Expanding the Informatics Competencies of Nurse Practitioners Through Online Learning

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Abstract

Nurse practitioners' informatics competencies are not well-understood due to a lack of studies. Limited evidence alludes to the potential need to improve the informatics competencies of nurse practitioners. The primary purpose of this study was to analyze the informatics competencies of nurse practitioners, including nurses training to become nurse practitioners, before and after completing an online learning module in nursing informatics. Six topics (nursing informatics overview, datasets, data reporting, telehealth, online information evaluation, and data protection) were covered in the investigator-developed learning module. A pretest-posttest, one-group, quasi-experimental design was used in the study. Link to the surveys and the learning module was emailed to members of a local nurse practitioners' association in California and graduate nursing students at a public university in Missouri. The study was also shared on a professional networking website, LinkedIn. Data were collected from 15 nurse practitioners and two nurses studying to become nurse practitioners, using a demographic questionnaire and an 18-item self-assessment of informatics competency scale. A related-samples Sign test was conducted to compare the pre-intervention and post-intervention scores. Statistically significant median increases ($p = 0.001$ to < 0.001) were found in five areas: aggregated data management, data extraction, data protection, online health information evaluation, and information application. Findings suggest that the online learning module expanded the participants' competencies in specific areas of informatics. The results provide an initial understanding of nurse practitioners' informatics competencies and inform future iterations of the study that could continuously expand informatics competencies.

Keywords: nursing, informatics, competencies, nurse practitioners, online learning

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Informatics competencies are vital for all healthcare professionals in today's technologically advanced practice settings. Informatics refers to a synergistic relationship between people, processes, and technologies that generates reliable, relevant, and meaningful information (San Jose State University, n.d.). In nursing informatics (NI), nursing intertwines with technologies, information systems, and information management to support practice, clinical decision making, communication, and coordination of health services with multi-disciplinary team members, including patients and other stakeholders (American Nurses Association [ANA], 2015; see Appendix A for the glossary). Informatics competencies play significant roles in improving healthcare quality, care coordination, patient outcomes, and cost-effectiveness (Abdrbo, 2015; Bryant et al., 2016).

For nurse practitioners (NPs), the expectation is not only to possess the essential skills to use information technologies but also to be equipped with fundamental clinical informatics competencies (American Association of Colleges of Nursing [AACN], n.d.; National Organization of Nurse Practitioner Faculties [NONPF], 2017). Moreover, NPs with terminal degrees in nursing, such as Doctor of Nursing Practice (DNP), are expected to influence or lead in implementing or optimizing the application of technologies within healthcare systems and academic settings (AACN, 2006). Although there are studies that allude to the potential need of NPs to expand their informatics competencies (Choi & De Martinis, 2013; Kupferschmid et al., 2017), to date, no studies are available in the literature that focus on evaluating or expanding the informatics competencies of NPs or registered nurses training to become NPs (NP students). This study leads to understanding the current levels of informatics competencies, expanding specific areas of informatics knowledge and skills, and determining informatics-related continuing education or training needs of NPs and NP students.

Significance

Over 290,000 NPs (American Association of Nurse Practitioners [AANP], 2020a) are impacted by the widespread technological advances in healthcare and evolving regulatory requirements related to electronic health record (EHR) technologies. As NPs continue to shift how they manage information, communicate, and make intervention decisions, informatics competencies have become increasingly essential. Notably, NPs are key users of EHR systems and various point-of-care and communication technologies in patient-care settings. Nurse practitioners are compelled to use information technologies to perform work effectively, efficiently, and safely (Swenty & Titzer, 2014). Hence, NPs must continuously expand their informatics competencies to support quality care, satisfy regulatory and accreditation requirements, and influence the continuous improvement of clinical information systems.

Issue

Lack of informatics competencies in technologically advanced clinical settings can contribute to adverse events that compromise patient safety and the overall quality of healthcare delivery (Abdrbo, 2015; Bryant et al., 2016; McGonigle & Mastrian, 2015; Swenty & Titzer, 2014). Currently, there are no studies that focus on nurse practitioners and their informatics competencies. Limited evidence indicates that graduate nursing students, including NPs pursuing DNP degrees, report a varying lack of knowledge and skills in the core areas of informatics (Choi & De Martinis, 2013; Choi & Zucker, 2013; Kupferschmid et al., 2017). Although the use of EHR technology by NPs is widespread, preparation and competence to apply informatics competencies may be inadequate (Swenty & Titzer, 2014).

Diversity Considerations

Practicing NPs and NP students were invited to participate in this study regardless of practice setting and geographic location in the United States. No demographic elements restricted participation. All eligible participants had an equal opportunity to complete the surveys and online learning module.

Problem and Project Purpose

Problem Statement

Lack of informatics competencies may contribute to sub-optimal healthcare outcomes. Current information on the informatics knowledge and skills of nurse practitioners is scarce in the literature; thus, the state of NPs' informatics competencies is not well-understood. Some studies that focused on graduate nursing students, including NPs in a DNP program, alluded to the need of the graduate nursing students to expand their competencies in informatics (Choi & De Martinis, 2013; Choi & Zucker, 2013; Kupferschmid et al., 2017). However, the informatics competencies of NPs have remained unclear.

Project Purpose

The primary purpose of this project was to expand the informatics competencies of nurse practitioners. Registered nurses enrolled in an NP program were also part of the target population as they could benefit from the opportunity to expand their informatics competencies before becoming certified NPs. Closely related to the primary purpose was to develop an initial understanding of NPs as an under-researched population in relation to informatics competencies. The project aimed to measure the informatics competencies of a population of NPs and NP students before and after completing an online learning module in nursing informatics. The relevant and concise educational content on a dedicated website was intended to facilitate participants' completion of the study (see Appendix B for the project timeline).

Project Facilitators and Barriers

Implementation of the project was supported by the North Bay Chapter of the California Association for Nurse Practitioners (CANP; see Appendix C for the project site approval) and the DNP faculty at the University of Missouri-Kansas City (UMKC; see Appendix D for the project proposal approval). Invitations were sent to potential study participants through email distribution lists and posts on a professional networking site. Moreover, the learning platform was considered a project facilitator as participants could access the surveys and online learning materials anytime and anywhere they had an Internet connection using a desktop, a laptop, or a smart mobile device. The website was developed to be compatible with operating systems by Apple, Google, and Microsoft. Additionally, the relatively low cost of the project, including the in-kind labor of the investigator, was deemed a facilitator for the study (see Appendix E for the cost table).

The main barriers of the project were related to the data collection duration and the length of time to complete the online learning module. Within the three-month data collection window, the COVID-19 pandemic and December holidays might have contributed to a lack of time and motivation to participate in the study. Furthermore, a commitment of about an hour was needed to complete the surveys and the online learning module, which might have discouraged participation if the study was perceived as time-consuming.

Review of the Evidence

Inquiry

In nurse practitioners and nurses training to become nurse practitioners, does online learning in nursing informatics, compared to no intervention, expand informatics competencies post-completion of the learning activities on the Nursing Informatics e-Learning Module website?

Search Strategies

Evidence around nursing informatics competencies, nurse practitioners, and online learning was searched using Academic Search Premier, Cumulative Index to Nursing and Allied Health (CINAHL), Education Resources Information Center (ERIC), Medline, and Google Scholar. Various combinations of the following sets of keywords were applied using Boolean operators "and" and "or" for the literature search: (1) nurse practitioner or advanced practice or clinician or nurse or nursing, and (2) informatics or information technology or information system or information management or technology, and (3) competency or competence or knowledge or skill or proficiency, and (4) online or web-based or distance or learning or e-learning or education or training. Only full-text articles published in English between 2010 and 2020 were considered for inclusion. Further refinements were applied by only including items from academic publications. Ultimately, a total of 31 articles were deemed relevant and appropriate for the inquiry. The studies were evaluated for their hierarchy of evidence (Melnyk & Fineout-Overholt, 2018) and represented Level II: three studies, Level III: seven, Level V: one, Level VI: seventeen, and Level VII: three (see Appendix F for the PRISMA diagram).

Evidence by Themes

The 31 articles in the integrative review were a mixture of quantitative and qualitative studies. The studies were subjected to critical appraisal or thematic analysis (see Appendix G for the evidence table). Consequently, the following three themes were identified: nursing informatics competencies, nursing informatics competency assessment, and online learning and online learning module implementation (see Appendix H for the evidence grid).

Nursing Informatics Competencies

Nurses are expected to possess a range of primary and advanced NI competencies (Choi & De Martinis, 2013; Choi & Zucker, 2013; Kupferschmid et al., 2017; Rajalahti et al., 2014). Rajalahti et al. (2014) described basic informatics competency as the ability to perform simple tasks with computers, such as connecting and browsing on the Internet, managing emails, and using basic software applications, such as text processing. This description is equivalent to what Choi and Zucker (2013) referred to in one study as basic desktop software skills. Conversely, advanced competency involves higher-level skills, such as information management (e.g., electronic documentation), information literacy (e.g., data protection and security, legislation, and policies), applied computer skills (e.g., data access and retrieval), and clinical informatics role (e.g., participation in workflow analysis, and incorporation of standardized language in the EHR; Choi & De Martinis, 2013; Choi & Zucker, 2013; Rajalahti et al., 2014).

Various classifications of informatics competencies exist, but the variations cover the core areas of NI skills and knowledge. Informatics competencies can be categorized into three areas based on a competency assessment tool (CAT) for beginning and experienced nurses: computer skills (e.g., basic desktop software use, decision support, communication), informatics knowledge (e.g., information systems, data, policies), and informatics skills (e.g., data management, protection of privacy and security; Choi & Zucker, 2013). In another classification used in a study involving nurses enrolled in a DNP program, NI competencies are grouped into informatics skills and informatics concepts (Kupferschmid et al., 2017). Informatics skills are further divided into working with datasets (data entry, data analysis, and display of results) and databases (exploration of public health databases), while informatics concepts are included in the application of Internet resources to the learning needs of a vulnerable patient and the analysis of the challenges in meeting the Meaningful Use (MU) Program's metrics set by the Centers for Medicare and Medicaid Services (CMS; Kupferschmid et al., 2017).

In the Self-Assessment of Nursing Informatics Competencies Scale (SANICS), NI competencies are categorized into five areas: (1) basic computer knowledge and skills, (2) applied computer skills, (3) clinical informatics role, (4) clinical informatics attitude, and (5) wireless device skills (Choi & De Martinis, 2013; Yoon et al., 2015). A later revision of SANICS led to the re-classification of NI competencies into basic computer skills, roles in informatics, and advanced computer skills and clinical informatics (Yoon et al., 2015). Despite the variations, the core informatics knowledge, skills, and concepts of the groupings of NI competencies align with the recommendations of the Technology Informatics Guiding Education Reform (TIGER; Hübner et al., 2018) and the DNP Essential VIII (Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care) endorsed by the American Association of Colleges of Nursing (2006).

