016 Aug 26. PMID: 28804184; PMCID: PMC5552070.

Dykes, P. C., Hurley, A., Cashen, M., Bakken, S., & Duffy, M. E. (2007). Development and psychometric evaluation of the Impact of Health Information Technology (I-HIT) Scale. *Journal of the American Medical Informatics Association, 14*(4), 507–514. https://doi.org/10.1197/jamia.M2367

Egan, M. (2006). Clinical dashboards: Impact on workflow, care quality, and patient safety. *Critical Care Quarterly*, *29*(4), 354-361. doi.10.1097/00002727-200610000-00008

Ejnerfjall, T., & Agerfalk, P. J. (2019). Conceptualizing workarounds: Meanings and manifestations in information system research. *Communications of the Association of Information System*, *45*, doi.10.17705/1CAIS.04520

Eley, R., Fallon, T., Soar, J., Buikstra, E., & Hegney, D. (2008). Barriers to use of information and computer technology by Australia's nurses: a national survey. *Journal of Clinical Nursing, 18*(8), 1151-1158. doi.10.1111/j.1365-2702.2008.02336.x

Ellis, B., & Herbert, S. I. (2011). Complex adaptive systems (CAS): An overview of key elements, characteristics and application to management theory. *Informatics in Primary Care*, 19(1), 33-37. doi.10.14236/jhi.v19i1.791

Famolaro T, Hare R, Yount ND, Fan L, Liu H, Sorra J. (2021). Surveys on Patient Safety CultureTM SOPS™ ®) Hospital Survey 2.0: 2021 User Database Report. (Prepared by Westat, Rockville, MD, under Contract No. HHSP233201500026I/HHSP23337004T). Rockville, MD: Agency for Healthcare Research and Quality; March 2021. AHRQ Publication No. 21-0017.

Frankel, A. S., Leonard, M. W., & Denham, C. R. (2006). Fair and Just Culture, team behavior, and leadership engagement: The tools to achieve high reliability. *Health Services Research, 41*(4), 1690-1709. doi.10.1111/j.1475-6773.2006.00572.x

Fosnacht, K., Sarraf, S., Howe, E., & Peck, L. K. (2017). How important are high response rates for college surveys. *The Review of Higher Education*, 40(2), 245–265. https:// doi.org/10.1353/rhe.2017.0003

Foster, J., & Bryce, J. (2009). Australian nursing informatics competency project. In Park, H. A., Ensio, A., Saranto, K., Brennan, P., & Tallberg, M. (Eds.), *Proceedings of the 10th International Congress on Nursing Informatics: Connecting Health and Humans* (pp. 556-560). IOS Press BV. http://eprints.qut.edu.au/31927/

Gagnon, M. P., Desmartis, M., Labrecque, M., Car, J., Pagliari, C., Pluye, P., Fremont, P., Gagon, J., Tremblay, N., & Legare, F. (2012). Systematic review of factors influencing

the adoption of information and communication technologies by healthcare professionals. *Journal of Medical Systems*, *36*(1), 241-277. doi.10.1007/s10916-010-9473-4

Gioia, D.A. (1986). Symbols, scripts, and sensemaking: Creating meaning in the organizational experience. In H.P. Sims, Jr., D.A. Gioia, & Associates (Eds.), *The thinking organization*. Jossey-Bass.

Grochow, D. (2008). From novice to expert: Transitioning graduate nurses. *Nursing Management, 39(3), 10-12.* doi.10.1097/01.NUMA.0000313089.04519.f4

Grunloh, C., Cajander, A., Myreteg, G. (2016). The record is our work tool! Physicians framing of a patient portal in Sweden. *Journal of Medical Internet Research*, *18*(6). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4940602/

Halbesleben, J. R., Savage, G. T., Wakefield, D. S., & Wakefield, B. J. (2010). Rework and workarounds in nurse medication administration process: Implications for work process and patient safety. *Health Care Management Review*, *35*(2), 124-33. doi.10.1097/HMR.0b013e3181d116c2

Halbesleben, J. R., Rathert, C., & Bennett, S. F. (2013). Measuring nursing workarounds: Tests of the reliability and validity of a tool. *The Journal of Nursing Administration*, *43*(1), 50-55. doi.10.1097/NNA.0b013e31827860ff

Halbesleben, J. R., Savage, G. T., Wakefield, D. S., & Wakefield, B. J. (2008). Work-arounds in healthcare settings: Literature review and research agenda. *Health Care Management Review*, *33*(1). doi.10.1097/01.HMR.0000304495.95522.ca

Hart, M. D. (2008). Informatics competency and development within the US nursing population Workforce: A systematic literature review. *Computers, Informatics, Nursing, 26*(6), 320-329. doi.10.1097/01.NCN.0000336462.94939.4c