Rajalahti et al. (2014) and Choi and De Martinis (2013) suggested that nurses already possess basic informatics skills. However, nurses in one study described themselves as not competent to somewhat competent in using clinical decision-making tools, accessing and extracting clinical datasets, and performing literature search and file maintenance (Choi & Zucker, 2013). Similarly, Choi and De Martinis (2013) found that nurses in a graduate nursing program perceived themselves as least competent in data access and extraction from clinical datasets, systems implementation and design, and use of resources for ethical decisions in computing.

Nursing Informatics Competency Assessment

Self-assessment is a commonly used method to determine NI competencies (Alexander et al., 2020; Choi & Bakken, 2013; Choi & De Martinis, 2013; Choi & Zucker, 2013; Forman et al., 2020; Yoon et al., 2015). In several studies, research participants have been asked to self-report their competencies based on the questions on a measurement tool. One of the measurement tools is the SANICS instrument, which is a 30-item questionnaire categorized into five groups of NI competencies (Alexander et al., 2020; Choi & Bakken, 2013; Choi & De Martinis, 2013; Forman et al., 2020; Yoon et al., 2015). The tool was derived from the same set of informatics competency statements that were used for the competency assessment tool (CAT) questionnaire applied by Choi and Zucker (2013) in their study. The only difference is that the latter contained 86 questions and categorized into three groups, with 18 questions per group. Each question on both self-assessment questionnaires is on a 5-point Likert scale, where 1 corresponded to *not competent* and 5 to *expert* (Choi & Bakken, 2013; Choi & De Martinis, 2013; Choi & Zucker, 2013). The internal consistency of both instruments is high. For the CAT questionnaire, the Cronbach's alpha ranges from 0.93 to 0.97 (Choi & Zucker, 2013). For the SANICS questionnaire, the Cronbach's alpha ranges from 0.89 to 0.94 (Choi & Bakken, 2013; Choi & De Martinis, 2013; Yoon et al., 2015). Yoon et al. (2015) further refined the SANICS measurement tool to reflect the relevance to interprofessional education and interprofessional practice (Yoon et al., 2015). The refined SANICS tool, also known as Self-Assessment of Informatics Competency Scale for Health Professionals, lists 18 competencies arranged in increasing levels of competency difficulty, which are strategically designed to accommodate varying levels of informatics expertise (Yoon et al., 2015). The reliability of the refined SANICS scale is Cronbach's alpha 0.93.

Other instruments were developed for informatics competency assessment, specifically in evaluating perceptions and attitudes of undergraduate nursing students toward information and communication technology (ICT). One such instrument is the ICT questionnaire, an 86-item tool that was used to describe the perceived competence and confidence of nursing students toward the relevance of ICT in clinical practice (Levett-Jones et al., 2009). Similarly, the Knowledge, Skills, and Attitudes towards Nursing Informatics (KSANI) was established in response to a lack of evidence around informatics knowledge, skills, and attitudes of undergraduate nursing students (Bryant et al., 2016). The KSANI instrument was based on three factors: perception of informatics, perception of skills in using informatics, and attitudes toward the use of informatics (Bryant et al., 2016). Likewise, the Information Technology Attitude Scales for Health (ITASH) was developed to investigate nursing students' attitudes toward the value of ICT in providing care, ICT skills training needed, confidence in technologies, and value of ICT on workload (Lee & Clarke, 2015). Assessing nursing students' attitudes, perceptions, and dynamics around the use of ICT had been deemed crucial in promoting the optimal use of technologies in clinical and educational settings (Gonen et al., 2014; Lee et al., 2019).

Another method for assessing NI competencies is through formal evaluation post-completion of an informatics course. Faculty grading was used in one study to evaluate DNP students' NI knowledge and skills in acquiring informatics skills and applying informatics concepts (Kupferschmid et al., 2017).

Online Learning and Online Learning Module Implementation

Online learning, e-learning, or web-based learning can facilitate the increase or retention of knowledge, change of behavior, or improvement of competence in performing skills (Boiling et al., 2012; Bond et al., 2017; Covington et al., 2019; Creedon & Cummins, 2012; Karvinen et al., 2017; Rosvall & Carlson, 2017; Sikkens et al., 2018). With this education delivery method, learners are not restricted to specific locations and time to acquire new knowledge and skills (Boiling et al., 2012; Covington et al., 2019; Yoshioka-Maeda et al., 2019). However, achieving the expected outcomes or positive effects from an online learning module depends on a variety of factors, such as design and features (Sikkens et al., 2018), interactivity with real-world experiences and use of multimedia (Boiling et al., 2012; Brasier et al., 2019; Cacciamani et al., 2012), simulation exercises (Covington et al., 2019; Gonen et al., 2016), inclusion of game design principles and humor (Bond et al., 2017), and time allocated for completing the learning module (Karvinnen, 2017; Yoshioka-Maeda, 2019).

In a study conducted by Sikkens et al. (2018), medical students in the intervention (online learning) group increased their competence in antibiotic-prescribing practices compared with the control-group students. The desired outcome was enhanced by problem-based activities, interactive features, and the inclusion of exercises and feedback (Sikkens et al., 2018). The findings are similar to the results of other studies (Oh et al., 2019; Todhunter, 2015; Yu et al., 2013). Inversely, in a study by Karvinen et al. (2017), unfavorable findings were linked to the inadequate time allocated to complete the e-learning activities (Karvinen et al., 2017).

The design of an online learning module must be aligned with adult learning principles. Learners expect the knowledge or skills to be relevant, practical, and applicable to realistic situations and immediate circumstances (Boiling et al., 2012; Cummings et al., 2016; Kobewka et al., 2014). Application of real-world experiences and a sense of community are conducive to learning online (Boiling et al., 2012). Monsivais (2019) also suggested partnering with a seasoned educator who has expertise in adult education when developing online learning materials.

Evidence Discussion

Support for the Inquiry

Despite most of the studies (21/31) in the integrative review representing lower evidence levels V to VII (Melnyk & Fineout-Overholt, 2018; see Appendix G), the mere lack of studies specific to NI competencies of nurse practitioners strongly supports the inquiry. One study included, but not exclusive to, NPs enrolled in a DNP program as research participants (Kupferschmid et al., 2017), while two other studies involving DNP students did not specify the inclusion of NPs as research subjects (Choi & De Martinis, 2013; Choi & Zucker, 2013). Nonetheless, all three studies suggested that the NI competencies of study participants needed to expand. To support the expansion of informatics competencies of NPs, the use of an online platform can be conducive to learning when a variety of evidence-based design elements and implementation strategies (Boiling et al., 2012; Bond et al., 2017; Covington et al., 2019; Karvinen et al., 2017; Rosvall & Carlson, 2017; Sikkens et al., 2018; Yu et al., 2013) are carefully incorporated into improvement projects.

Limitations and Gap

The studies in the integrative review were mostly from academic settings and none that exclusively targeted NPs or NP students as subjects. The majority of the studies had undergraduate nursing students, nurses in non-NP roles, or professionals from other disciplines as the target populations. Furthermore, standards appeared to be unclear on how to assess informatics competencies. Self-assessment was used in several studies to evaluate NI competencies, which is subject to bias as levels of competencies may be over-estimated or under-reported by participants (Forman, 2020). Conversely, even third-party assessment of students' NI skills may also be subjective and lead to inconsistent results. Despite the limitations, findings from those studies are transferable and can be extrapolated, adjusted, and applied to the inquiry.

Theory

The Attention Relevance Confidence Satisfaction (ARCS) Motivation Theory is the conceptual model that guided the development of the online learning module in NI (see Appendix I for the theory-to-application diagram). The ARCS Motivation Theory, which was derived from the theory of motivation and instructional design, implies that attention, relevance, confidence, and satisfaction are required elements that contribute to the core concept of learner motivation (Gatti-Petito et al., 2013; Gormley et al., 2012; Keller, 2010). Motivation refers to the learner's ability to initiate and sustain a goal-directed activity, which can be influenced by the delivery method and execution of the learning materials (Schunk et al., 2014). According to Keller (2010), the first aspect of the ARCS model, attention, can be gained by applying learning strategies that include active participation, various activities, and problem-solving. The second component, relevance, emphasizes the learners' understanding of the usefulness and application of what is being learned (Keller, 2010). The third part, confidence, promotes success that is meaningful to the learners (Keller, 2010). The fourth one, satisfaction, refers to the achievement of positive experiences from the learning activities (Keller, 2010). Achieving the desired learning outcomes will depend on the application of the conceptual model.

The application of the ARCS Motivation Theory is not restricted to specific industries or learning environments. As the conceptual model has been used as a theoretical and practical framework in various education settings and professional development training (Gatti-Petito et al., 2013; Gormley et al., 2012; Keller, 2010), strategies for each component of the ARCS

Motivation Theory are appropriate and applicable in the design and development of online learning materials for this project.

Methods

Approvals, Ethics, and Funding

The UMKC Institutional Review Board (IRB) determined that the study was exempt research (see Appendix J). No personally identifiable participant information was gathered, shared, or used for reporting. Project site approvals were received from the North Bay Chapter of the California Association for Nurse Practitioners (CANP; see Appendix C) and UMKC School of Nursing and Health Studies (see Appendix K). Participation in the study was voluntary, anonymous, and offered to all eligible participants without restrictions on age, race, gender, level of education, EHR proficiency, years of work experience, and other demographic data. The investigator had no conflicts of interest that could compromise the integrity of the study. Funding for the project was covered entirely by the investigator.

Setting and Participants

The CANP North Bay Chapter and UMKC School of Nursing and Health Studies were the primary settings for the project. The study's website (see Appendix L for screenshots of the web pages) was shared with members of these organizations. LinkedIn, a professional online networking platform, was also a setting for the project where the study's website was posted and shared. The target participants were practicing NPs and NP students; retired and inactive NPs were excluded from the study. A voluntary sampling method was used for recruiting participants. Approximately 500 eligible participants were reached online and invited to participate in the study.

Evidence-Based Practice Intervention

The evidence-based practice (EBP) intervention was online education in nursing informatics. The online learning module covered the following six topics: (1) nursing informatics overview, (2) datasets and Microsoft Excel, (3) EHR data reporting, (4) telehealth best practices, (5) evaluating online information, and (6) malware and phishing overview. Participants were asked to complete an 18-item questionnaire to determine their levels of informatics competencies before and after completing the learning module.