HealthIT.gov. (2021). *HealthIT legislation*. https://www.healthit.gov/topic/laws-regulation-and-policy/health-IT-legislation

Hebda, T., & Calderone, T. (2010). What nurse educators need to know about the TIGER initiative. *Nurse Educator, 35*(2), 56-60. doi.10.1097/NNE.0b013e3181ced83d

Hickerson, K. A., Taylor, L. A. & Terhaar, M. F. (2016). Preceptor support to improve nurse competency and satisfaction: A pilot study of novice nurses and preceptors in a pediatric intensive care unit. *Journal of Nursing Education and Practice, 6*(12). https://www.sciedupress.com/journal/index.php/jnep/article/view/9531

Hickerson, K. A., Taylor, L. A. & Terhaar, M. F. (2021). The preparation-practice gap: An integrative literature review. *The Journal of Continuing Education in Nursing, 47*(1), 17-23. https://doi-org.proxy.library.kent.edu/10.3928/00220124-20151230-06

HIMSS. (2012). *Position statement on transforming nursing practice through technology & informatics.*http://www.himss.org/files/himssorg/handouts/himssnipositionstatementmonographreport.pdf

Shaw, T., Blake, R., Hübner, U., Anderson, C., Wangia-Anderson, A., Elias, B., (2020). The Evolution of TIGER Competencies and Informatics Resources Executive Supplemental Report. Retrieved from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.himss.org/sites/hde/files/media/file/2020/03/10/the-evolution-of-tiger-competencies-and-informatics-resources-final-10.2017.pdf

Huang, D.T., Clermont, G., Sexton, J. B., Karlo, C. A., Miller, R. G., Weissfeld, L. A., Rowan,

K. M., & Angus, D. C. (2007). Perceptions of safety culture vary across the intensive care units of a single institution. *Critical Care Medicine, 35*(1), 165-76. doi.10.1097/01.CCM.0000251505.76026.CF.

Hunter, K. M., McGonigle, D. M., & Hebda, T. L. (2013). TIGER-based measurement of nursing informatics competencies: The development and implementation of an online tool for self-assessment. *Journal of Nursing Education and Practice*, *3*(12), 70-80. https://doi.org/10.5430/jnep.v3n12p70

Hydari, M. Z., Telang, R., & Marella, W. M. (2016). Saving patient Ryan—Can advanced electronic medical records make patient care safer? *SSRN*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2503702

Institute of Medicine. (2000). *To err is human: Building a safer health system* (1st ed). National Academics Press.

Institute of Medicine. (2003). *Health professions education: A bridge to quality*. National Academies Press.

Institute of Medicine (2010). *The future of nursing: Leading change, advancing health*. National Academies Press.

Johnson, T.P. & Wislar, J.S. (2012). Response rates and nonresponse errors in surveys. *JAMA*, 307(17), 1805-1806.

Keller, S., Yule, S., Zararese, V., & Hendrickson-Parker, S. (2020). Predictors and triggers of incivility within healthcare teams: A systematic review of the literature. *BMJ* 10(6), DOI: 10.1136/bmjopen-2019-035471

Kim, S., Lee, K., Hwang, H., & Yoo, S. (2016). Analysis of the factors influencing healthcare

professionals' adoption of mobile electron medical record (EMR) using the unified theory of acceptance and use of technology (UTAUT) in a tertiary hospital. *BMC Medical Informatics and Decision making*, *16*(12). doi.10.1186/s12911-016-0249-8

Kimiafar, K., Sarbaz, M., Sheikhtaheri, A., & Azizi, A. (2015). The impact of management factors on the success and failure of health information systems. *Indian Journal of Science and Technology*, *8*(27), doi.10.17485/ijst/2015/v8i27/84083

Khezri, H.& Abdekhoda, M. (2019). Assessing nurses' informatics competency and identifying its related factors. *Journal of Research in Nursing*. 2019;24(7):529-538. doi:10.1177/1744987119839453

Koppel, R., Wetterneck, T., Telles, J. L., & Karsh, B. (2008). Workarounds to barcode medication administration systems: Their occurrences, causes, and threats to patient safety. *Journal of American Medical Informatics Association, 15*(4), 408-423. doi.10.1197/jamia.M2616

Kuo, Y. W., Jerng, J. S., Lin, C. K., Huang, H. F., Chen, L. C., Li, Y. T., Huang, S. F., & Hung, K. Y. (2020). In-hospital patient safety events, healthcare costs, and utilization: An analysis from the incident reporting system in an academic medical center. *Healthcare*, *8*(4), 388. doi.10.3390/healthcare8040388

Lee, J.J. & Yang, S.C. (2019). Professional socialization of nursing students in a collectivist culture: A qualitative study. *BMC Medical Education*, 254, https://bmcmededuc.biomedcentral.com/articles/10.1186/s12909-019-1690-z

Leonardi, P. M. & Barley, S. R. (2010). What's under construction here? Social action, materiality, and power in constructivists studies of technology and organizing. *Academy of Management Annals*, *4*(1), 1-51. doi.10.1080/19416521003654160

Magrabi, F., Mei-Sing, O., Runciman, W., & Coiera, E. (2010). An analysis of computer-related patient safety incidents to inform the development of a classification. *Journal of the American Medical Informatics Association*, *17*(6), 663-670. doi.10.1136/jamia.2009.002444.