Protocol

The online learning module, including the demographic questionnaire and surveys, was housed in one dedicated website. The website was designed and developed by the investigator using Wix, a cloud-based website builder and web-hosting provider (Wix, 2021). Online forms for the demographic questionnaire and pre- and post- intervention competency surveys were strategically built on the website to facilitate the sequential flow for completing the study. Participants' input was securely stored and organized in the backend of Wix and exportable to a spreadsheet for data analysis. Access to the study's data was password-protected. Only the investigator had access to the study's raw data.

Six topics were included in the e-learning module. Each of the six topics had a dedicated page within the website. Five out of the six topics had one embedded YouTube video and a short quiz each, while one topic contained two embedded YouTube videos with one brief quiz. Four of the seven videos (nursing informatics overview, datasets and Microsoft Excel, EHR data reporting, and evaluating health information online) were produced by the investigator using Microsoft PowerPoint, Doodly whiteboard animation program (Doodly, n.d.), and Movavi audio-video editing software (Movavi Software, 2020). The other three videos (telehealth best practice, malware, and phishing awareness) were created by other parties and publicly available on YouTube. The telehealth best practices video was published by the Hawaii State Department of Health Genomics (2020), and the malware (2019) and phishing awareness (2020) videos were created by Lucy Security. For the short quizzes that allowed participants to verify their knowledge after each e-learning video, they were built using Google Forms.

The welcome page of the online learning website described the study, voluntary and anonymous participation, and freedom to withdraw from the study at any time. The participant clicked on the "New Participant" button that was linked to a page for creating a participant ID to proceed with the study. The unique ID was essential in matching the pre- and post-intervention scores of the participants. Suggestion to use the first four letters of the individual's favorite food or place, and a two-digit number (and no identifiable information like name or email address) was displayed on the page. If the participant ID was already being used by somebody else, the individual was prompted to enter a different ID. Once the participant ID was successfully created, the individual proceeded to the demographic questionnaire, then to the 18-item competency survey before starting the first e-learning topic. Creating the participant ID and completing the demographic questionnaire and the pre-intervention survey took approximately five minutes.

The first topic focused on the definition and objectives of nursing informatics. An e-learning video explained nursing informatics as a nursing specialty, the roles of NI specialists or informatics nurses, and the significance of NI competencies for all practicing nurses. The runtime for the video was eight minutes and 33 seconds, and the post-e-learning quiz contained three multiple-choice questions. The second topic was a step-by-step demonstration of downloading a public dataset and using Microsoft Excel to organize and present the data. A sample scenario involving Lyme disease in one county in California was used for the demonstration. The video runtime was 10 minutes and 51 seconds, and a one-item quiz followed the video. The third topic was a broad review of EHR-related regulatory requirements that impact healthcare providers, including the Meaningful Use Program (now known as the Promoting Interoperability Program), electronic clinical quality measures, and the Merit-Based Incentive Payment System (MIPS). The video runtime for this topic was 10 minutes and 19 seconds, and the post-e-learning quiz had three multiple-choice questions.

The fourth topic described the best practices for conducting telehealth sessions, including tips on optimal lighting, background, webcam, and audio settings. The e-learning video runtime was four minutes and seven seconds, and a one-question quiz followed the presentation. The fifth topic offered a systematic method on how to evaluate online information for overall reliability and quality. The video runtime was four minutes and 22 seconds. The post-e-learning quiz had one true-or-false question. The sixth topic covered data security and how to recognize and prevent phishing or malware attacks. There were two short videos for this topic with a combined runtime of seven minutes and 19 seconds. The post-e-learning quiz had three multiple-choice questions. With seven e-learning videos and six quizzes, participants could complete all the activities in approximately 55 minutes. Lastly, participants completed the post-intervention survey, which could take roughly five minutes.

Invitations to participate in the study were sent via email through the distribution lists for the North Bay Chapter members of CANP and graduate nursing students (including practicing NPs) at UMKC (see Appendix M for the information letter). The email provided a brief description of the study and a link to the website of the online learning module. The study information and link to the online module were also shared on LinkedIn through public posts as well as direct messages to NP colleagues of the investigator.

Change Process and EBP Model

The organizational change framework selected for the project was based on Lewin's Change Management Model. In this model, there are three sequentially structured stages of change: (1) Unfreeze, which is the preparation stage of change; (2) Change, where the implementation of the actual change and transition begins; and (3) Refreeze, where people, workflows, and systems begin and continue to stabilize (Manchester et al., 2014). As the implementation of an online learning module impacts changes in knowledge and skills, Lewin's Change Management Model can be applied to the improvement of NI competencies of NPs.

The EBP Model that supported this project is the Knowledge-to-Action (KTA) Framework. In the KTA Framework, knowledge creation (knowledge inquiry, synthesis, and products/tools) is influenced by an action cycle composed of seven activities: (1) identifying problem, (2) sustaining knowledge, (3) evaluating outcomes, (4) monitoring knowledge use, (5) selecting, tailoring, and implementing interventions, (6) assessing barriers to knowledge use, and (7) adapting knowledge to the local context (Field et al., 2014). The KTA Framework is appropriate for the implementation of an online learning module in NI as the intent of the project is to apply newly acquired or expanded NI knowledge into practice.

Iterations of the project can continue using Lewin's Change Management Model and the KTA Framework. As the project is not a complete course in NI, the online learning module can be the foundation for developing an entire course in NI. Sustainability and expansion of the project are highly feasible.

Study Design

As competencies of one non-randomized group were measured before and after an intervention, a within-subjects, pretest-posttest, quasi-experimental design was used for the study. This study design was deemed appropriate for determining whether informatics competency scores of NPs increased before and after completing the online learning module in nursing informatics.

Validity

Internal validity was promoted in the study by matching the e-learning topics with five of 18 specific areas of informatics competencies listed on the measurement tool. Participants completed an 18-item survey before and after the online learning module, but they were uninformed of the five informatics competencies of interest. Determining median differences in levels of competencies in those five specific areas of competencies and not finding differences in the other 13 areas of competencies could strengthen the internal validity of the study and increase the likelihood of rejecting the alternative hypotheses. Furthermore, the design of the online learning module was conducive for participants to follow a sequential and consistent pattern in completing all activities in the study. Participation was also anonymous. Participants did not interact with the investigator or with each other. As such, variations in completing the study and other confounding factors were minimized. In terms of the transferability of the intervention, with some adjustments that address specific education needs, implementing the intervention could be highly likely and achievable with other groups of nurses or healthcare professionals.

Outcomes

The anticipated primary outcome aligned with the measurement in the project, which was enhanced or expanded competencies of nurse practitioners and NP students in specific areas of informatics. Through the completion of an online learning module in nursing informatics, the anticipation was for participants to score higher in specific areas of the informatics competencies compared to their pre-intervention scores. The study also collected data related to informatics competencies of an under-researched population (see Appendix N for the logic model).

Measurement Instrument

The Self-Assessment of Informatics Competency Scale for Health Professionals was used in the study. The measurement instrument is an 18-item hierarchical scale divided into three categories: basic computer skills, roles in informatics, and advanced computer skills and clinical informatics (Yoon et al., 2015). Each area of competency is assessed using a 0-to-4 scale, where 0 corresponds to *not competent*, 1 is *somewhat competent*, 2 is *competent*, 3 is *proficient*, and 4 is *expert* (Yoon et al., 2015). The scale was refined from the 93-item SANICS tool using the item response theory (IRT) as an analytical framework, which has been shown to improve the reliability and validity of self-reported outcomes (Yoon et al., 2015). The Cronbach's alpha coefficient for internal consistency reliability for this measurement tool is 0.932 (Yoon et al., 2015). Permission to use the measurement instrument was requested and granted by the developer of the instrument (see Appendix O for the permission letter). The 18-item questionnaire was integrated on the e-learning website with instructions to complete before and after the online learning module on nursing informatics.

Quality of Data

Data input by participants was simplified by using drop-down menus, checkboxes, or radio buttons on the pretest and posttest surveys. This questionnaire design minimized the risk of typographical errors related to manual entry of data, ensured consistency, promoted accuracy, and facilitated data preparation and analysis. The data collection period was three months, which was deemed adequate for participants to complete the roughly one-hour online learning module either in one session or multiple sessions.

Post hoc power analyses were conducted using G*Power (Faul et al., 2007; see Appendix P for the calculation details). The calculations were based on an Exact Sign test (binomial test), one-sided tail, sample size N = 17, and alpha error = .05. The effect size conventions used in G*Power were as follows: small (g = .05), medium (g = .15), and large (g = .25; Faul et al., 2007). The statistical power for the Sign test was calculated at .06 for a small effect size (g = .05) and .54 for moderate effect size (g = .24). Statistical power exceeded .8 with large effect size g = .32. Adequate power for this Sign test could be found at the large effect size level (g > .31) but inadequate statistical power at the small and moderate effect size levels.

As there are no studies in the literature that specifically focus on informatics competencies of NPs, there are no benchmark data that can be used for comparison. Nonetheless, studies involving NI competencies and graduate nursing students, including NPs in a DNP program (Choi & De Martinis, 2013); Choi & Zucker, 2013); Kupferschmid et al., 2017), were reviewed as they are somewhat aligned with this project.

Analysis Plan

Descriptive statistics, including frequencies, percentages, and means, were used with the demographic data. For statistical tests, as the dependent variable in the study was not measured at the continuous level (see Appendix Q for the variable definition), a non-parametric equivalent of the paired-samples t-test was planned (Laerd Statistics, 2015). Wilcoxon signed-rank test could have been used with ordinal data to determine whether a median difference exists between paired observations (Laerd Statistics, 2015). However, because symmetrically shaped distributions of the differences between the related pre-intervention and post-intervention groups could not be assumed, the related-samples Sign test (Laerd Statistics, 2015) was used for the study instead.

Results

Setting and Participants

The time frame of the study was December 1, 2020 to March 1, 2021. The study was conducted on a dedicated website, which was built specifically for the project. The sample population for the study was composed of 17 participants (see Appendix R for the complete demographic data), including two NP students. Participants were predominantly in the 30-39 age range (64.7%), while the 40-49 and 50-59 age ranges had equal frequency (17.6%). Most participants selected DNP (41.2%) and MSN (41.2%) as their highest level of education completed, while 11.8% chose BSN and 5.9% indicated MSN/DNP Candidate. A majority of the participating NPs reported at least one year of NP experience (76.5%) compared to 11.7% with less than one year, and 11.8% of the nurses enrolled in NP programs reported their NP experience as less than one year. Participants selected a range and a combination of NP specialties, but the most common practice area was Family (>41.2%), followed by Psychiatric/Mental Health (11.8%). All participants indicated having at least two years of EHR experience, with the majority reporting >5 years (88.2%). The highest frequency of EHR use was several times/day (64.7%), followed by several times/week (29.4%), and once a day (5.9%). Most participants had never taken an informatics course (64.7%), while 35.3% had completed an informatics course in the past.

Intervention Course

On the study's homepage, the participant clicked on the "New Participant" button to create a unique participant ID before starting the online learning activities (see Appendix S for the intervention flow diagram). Then, the participant completed the 18-item pre-e-learning informatics competency survey. When the pre-intervention survey was submitted, a webpage for the first topic automatically displayed an embedded e-learning video along with a short quiz. The participant watched the e-learning video and answered the post-e-learning quiz questions. Once all the activities were completed for the topic, the participant clicked the “Next Topic” button to proceed to the subsequent topic. All six topics were uniformly presented or designed with an e-learning video (except for the sixth topic with two short videos), a post-e-learning quiz, and navigation buttons such as “Previous Topic” and “Next Topic.” On the sixth or last topic’s webpage, the “Next Topic” button was replaced with a “Post-eLearning Survey” button. The participant clicked the “Post-eLearning Survey” button, entered their own unique participant ID, completed the 18-item post-e-learning survey, and clicked “Submit.” A thank-you note displayed upon submission of the post-intervention survey.

Only participants who completed the demographic questionnaire and both pre-intervention and post-intervention surveys had data included in the analysis. Fifty-six individuals completed the pre-intervention survey, but only 17 finished the post-intervention questionnaire. The completion rate was 30%.

Outcome Data

A related-samples Sign test was conducted using IBM SPSS, Version 26, predictive analytics software to determine the difference in participants' informatics competencies before and after completing the online learning module in nursing informatics. Medians were used in the analysis unless otherwise stated. Out of the 17 participants in the study, 11 reported improvements in the management of aggregated data, data extraction, data protection, and online health information evaluation, while 10 reported improvements in the application of relevant information (see Appendix T for the data collection template). The median of differences between the pre-intervention and post-intervention scores was found to be statistically significant in the following areas of informatics competencies: management of aggregated data (*Mdn* = 1.00), $p < 0.001$; data extraction (*Mdn* = 1.00), $p < 0.001$; data protection (*Mdn* = 1.00), $p < 0.001$; online health information evaluation (*Mdn* =1.00), $p < 0.001$; and the application of relevant information (*Mdn* =1.00), $p = 0.001$. Inversely, the median of differences between the pre-intervention and post-intervention scores was not statistically significant in the other 13 areas of informatics competencies (*Mdn* = 0), $p = 0.06$ to 0.50 (see Appendix U for the detailed statistical analysis).

Discussion

Successes

The leading success in the study outcome was the self-reporting of participants' expansion of their competencies in the management of aggregated data, data extraction, data protection, online health information evaluation, and application of relevant information. Competency scores for these five areas of informatics were anticipated to increase as they were related to the topics covered in the online learning module. Despite the small number of NPs and NP students in the study, increases in median scores between the pre- and post-intervention were shown to be statistically significant. Findings from this project could be used as baseline or comparison data for iterations of similar studies.

Study Strengths

The overall design of the study's website and the online format of the intervention were significant contributors to the success of the study. All activities in the study were arranged sequentially and logically to facilitate the participant's completion of the study. Each topic within the online learning module had a dedicated page with at least one embedded short YouTube video and a brief quiz. Each webpage also contained navigation buttons that guided the participants from the beginning until the end of the study. All questionnaires and learning materials were housed on a dedicated website, allowing participants to complete the learning materials, free from distractions, such as advertising pop-ups and auto-playing video commercials. The delivery of the learning materials via the web enabled the participants to access the study anytime and anywhere they could connect to the Internet with either a personal computer or smart mobile device.

Results Compared to Evidence in the Literature

No published studies were found in the literature that specifically evaluated the informatics competencies of nurse practitioners and NP students before and after an education program in informatics. Hence, this study appears to be the first to report that NPs and NP students could expand areas of informatics competencies after completing an online learning module in nursing informatics. Although one study by Kupferschmid et al. (2017) evaluated the informatics competency mastery of DNP students, including nurse practitioners, after completing an informatics course, the objective of that study was to analyze the performance difference between post-baccalaureate and post-MSN students. The participants' informatics competencies in the study by Kupferschmid et al. (2017) were also not measured pre-intervention.

Limitations

Internal Validity Effects

Convenience or voluntary sampling and attrition were confounding factors in this project. As the sampling method in the study did not include randomization, participants might not have been an accurate representation of the target population. Findings in the study might have been based on a biased sample of NPs and NP students who were highly driven and felt the need to improve their informatics competencies. Out of 56 participants who submitted the pre-intervention survey, only 17 completed the post-intervention questionnaire. The low completion rate might have been related to a lack of time and motivation during the data-collection period, especially when major holidays in December and the COVID-19 pandemic fell within the project period. Furthermore, self-assessment of competencies was a confounding factor as participants might have over-rated or under-estimated their actual informatics competencies.

External Validity Effects

The generalizability and transferability of the study findings might be limited due to the small sample size and non-randomized selection of participants. The average age of NPs in the United States is 47 years (AANP, 2020b), but the NPs in this study (64.7%) were primarily in the 30-39 age range. Also, the average practice experience of NPs in the United States is 10 years (AANP, 2020b), but the majority of the NPs in the study indicated that their years of NP experience were in the 1-5 (29%) and 6-10 (29%) ranges. Characteristics of the participants in the sample were elements that could threaten the external validity of the study.

Sustainability of Effects and Plans to Maintain Effects

The informatics competencies gained by participants from the completion of the online learning in NI can weaken over time if the acquired knowledge is not applied in practice. However, the website for the NI e-learning module will remain active and can be accessed by the study participants and other interested individuals. If desired, study participants can return to the e-learning videos and quizzes at their convenience to review or reinforce their newly acquired knowledge. Out of the six topics in the online learning module, one will need to be updated on a yearly basis (EHR data reporting) as federal and state mandates are revised annually. Nevertheless, links to government sites related to up-to-date EHR data requirements are embedded on the webpage.

Efforts to Minimize the Study Limitations

Efforts to recruit a larger sample size were made by promoting study participation of NPs and NP students through various channels, such as email distribution lists for members of a local NP association in California and nurses in an NP program at a public university in Missouri. Additionally, the study details were shared on a professional networking platform through multiple posts and direct messages to the investigator's NP colleagues. Recipients of the recruitment message were also encouraged to share the study with NPs and NP students within their professional and personal circles. No restrictions to demographic information, NP specialty, or NP experience were indicated for the study.

To reduce participant attrition and encourage participation, participants had the option to access the learning module from a desktop or a mobile device. The study's website was designed to simplify the navigation and completion of surveys and learning activities. The e-learning videos were short, relevant, and engaging. The end date for data collection was also displayed on the website as a friendly reminder to complete the study before the deadline.

Interpretation

Expected and Actual Outcomes

Competency scores for five out of the 18 items in the survey were expected to increase as the topics in the online learning module in NI targeted those areas of competencies. Thus, the statistically significant competency score increases for the management of aggregated data, data extraction, data protection, online health information evaluation, and application of relevant information align with the expected outcomes of the study. For the other 13 areas of competencies, most of the pre-intervention and post-intervention scores remained the same, with no statistically significant difference in scores found, as expected.

Intervention Effectiveness

The online learning module in NI is deemed effective in expanding the informatics competencies of the target population, as evidenced by the study results. The project's web-based platform facilitates not only the circulation of invitations to participate in the study but also the completion of surveys and learning activities online. The target population can be effortlessly reached through the web, and the study can be accessed remotely at the participants' convenience. Moreover, the website that houses the surveys and learning activities was designed to be simple to follow and conducive to learning. With appealing, pertinent, and concise learning materials, the participants can pause, play, and repeat the e-learning videos as needed. For each e-learning video, a corresponding brief quiz follows, allowing participants to verify their understanding of the material and reinforce learning.

An online learning module similar to this project can be developed and implemented in situations where continuing education and professional development can be appropriately delivered remotely through the web. Such intervention can connect with a broader target population and extend to locations that are otherwise unattainable or impractical for a study to be conducted in person. Barriers related to learning through traditional classroom settings, such as employment and family commitments, can be overcome in web-based learning.

Intervention Revision

The total length of time for all the learning activities might have been a deterrent for the participants who did not complete the study. The total runtime for the e-learning videos alone was 45 minutes, excluding the time for the quizzes and the pretest and posttest surveys. A more compressed video runtime might have encouraged the participants to complete the study. The e-learning videos for two topics, Nursing Informatics Overview and EHR Data Reporting, which had a combined runtime of approximately 19 minutes, could have been presented as optional learning activities. As the informatics competency survey did not have items to measure the participant's knowledge in nursing informatics and EHR-related reporting requirements, dedicated pages should not have been created for these two topics. Instead, the participants should have been provided the option to click on hyperlinks to the e-learning videos on nursing informatics overview and EHR data reporting if they wished to learn or review these topics. Also, one e-learning video (Datasets and Microsoft Excel), which was almost 11 minutes long, could have been compressed further.

Another factor that might have influenced the low study completion rate was the project's three-month duration. Major holidays in December that fell within the project's window might have contributed to the lack of time and motivation for participants to complete the study. Avoiding major holidays and extending the project time frame to longer than three months might have improved the recruitment and study completion rate.

Expected and Actual Impact on Health System, Costs, and Policy

The expected and actual impact of the NPs' and NP students' expansion of informatics competencies may be immediately apparent when conducting telehealth sessions with patients and evaluating health information online. Telehealth encounters have become more prevalent, especially during the COVID-19 pandemic, and are anticipated to continue past the pandemic (Koonin et al., 2020). Applying telehealth best practices around communication and video setup can increase the quality of the clinician-patient interaction, promote a positive virtual visit experience, and enhance patient satisfaction (Hawaii State Department of Health Genomics Section, 2020). Competencies in evaluating health information online also impact the quality of care provided to patients. Nurse practitioners and NP students who are equipped with the competency to evaluate the validity and reliability of health information online can incorporate their knowledge during patient education sessions.

The impact of competency expansion in other areas of informatics covered in the online learning module, such as datasets and Microsoft Excel, EHR data reporting, and data security, may not be evident immediately. However, competencies in these areas are significant. For NPs and NP students involved in data collection and analysis, particularly in research, quality improvement, and epidemiology, working proficiently with datasets and Microsoft Excel can lead to findings that can improve health outcomes. Equally impactful is the NPs' and NP students' understanding of EHR data reporting. Nurse practitioners, along with physicians and other healthcare team members, play vital roles in complying with federal and state mandates around the meaningful use of EHR systems. Compliance with EHR-related rules equates to the appropriate capture of patient data, timely reconciliation of information, and accurate health information exchange, leading to better patient outcomes and decreased healthcare cost (CMS, 2020). Lastly, competencies around data security are critically impactful. Knowledge and skills in preventing malicious attacks (malware) can protect patients and the integrity of their data within clinical information systems and save the healthcare organization the high cost of recovering from malware. A cyberattack, such as ransomware, can paralyze a healthcare organization by preventing access to their data until a ransom is paid, which can be costly and can compromise patient safety, disrupt the delivery of healthcare services, and damage an organization's reputation and public trust.