Magrabi, F., Mei-Sing, O., Runciman, W., & Coiera, E. (2012). Using FDA Reports to inform a classification for health information technology safety problems. *Journal of the American Medical Informatics Association*, *19*(1), 45-53. doi.10.1136/amiajnl-2011-000369

Martin, B., & LaVigne, R. (2016). Benchmarks: An evidence-based approach to creating high performing nurses. *Journal of Health Science, 4*, 26-34. doi.10.17265/2328-7136/2016.01.004

Marx, M. (2013). Examining the structural challenges to communication as experienced by nurse managers in two U.S. hospital settings. *Journal of Nursing Management*, *22*(8), 964-973. doi.10.1111/jonm.12091

McGonigle, D., Hunter, K., Sipes, C., & Hebda, T. (2014). Why nurses need to understand nursing informatics. *AORN, 100*(3), 324-327. https://doi.org/10.1016/j.aorn.2014.06.012

McGonigle, D., & Matrian, K. (2022), *Nursing informatics and the foundation of knowledge* (4th ed). Jones & Bartlett Learning.

Meeks, D. W., Takian, A., Sittig, D. F., Singh, H., & Barber, N. (2014). Exploring the sociotechnical intersection of patient safety and electronic health record implementation. *Journal of the American Medical Informatics Association, 21*(e1), 28-34. https://doi.org/10.1136%2Famiajnl-2013-001762

Mrayyan, M. T. (2022). Predictors and outcomes of patient safety culture: A cross-sectional

comparative study. *BMJ Open Quality*, *11*(3), e001889. doi.10.1136/bmjoq-2022-001889

National Council of State Boards of Nursing (NCSBN). (2019). *NCLEX-RN examination: Test plan for the national council licensure examination for registered nurses.* https://www.ncsbn.org/2019_RN_TestPlan-English.pdf

Nelson, R., & Staggers, N. (2018). *Health informatics: An interprofessional approach*. Elsevier.

Orlikowski, W. J., & Gash, D. C. Technological frames: Making sense of information technology in organizations. *ACM Transactions on Information Systems, 12*(2), 174-207. doi.10.1145/196734.196745

Piscotty, R. J., Kalisch, B., & Gracey-Thomas, A. (2015). Impact of healthcare information technology on nursing practice. *Journal of Nursing Scholarship*, *47*(4), 287-293. doi:.10.1111/jnu.12138

Politi, L., Codish, S., Sagy, I., & Fink, L. (2014). Use patterns of health information exchange through a multidimensional lens: Conceptual framework and empirical validation. *Journal of Biomedical Informatics*, *52*, 212-221. http://dx.doi.org/10.1016/j.jbi.2014.07.003

Pouloudi, N., Currie, W., & Whitley, E. A. (2016). Entangled stakeholder roles and perceptions in health information systems: A longitudinal study of the U.K. NHS N3 network. *Journal of the Association for Information Systems*, *17*(2), 107-161. doi.10.17705/1jais.00421

Rooyen, D., Jordan, P., Caka, E.M., & Ham-Baloyi, W. (2019). Transitioning of final year nursing students to professional nurses: A best practice guideline. *South African Journal of Higher Education*, 33(6), 300-314.

Rouse, W. B. (2008). Engineering and the health care delivery system. National Academy of Engineering, *38*(1). https://www.nae.edu/7704/HealthCareasaComplexAdaptiveSystemImplicationsforDesignandManagement

Shirali, G., Shekari, M., & Angali, K. A. (2018). Assessing reliability and validity of an instrument for measuring resilience safety culture in sociotechnical systems. *Safety and Health at Work*, *9*(3), 296-307. https://doi.org/10.1016/j.shaw.2017.07.010

Sittig, D. F., & Singh, H. (2010). A new socio-technical model for studying health information technology in complex adaptive healthcare systems. *Quality & Safety in Health Care*, *19*(Suppl 3), i68–i74. https://doi.org/10/cb3j3z

Sirosi, P., Fournier, H., Lebouthilier, A., Guerette-Daigle, L., Robichaud, S., Leblanc-Cormier, G., Molyneaux, H., O'Donnell, S., & Mather, L. (2013). Nurses' perceptions and attitudes towards new ADU technology and use. *Technology and Health Care*, *21*(1), 41-47. doi.10.3233/THC-120708