Opportunities

Further research with a larger sample size and a longer time period for data collection can be conducted to validate the findings from this study. Another opportunity is to expand the online learning module in NI to include other areas of informatics competencies, as only six topics were covered in the project. This online learning module can also be a base for developing a complete course in nursing informatics. Moreover, all topics in the online learning module may be applicable to other healthcare professionals. Although the target population of this study is NPs and NP students, the online learning module can be extended to nurses in various specialties and clinicians from other disciplines. Iterations of this project can be made to address specific informatics competency needs.

Conclusions

Practical Usefulness of Intervention

Informatics competencies are crucial in supporting effective, efficient, and safe health care. The online learning module in NI can promote the advancement and expansion of informatics competencies of NPs and NP students. The findings from the study have provided evidence that levels of informatics competencies can be increased after completing the activities in an online learning module in NI. The study yielded increased levels of informatics competencies in aggregated data management, data extraction, data protection, online health information evaluation, and information application. These expanded competencies can positively contribute or enhance clinician-patient communication, patient education, patient safety, cost-effectiveness, public trust, patient satisfaction, and ultimately patient outcomes. Furthermore, the knowledge and skills gained from completing the online learning module in NI are transferable and applicable to other practice settings.

Further Study of Intervention

The online learning module in NI is a general intervention that addresses the informatics competencies of nurse practitioners and NP students. Further studies can strengthen the validity of the findings from this study and address the informatics knowledge needs of NPs and NP students. As there is a lack of studies involving NPs and NP students and NI competency assessment, publishing the findings from this project can add to the body of knowledge in the subject area. Findings from this project can also be used for comparison with similar studies.

Dissemination

Results of this study will be disseminated through a poster presentation at the American Nursing Informatics Association's annual conference in San Diego, California, in August 2021. The investigator will also submit a manuscript for publication on the CIN: Computers, Informatics, Nursing journal.

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Appendix A

Definition of Terms

Competence: an individual's overall capacity to perform something successfully using pertinent knowledge and skills (Pijl-Zieber et al., 2014)

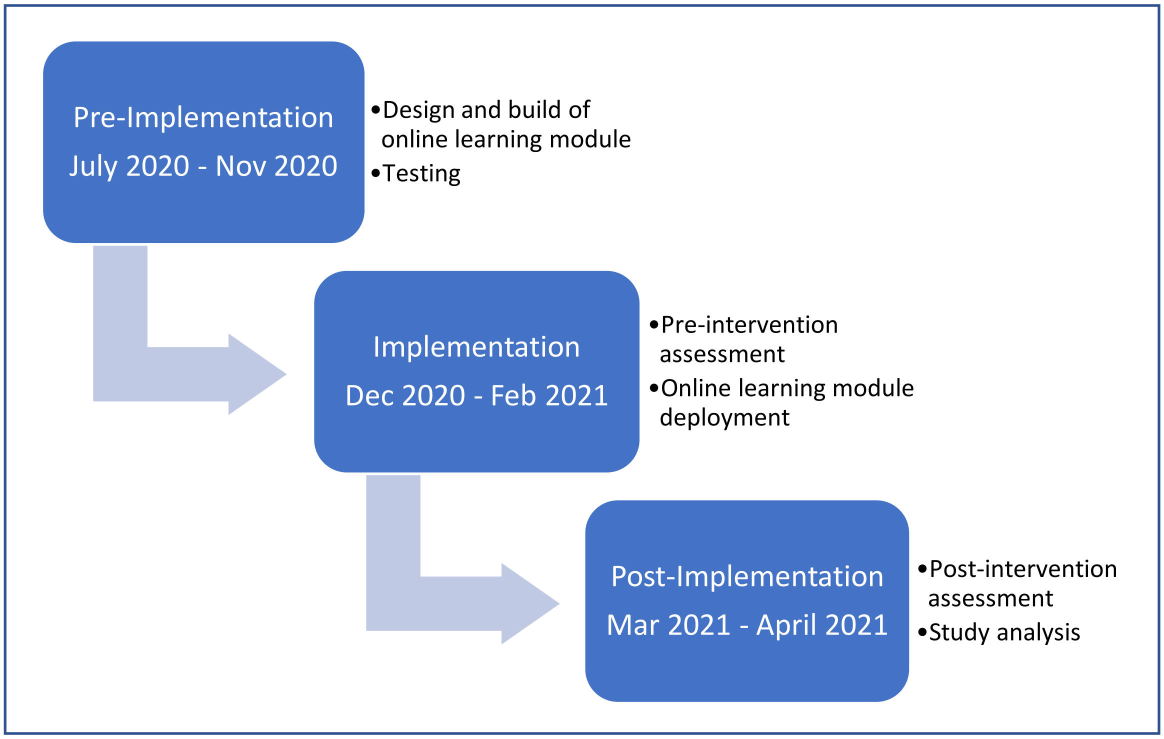
Competencies: skills, knowledge, values, and attitude (Pijl-Zieber et al., 2014)

Informatics: a mutual connection between people, processes, and technologies that provides reliable, useful, and meaningful information (San Jose State University, n.d.)

Nursing informatics: nursing science intersects with technologies, information systems, and data analytics to improve healthcare outcomes through continuous improvements in nursing practice, clinical decision making, communication and coordination of health services with other members of the multidisciplinary team, and partnership with patients and other stakeholders (ANA, 2015)

Appendix B

Project Timeline



Appendix C

DNP Site Approval from the CANP – North Bay Chapter

CALIFORNIA ASSOCIATION FOR NURSE PRACTITIONERS

3242 Cobblestone Drive
Santa Rosa, California 95404
707-321-5406
canpweb.org

Lyla Lindholm, DNP, Adult CNS
MSN-DNP Coordinator, Clinical Assistant Professor
School of Nursing and Health Studies
University of Missouri-Kansas City (UMKC)
2464 Charlotte Street
Kansas City, MO 64108

RE: SITE APPROVAL FOR BRIAN GALACIO'S DNP PROJECT

Dear Dr. Lindholm:

The North Bay CANP Chapter is supporting Brian Galacio, a Doctor of Nursing Practice (DNP) student at UMKC, in implementing his DNP project.
Please consider this letter as an approval for Brian Galacio to conduct his DNP project within the North Bay CANP Chapter membership from December 2020 to May 2021.

Sincerely,

Thank you,
Surani

Surani Hayre-Kwan DNP, MBA, FNP, FACHE, FAANP
Past President, North Bay Chapter

Power in Practice

Appendix D

DNP Project Proposal Approval from UMKC DNP Faculty

UMKC School of Nursing and Health Studies

July 17, 2020

UMKC DNP Student, Brian Galacio

Congratulations. The UMKC Doctor of Nursing Practice (DNP) faculty has approved your DNP project proposal, *Implementing an Online Learning Module to Expand the Nursing Informatics Competencies of Nurse Practitioners.*

You may proceed with IRB application

Sincerely,

Lyla Lindholm, DNP, RN, ACNS-BC
Clinical Assistant Professor, DNP Faculty
MSN-DNP Program Coordinator
UMKC School of Nursing and Health Studies
lindholml@umkc.edu

Cheri Barber, DNP, RN, PPCNP-BC, FAANP
Clinical Assistant Professor
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DNP Faculty Mentor Dr. Lindholm, DNP
UMKC School of Nursing and Health Studies

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an equal opportunity/affirmative action institution

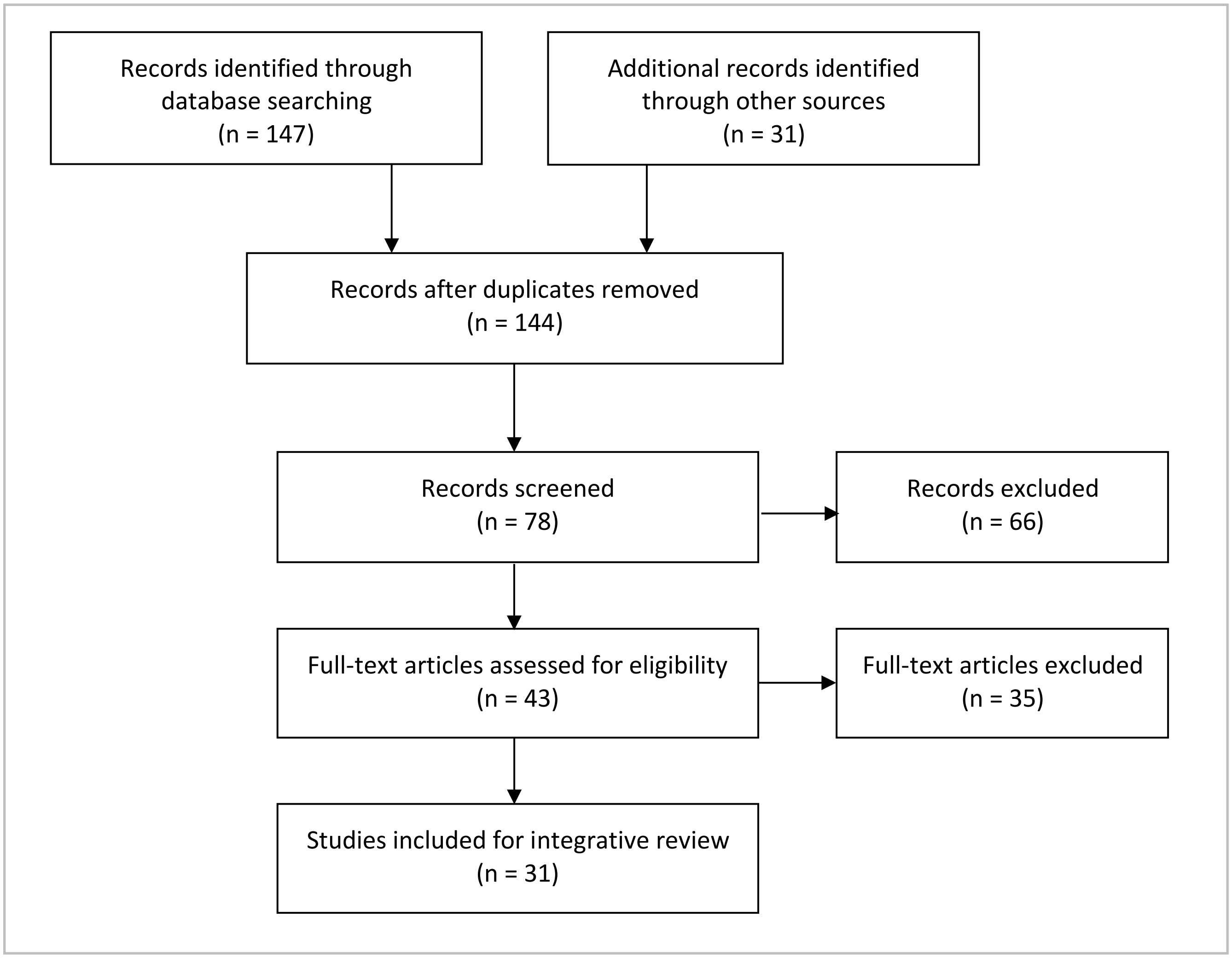
Appendix E

Project Cost Table

Item	**Quantity**	**Cost**	**Total**
Doodly (whiteboard animation software)			
Enterprise membership	1	$319.00	$319.00
Rainbow addon	1	$49.00	$49.00
Healthcare pack	1	$49.00	$49.00
Movavi Academic (video editing software)			
One-year license	1	$49.95 / year	$49.95
Wix (website builder and hosting service)	1		
Premium plan unlimited	1	$102.00 / year	$102.00
Domain setup	1	$9.90 / year	$9.90
Shutterstock images	4	$2.99 / item	$11.96
In-kind labor (e-learning and website development)	320	$50 / hour	($16,000.00)
			$540.86

Appendix F

PRISMA Diagram



Appendix G

Evidence Table

First author, Year, Title, Journal	Purpose	Research design, Evidence level & Variables	Sample & Sampling, Setting	Measures & Reliability (if reported)	Results & Analysis Used	Limitations & Usefulness
Nursing Informatics Competencies						
Kupferschmid (2017). Evaluation of doctor of nursing practice students' competencies in an online informatics course. Journal of Nursing Education	Evaluate the competencies of a convenience sample of DNP students enrolled in an online informatics course.	Descriptive design. Level 6. Variables: acquisition of information skills and informatics concepts analysis and application.	Sample: DNP students. Sampling: Convenience sampling. Setting: One university in the midwestern US.	Faculty evaluation of students' competency	Post-baccalaureate students performed better than post-master's students in informatics skills. Post-master's students performed better than post-baccalaureate students. Analysis: descriptive statistics	Sample from a single school. May not be generalizable. Useful to know the competency categories used in the study. May apply to the inquiry.
Gonen (2016). Integrating information technology's competencies into academic nursing education—An action study. Information & Communications Technology in Education	Promote the knowledge of information technology competencies among nurse educators and students.	Descriptive design. Level 6. Variables: attitude toward IT, IT knowledge, and IT competencies.	Sample: 59 nursing students (for a questionnaire. Nurse educators and academic nurses (for interview). Sampling: convenience sampling. Setting: One academic center in Israel.	Interviews and questionnaires Instrument reliability not reported	Lack of computer skills in some areas for both the students and nurse educators. Simulation More simulation exercises suggested in the nursing curriculum and in clinical areas. Analysis: descriptive statistics (means and standard deviations of sequential variables and frequencies of categorical variables).	Study in Israel; there may be cultural differences. Study participants were undergraduate nursing students. Results may be useful in the implementation of an online NI learning module.
Rajalahti (2014). Developing nurse educators' computer skills towards proficiency in nursing informatics. Journal for Health & Social Care	Assess nurse educators' competence dev elopment in nursing informatics (NI) and compare their competence to the NI competence of other healthcare professionals.	Quasi-experimental design. Level 3. Variables: computer competence, advanced NI competence.	Sample: 124 participants (nurse educators, nurses, and other health professionals). Sampling: Convenience sampling. Setting: one university and health system in Finland.	158-item questionnaire Cronbach's alpha between 0.74 and 0.98	Skills in information management concerning nursing varied. Nurse educators improved somewhat in their evidence-based nursing and the use of the nursing process model. Analysis: descriptive statistics, correlation comparison.	Actual study conducted in the late 1990s. Setting in Finland. Recommendations from the study may be useful for the inquiry.

Swenty (2014). A sense of urgency: Integrating technology and informatics in advanced practice nursing education. Journal for Nurse Practitioners	To explore the external forces and current trends driving the use of informatics in health care and the need to integrate this content into the advanced practice nursing education curriculum.	Descriptive design. Level 7.	N/A	N/A	Hypothetical advanced practice nursing program incorporating technology into specific courses presented. Analysis: expert opinion	Not a study. APN program presented not tested. Recommendations are useful to consider in incorporating informatics into an NP program.
Choi (2013). Nursing informatics competencies: assessment of undergraduate and graduate nursing students. Journal of Clinical Nursing	Report the informatics competencies of students in selected undergraduate and graduate nursing programs, to examine whether informatics competencies differed between the different programs and to suggest competency-based applications that will strengthen informatics courses and informatics-related content throughout the curricula.	Quantitative, non-experimental. Level 6. Variables: nursing programs and nursing informatics competencies.	Sample: 158 DNP students and 131 nursing undergraduate students. Sampling: Convenience sampling. Setting: one university in Massachusetts.	30-item Self-Assessment of Nursing Informatics Competencies Scale (SANICS). Five sections of SANICS with Cronbach alpha between 0.87 and 0.94	DNP and undergraduate students showed competencies in three informatics subareas. DNP students scored slightly higher mean competency scores in three informatics subareas. Analysis: tables containing respondents' characteristics and summary of competency scores included.	Competencies measured using self-report as opposed to their actual skills and knowledge. Discussion about the SANICS tool and nursing informatics course contents is relevant and useful.
Choi (2013). Self-assessment of nursing informatics competencies for doctor of nursing practice students. Journal of Professional Nursing	Examine the informatics competencies of doctor of nursing practice (DNP) students and whether these competencies differe d between DNP students in the post-baccalaureate (BS) and post-master's (MS) tracks.	Quantitative, non-experimental. Level 6. Variables: DNP tracks and informatics competencies.	Sample: 68 post-BS and 64 post-MS DNP students. Sampling: convenience sampling. Setting: one university in Massachusetts.	86-item informatics competency assessment based on 43 informatics competency statements for beginning and experienced nurses. Each item on a Likert scale (1 – 5). Instrument with Cronbach's alpha 0.98.	Knowledge and skills in informatics need to be improved, especially in computer skills for data access and the use of decision support systems. Analysis: table containing competency scores included.	Competencies measured using self-report as opposed to their actual skills and knowledge. Strategies suggested to improve NI competencies relevant and useful.

Nursing Informatics Competency Assessment						
Forman (2020). A review of clinical informatics competencies in nursing to inform best practices in education and nurse faculty development. Nursing education perspectives	Determine the state of the science related to clinical informatics competencies of registered nurses and determine best practices in educational strategies for both nursing students and faculty.	Integrative review. Level 5. Variables: clinical informatics competencies and educational strategies.	Sample: 69 publications. Sampling: Database search. Setting: online search.	Whittemore and Knalf's five-step integrative review process	Nursing educational programs do not adhere to standardized criteria for teaching nursing informatics competencies. Analysis: critical appraisal.	Findings support the need for strategies to improve NI competencies.
Lee (2019). Nursing students' learning dynamics with clinical information and communication technology: A constructive grounded theory approach. Nurse Education Today	Develop a theoretical model by identifying nursing students' learning dynamics with clinical information and communication technology and the factors influencing the dynamics.	Qualitative interview. Level 6. Variables: learning dynamics with ICT and factors influencing the dynamics.	Sample: 16 4th-year nursing students. Sampling: Purposive sampling. Setting: four universities in South Korea.	Open-ended and semi-structured interview questions	A model developed to explain three dynamics that influence nursing students' use of clinical information and communication technology (interpersonal, organizational, and emotional dynamics) and the students' responses regarding the dynamics for learning in clinical contexts. Analysis: all interview data analyzed using three coding methods: initial, focused, and theoretical coding. Nvivo 11 used for data management.	Educators can use the theoretical model to understand how best to support building competency in using clinical information and communication technology.
Bryant (2016). Development and testing of an instrument to measure informatics knowledge, skills, and attitudes among undergraduate nursing students. Online Journal of Nursing Informatics	Report on the development and psychometric testing of the Knowledge, Skills, and Attitudes towards Nursing Informatics (KSANI) Scale to measure these constructs among entry-level nursing students.	Qualitative descriptive. Level 6. Variables: KSANI Scale content validity and Quality and Safety Education for Nurses (QSEN) Institute informatics competencies.	Sample: 300 undergraduate nursing students. Sampling: convenience sample. Setting: Students' annual convention.	Measurement instrument developed based on the QSEN Institute informatics competencies for pre-licensure students 0.90 Cronbach's test	Alpha for the overall scale exceeded the 0.70 benchmark for acceptability, which suggests that the items on the scale measure the same thing. Analysis: principal component analysis (PCA). Tables showing questionnaire items and corresponding Cronbach's alphas.	Undergraduate nursing students as study participants. Self-reporting of competencies. Instrument developed may be useful for NI competencies assessment pre- and post-completion of an online NI learning module

Lee (2015). Nursing students' attitudes towards information and communication technology: an exploratory and confirmatory factor analytic approach. Journal of Advanced Nursing	Develop and psychometrically test a shortened version of the Information Technolog y Attitude Scales for Health in the investigation of nursing students with clinical placement experiences.	Descriptive design. Level 6. Variables: nursing students' attitude and ICT competency.	Sample: 508 nursing students. Sampling: convenience sampling. Setting: six universities in South Korea.	19-item questionnaire Cronbach alpha between 0.75 and 0.90	The instrument was shown to be both valid and reliable for measuring nursing students' attitudes towards technology, thus aiding in the current understandings of this aspect. Analysis: descriptive statistics used to describe participants and interpret the results.	Study conducted in South Korea. Used convenience sampling. May not be generalizable. Instrument may be useful in assessing NI competencies.
Yoon (2015). Refining a self-assessment of informatics competency scale using Mokken scaling analysis. Journal of Interprofessional Care	Describe the refinement of the Self-Assessment of Nursing Informatics Competencies Scale (SANICS) using analytic techniques based upon item response theory (IRT) and discuss its relevance to interprofessional education and practice	Quantitative, descriptive. Level 6. Variables: informatics competence rating, item scalability, monotonicity, invariant item ordering.	Sample: 604 nursing students	93-item self-report instrument	Newly refined questionnaire with 18 items. Reliability with Cronbach's alpha = 0.932	New questionnaire not yet used in other studies. Shorter refined version may be more precise than older versions of SANICS. The questionnaire may be less time-consuming for the project participants.
Gonen (2014). How to enhance nursing stud ents' intention to use information tech nology: the first step before integrating it in nursing curriculum . CIN: Computers, Informatics, Nursing	Examine the correlation between nursing students' attitudes and a few variables.	Quantitative, descriptive. Level 6. Variables: students' attitude and self-efficacy, threat, challenge, and innovativeness.	Sample: 70 undergraduate nursing students in their first and second year. Sampling: convenience sampling. Setting: one university in Israel.	Questionnaire developed by researcher Cronbach's alpha between 0.67 and 0.87	A positive relationship was found between the students' self-efficacy and their attitude, innovativeness, and intention to use computers, and perception of challenge and attitude to computer use. Analysis: descriptive statistics (Pearson correlations between research variables) were used. Tables provided to show correlations between variables.	Study in Israel; there may be cultural differences. Study participants were undergraduate nursing students. Results may be useful in the implementation of an online NI learning module.