Sittig, D., & Singh, H. (2017). Toward more proactive approaches to safety in the electronic health record era. *The Joint Commission Journal on Quality and Safety*, *43*(10), 540-547. doi.10.1016/j.jcjq.2017.06.005

Singh, H., & Sittig, D. (2020). A sociotechnical framework for safety-related electronic health record research reporting: The SAFER reporting network. *Annals of Internal Medicine*, *172*(11 suppl), s92-s100. doi.10.7326/M19-0879

Smith, J.G., Morin, K.H., & Lake, E.T. (2018). Association of the nurse work environment with nurse incivility in hospitals. *Journal of Nursing Management* 26(2) 219-226. doi: 10.1111/jonm.12537

Sorra, J., Gray L., & Streagle. S. (2018). AHRQ Hospital Survey on Patient Safety Culture: user's guide. (Prepared by Westat, under Contract No. HHSA290201300003C). AHRQ Publication No. 18-0036-EF (Replaces 04-0041, 15(16)-0049-EF). Agency for Healthcare Research and Quality. https://www.ahrq.gov/SOPS™ /quality-patient-safety/patientsafetyculture/hospital/index.html

Spath, P. L., & Jossey-Bass, C. A. (2011). *Error reduction in healthcare: A systems approach to improving patient safety* (2nd ed.). Hoboken.

Sruthi, M., Baiju, A., & Swathi-Krishua, T. P. (2021). Professional socialization among nursing students. *Indian Journal of Forensic Medicine & Toxicology, 15*(4). https://doi.org/10.37506/ijfmt.v15i4.17092

Staggers, N., Gassert, C. A., & Curran, C. (2002). A Delphi study to determine informatics competencies for nurses at four levels of practice. *Nursing Research, 51*(6), 383-390. doi.10.1097/00006199-200211000-00006

Staggers, N., Gassert, C. A., & Curran, C. (2001). Informatics competencies for nurses at four levels of practice. *Journal of Nursing Education, 40*(7), 303-316. doi.10.3928/0148-4834-20011001-05

Strumberg, J. P. & Bircher, J. (2019). Better and fulfilling healthcare at lower costs: The need to manage health systems as complex adaptive systems. *F1000Research, 8*(789), https://doi.org/10.12688/f1000research.19414.1

Technology Informatics Guiding Education Reform (TIGER) (2009). Informatics competencies for every practicing nurse: Recommendations from the TIGER collaborative. Retrieved from https://tigercompetencies.pbworks.com/f/TICC_Final.pdf

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of

information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425-478. https://doi.org/10.2307/30036540

Wachter, R. (2012). *Understanding patient safety* (2nd ed.). McGraw-Hill

Walker, D., Altmiller, G., Hromadik, L., Barkell, N., Barker, N., Boyd, T., Compton, M., Cook, P., Curia, M., Hays, D., Flexner, R., Jordan, J., Jowell, V., Kaulback, M., Magpantay-Monroe, E., Rudolph, B., Toothaker, R., Vottero, B., Wallace, S., (2020). Nursing students' perceptions of just culture in nursing programs: A multisite study. *Nurse Educator*: 45(3), 133-138. doi: 10.1097/NNE.0000000000000739

Westphal, J., Lancaster, R., & Park, D. (2014). Work-arounds observed by fourth-year nursing students. *Western Journal of Nursing Research*, *36*(8), 1002-1018. doi.10.1177/0193945913511707

Whitt, K.J., Eden, L., Merril, K.C., & Huges, M. (2017). Nursing student experiences regarding safe use of electronic health records. *CIN: Computers, Informatics, Nursing*, 35(1), 45-53.

Wu, D. (2010) Standards for health IT : meaningful use and beyond : hearing before the Subcommittee on Technology and Innovation, Committee on Science and Technology, House of Representatives, One Hundred Eleventh Congress, second session, September 30, 2010. U.S. G.P.O.

Yen, P. Y., McAlearney, A. S., Sieck, C. J., Hefner, J. L., & Huerta, T. R. (2017). Health information technology (HIT) adaption: Refocusing on the journey to successful HIT implementation. *JMIR Medical Informatics, 5*(3). doi.10.2196/medinform.7476

Yoon, S., Shaffer, J.A., & Bakken, S. (2015). Refining a self-assessment of informatics

competency scale using Mokken scaling analysis. Journal of Interprofessional Care, 29(6), 579-586. DOI: 10.3109/13561820.2015.1049340

Yoon, S., Yen, P., & Bakken, S. (2009). Psychometric properties of the self-assessment of nursing informatics competencies scale. *Health Technology & Informatics, 146,* 546-550. doi.10.3233/978-1-60750-024-7-546