Choi (2013). Validation of the self-assessment of nursing informatics scale among undergraduate and graduate nursing students. Journal of Nursing Education	Investigate the psychometrics of the Self-Assessment of Nursing Informatics Competencies Scale (SANICS) for nursing students in undergraduate and graduate programs.	Quasi-experimental design. Level 3. Variables: online nursing informatics course and nursing informatics competencies	Sample: 171 graduate students, 131 undergraduate students Sampling: Convenience sampling. Setting: State university in Northeastern US	SANICS questionnaire Cronbach's alpha = 0.96 for the total scale and 0.84 to 0.94 for subscales	Improved SANICS scores in nursing students after taking an informatics course. Analysis: descriptive statistics, factor analysis, paired t-test.	Self-reported competencies, limited generalizability, response rate subject to non-response bias. SANICS scale may be useful for NP assessment of NI competencies.
Levett-Jones (2009). Exploring the information and communication technology competence and confidence of nursing students and their perception of its relevance to clinical practice. Nurse Education Today	Explore nursing students' information and communication technology competence and confidence.	Descriptive design. Level 6. Variables: students' ICT competence and confidence, and attitudes towards ICT.	Sample: 995 undergraduate nursing students. Sampling: Survey. Setting: three universities in Australia.	Information and communication technology questionnaire Instrument reliability not mentioned	Some students resistant to the use of ICT as an educational methodology, and a quarter of those surveyed were unsure about the relevance of ICT, while 50% felt "very confident" with ICT. Analysis: descriptive statistics (frequency, percentage) used to describe results.	Older study. Conducted in Australia. Useful result emphasizing motivation is influenced by their level of confidence and competence, and understanding of the relevance of ICT to their career.
Online Learning and Online Learning Module Implementation						
Alexander (2020). Use of a simulated electronic health record to support nursing student informatics knowledge and skills. CIN: Computers, Informatics, Nursing	Examine the effect of a simulated EHR on self-perception of informatics competencies for prelicensure nursing students.	Quantitative, cross-sectional. Level 6. Variables: EHR simulation and self-perception of informatics competency.	Sample: 37 students enrolled in senior-level simulation lab. Sampling: Convenience. Setting: one university in the northeastern US.	18 item Self-Assessment of Nursing Informatics Competency Scale (SANICS) questionnaire No instrument reliability reported	Competency scores increased post-intervention (EHR simulation). Analysis: paired t-test conducted. Table used for the comparison of mean scores pre- and post-test.	Subjects are prelicensure nursing students. Restricted to one institution limiting generalizability. Application of EHR simulation may be useful in the intervention.

Brasier (2019). Pairing practice and feedback with animations optimizes student learning in online module. Journal of Computer Assisted Learning	Investigate the optimal placement of animations and practice and feedback exercises with respect to each other and to static text and graphics in an online DNA replication module.	Quasi-experimental design. Level 3. Variables: variation of either animation placement or PFE placement, post-test, and delayed transfer test scores.	Sample: 263 biology students. Sampling: Selective sampling. Setting: one university in Pennsylvania.	10 multiple-choice questions Instrument reliability not reported	Collocating animations with practice and feedback exercises increase student learning in an online module. No detectable difference between whether the animations + practice and feedback exercises are interspersed with text or after the end of the text. Analysis: regression testing and test of conditional effects.	Students in biology. May be useful in incorporating these designs in the online learning module.
Covington (2019). Improving emergency airway knowledge and self-efficacy levels of outpatient gastroenterology staff via implementation of online education and in situ simulation. Gastroenterology Nursing	Increase the competency and self-efficacy of nurses and surgical technicians in performing new life-saving measures through online learning and simulation.	Quasi-experimental design. Level 3. Variables: knowledge and self-efficacy.	Sample: 14 RNs and 7 procedural techs. Sampling: convenience sampling. Setting: Gastroenterology outpatient clinic in North Carolina.	36-item questionnaire (19 for knowledge assessment, and 17 for self-efficacy) Cronbach alpha not reported	Increase in both knowledge and self-efficacy post-completion of online learning and in situ simulation. Analysis: one-way analysis of variance (ANOVA) immediately, 6-week, and 3-month post-education assessments.	Setting specific to a gastroenterology clinic. Small number of participants. Similar methods and measures can apply to other implementations of an online learning module.
Monsivais (2019). Partnering to develop online teaching skills for master of science in nursing education students. Journal of Nursing Education	Describe the experience of MSN student nurses who participated in a free course that enables them to participate in course development and online teaching.	Qualitative descriptive. Level 6. Variables: -	Sample: 12-16 nursing students per semester. Sampling: convenience sampling. Setting: one university in Texas.	Program evaluation	Students' confidence as an online educator role increased, and they often express that their favorite part was creating a syllabus and course calendar for an online course. Analysis: program evaluation analysis.	Appears to be a small study and not generalizable to other settings. One thing to consider is to partner with other professionals who have the experience and expertise in online teaching.

Oh (2019). Development and evaluation of flipped learning using film clips within a nursing informatics course. Japan Journal of Nursing Science	Develop flipped learning classes by using film clips for undergraduate nursing students in an online nursing informatics course, based on the Analysis, Design, Development, Implementation, and Evaluation model, and to evaluate the effectiveness and students' responses to this method of teaching.	Quantitative, quasi-experimental. Level 3. Variables: film clips, students' satisfaction, achievement on the course outcomes, self-perceived NI competencies.	Sample: 64 second-year nursing students. Sampling: convenience sampling. Setting: one university in South Korea.	Multiple-choice questionnaires pre- and post-test Cronbach alpha = 0.92	Significant increase in students' NI knowledge between the pre- and post-intervention. Using film clips in an online nursing informatics course improved the nursing students' knowledge and is a format that is desired by students. Analysis: descriptive statistics (percentages, means, standard deviations, paired t-tests) were used.	Participants undergraduate nursing students. The results can lead to the intervention being incorporated in an online learning module.
Yoshioka-Maeda (2019). Impact of web-based learning for health program planning competence, knowledge, and skills among mid-level public health nurses: A randomized controlled trial. Public Health Nursing	Evaluate the impact of web-based learning modules for health program planning competency, recognition, knowledge, an d skills among mid-level public health nurses.	RCT experimental, single-blind design. Level 2. Variables: health program planning knowledge and skills, and web-based learning module completion.	Sample: 121 PHNs in intervention group 123 PHNs in control group. Sampling: random sampling. Setting: PHNs in Japan.	26-item Competency Measurement of Creativity for PHNs (CMC) questionnaire Cronbach alpha .93	Group with postgraduate training in program planning before taking the web-based modules, CMC scores for the intervention showed a significant improvement compared with the control group. Analysis: descriptive statistics.	Study conducted in Japan. Helpful to assess informatics education or background of participants.
Sikkens (2018). Improving antibiotic prescribing skills in medical students: the effect of e-learning after 6 months. Journal of Antimicrobial Chemotherapy	Determine if a short period of e-learning can improve antimicrobial prescribing skills and behavior in undergraduates in the long term.	RCT experimental design. Level 2. Variables: e-learning effects and students' prescribing behavior	Sample: Control group 1: 56 e-learning group (short term comparison): 68 Control group 2: 285 e-learning group (long term comparison): 71. Sampling: Random sampling. Setting: medical center in the Netherlands.	57 multiple-choice questions for knowledge test, validated by several experts Cronbach alpha not reported	Students in the e-learning group scored significantly higher on all continuous outcomes compared with control group. Analysis: descriptive statistics to characterize study groups. Univariate linear or logistic regression was used for all comparisons.	Participants are medical students. Average age of 23.5 years may be quite different from the average age of graduate nursing students. Results support the idea that even short e-learning modules can have a significant impact.

Bond (2017). Design and implementation of a novel web-based e-learning tool for education of health professionals on the antibiotic vancomycin. Journal of Medical Internet Research	Describe the design and implementation of a web-based e-learning tool created to improve knowledge in this area.	Quasi-experimental design. Level 3. Variables: trough concentration knowledge, rate of administration knowledge, maintenance dose knowledge, and loading dose knowledge.	Sample: 163 participants (pharmacists, nurses, and doctors). Sampling: Convenience sampling. Setting: multiple hospitals in Sydney, Australia.	Web-based survey with 4-point Likert scale	Self-reported levels of confidence increased. Analysis: chi-square to determine trend and Fisher exact tests to examine total survey scores.	Incorporating video-enhanced web-based learning tools may be useful for the inquiry.
Karvinen (2017). Evaluation of online learning modules for improving physical activity counseling skills, practices, and knowledge of oncology nurses. Oncology Nursing Forum	Examine the effectiveness of online learning modules for improving physical activity counseling practices among oncology nurses.	RCT experimental design. Level 2. Variables: percentage of cancer survivors counseled, self-efficacy for physical activity for counseling, knowledge of physical activity, and perceived barriers and benefit of physical activity counseling.	Sample: 54 oncology nurses. Sampling: random sampling. Setting: one association of nurses in Canada.	13-item questionnaire Cronbach's alpha 0.96	Significant differences were found in self-efficacy for physical activity counseling and perceived barriers to physical activity counseling at postintervention. No significant difference between the learning modules and control groups in the percentage of cancer survivors that oncology nurses counseled. Analysis: descriptive statistics (means, standard deviations, ANCOVAs).	Useful for online learning module implementation.
Rosvall (2017). Registered nurses' perception of self-efficacy and competence in smoking cessation after participating in a web-based learning activity. Journal of Clinical Nursing	Describe how registered nurses having undergone a web-based learning activity perceive their self-efficacy and competence to support patients with smoking cessation in connection with surgery.	Mixed-method design. Level 6. Variables: self-efficacy, competence, and web-based learning activity.	Sample: 47 RNs with questionnaires 11 semi-structured interviews. Sampling: Convenience sampling. Setting: one university hospital in Southern Sweden.	12-item questionnaire and semi-structured interview Questionnaire's Cronbach alpha: 0.83	Competency in supporting patients to stop smoking was enhanced post-intervention. Analysis: descriptive statistics with Wilcoxon signed-rank test.	Study conducted in Sweden. Reinforces that understanding about a subject can increase after an online learning module.

Cummings (2016). Embedding nursing informatics education into an Australian undergraduate nursing degree. Studies in Health Technology & Informatics	Describe the process used by one Australian university to integrate nursing informatics throughout the undergraduate nursing degree curriculum to ensure entry-level nurses have a basic level of skills in the use of informatics.	Descriptive design. Level 7. Variables: educational preparation and NI competencies.	Sample: Australian university. Sampling: N/A. Setting: one university in Australia.	N/A	Some steps have been completed in the development of a NI course. Final step is a NI education package for the teaching staff. Analysis: N/A	Not a research study and focuses on undergraduate nursing program, but the content can be useful in the development of an online NI learning module.
Todhunter (2015). Using principal components analysis to explore competence and confidence in student nurses as users of information and communication technologies. Nursing Open	Report on the relationship between competence and confidence in nursing students as users of information and communication technologies, using principal components analysis.	Quantitative, non-experimental. Level 6. Variables: ICT competence and confidence.	Sample: 375 first- and second-year undergraduate nursing students. Sampling: convenience. Setting: One university in the UK.	48-item survey questionnaire Cronbach's alpha = 0.78	Learning through talking, watching, and listening all play a crucial role in the development of computing skills. Analysis: principal component analysis (PCA). Tables used for participants' characteristics and structure matrix of study components.	Undergraduate subjects; setting in the UK. Results can be incorporated for the design and implementation of online NI learning module.
Kobewka (2014). The feasibility of e-learning as a quality improvement tool. Journal of Evaluation in Clinical Practice	Investigate the feasibility and acceptability of using e-learning (defined as computer-based learning modules) to address gaps in quality of care.	Qualitative descriptive. Level 6. Variables: -	Sample: 30 medical staff, residents, and students. Sampling: convenience sampling. Setting: 6 medical teaching units as a healthcare system in Canada.	Interviews and questionnaires Instrument reliability not reported	Learners at all levels thought the modules were easy to use. Participants liked the knowledge-based material in the CAP module because it directly applied to their work. There were less favorable opinions of the hand-hygiene module. Analysis: content analysis.	Subjects are medical students. Useful to incorporate materials that directly apply to work.
Yu (2013). Fostering nursing students' informatics competencies via a web-based information literacy course. Journal of Curriculum and Teaching	Develop a web-based course that fostered nursing students' competency in information literacy.	Descriptive design. Level 6. Variables: web-mediated teaching strategy and information literacy.	Sample: 42 undergraduate nursing students. Sampling: Convenience. Setting: nursing college in Southern Taiwan.	15-item online survey Cronbach alpha .85	Majority of students perceived positively about the teaching method, felt that they gained more knowledge and skills about information literacy, and had the abilities to apply these skills in their future nursing practices. Analysis: descriptive statistics used to describe participants and interpret the results.	Setting in Taiwan. Subjects are undergraduate nursing students. Restricted to one institution limiting generalizability. Course design can be considered for the project.

Boiling (2012). Cutting the distance in distance education: Perspectives on what promotes positive, online learni ng experiences. Internet and Higher Education	Inform the development and implementation of effective online learning en vironments by exploring, from both teacher and student perspectives, what constitutes effective online learning experiences.	Descriptive. Level 6. Variables: -	Sample: 6 online course instructors and 10 adult students. Sampling: Selective sampling. Setting: one university in New Jersey.	Interview	Most participants viewed courses that emphasized text-based content, individualized learning, and limited interaction with others as being less helpful than those courses and programs that were more interactive and incorporated the use of multimedia. Analysis: both deductive and inductive analyses conducted using constant comparative methods.	Findings subjective and not generalizable, but useful to consider the findings in the design and implementation of an online learning module.
Cacciamani (2012). Influence of participation, facilitator styles, and metacognitive reflection on knowledge building in online university courses. Computers & Education	To inquire as to how different levels of participation and different ways of course organization could influence the positive results of the course itself in terms of knowledge building.	Qualitative interview. Level 6. Variables: knowledge-building activity, levels of participation, facilitator style, and metacognitive reflection activity.	Sample: 67 undergraduate students. Sampling: convenience sampling. Setting: two universities in Italy.	Interview	High level of participation in the online discussion, supportive facilitator, and presence of metacognitive reflection places are associated with an Advanced Epistemic Agency. Analysis: coding scheme for the content analysis.	Study in Italy. Not in healthcare but may be useful in online learning principles and design.
Creedon (2012). Development of a blended model of teaching and learn ing for nursing stude nts on rostered placement to ensure competence i n information and communication tech nology for professional practice in Ireland. CIN: Computers, Informatics, Nursing	Describe the outcomes of a classroom-based and web-based course delivery in information and communication technology in healthcare.	Descriptive design. Level 7. Variables: student perspective and learning of ICT and professional practice.	Sample: BSc nursing students. Sampling: convenience sample. Setting: school of nursing and midwifery in Ireland.	Written course evaluation	Web-based courses may facilitate a deeper understanding of the course. Analysis: description of student comments.	Sampling is limited to students submitting course evaluations. Usefulness to consider incorporating participant engagement or encouraging interaction even in a web-based learning environment.

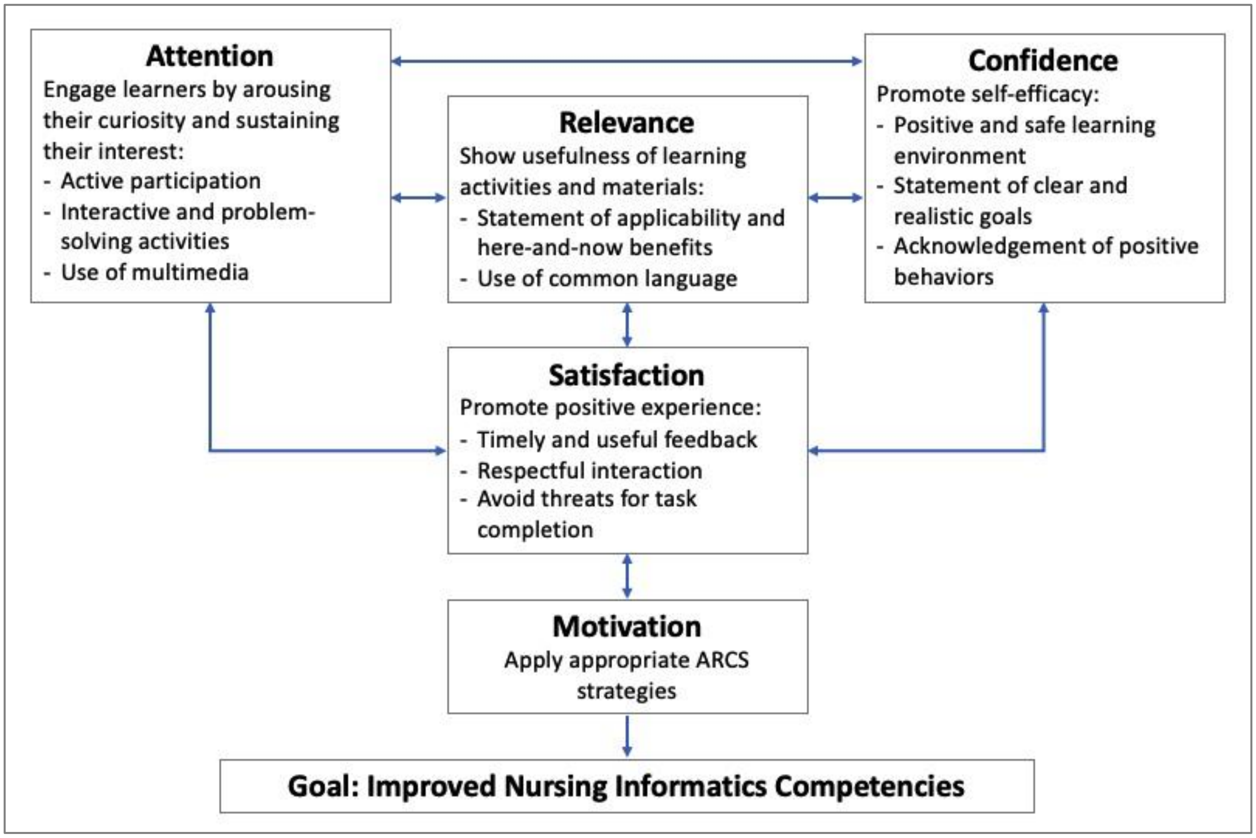
Appendix H

Evidence Grid

Article	**NI competencies** (NI knowledge, skills, and competencies)	**NI competency assessment** (measurement instrument or tools)	**Online learning and online learning module implementation** (online learning and design strategies)
Alexander, 2020			√
Boiling, 2012			√
Bond, 2017			√
Brasier, 2019			√
Bryant, 2016		√	
Cacciamani, 2012			√
Choi & Bakken, 2013	√	√	
Choi & De Martinis, 2013	√	√	
Choi & Zucker 2013	√	√	
Covington, 2019			√
Creedon, 2012			√
Cummings, 2016			√
Forman, 2020		√	
Gonen, 2014		√	
Gonen, 2016	√		√
Karvinen, 2017			√
Kobewka, 2014			√
Kupferschmid, 2017	√	√	
Lee, 2015		√	
Lee, 2019		√	
Levett-Jones, 2009		√	
Monsivais, 2019			√
Oh, 2019			√
Rajalahti, 2014	√		
Rosvall, 2017			√
Sikkens, 2018			√
Swenty, 2014	√		
Todhunter, 2015			√
Yoshioka-Maeda, 2019			√
Yoon, 2015		√	
Yu, 2013			√

Appendix I

Theory-to-Application Diagram



Note. The diagram was adapted from the ARCS Motivation Model (Keller, 2010).

Appendix J

UMKC IRB Review and Approval

UMKC Institutional Review Board
University of Missouri-Kansas City

5319 Rockhill Road
Kansas City, MO 64110
816-235-5927
umkcirb@umkc.edu

January 25, 2021

Principal Investigator: Lyla Jo Lindholm
Department: Nursing - General

Your Exempt Amendment Form to project entitled "Implementing an Online Learning Module to Expand the Nursing Informatics Competencies of Nurse Practitioners" was reviewed and determined to qualify for IRB exemption according to the terms and conditions described below:

IRB Project Number	2026562
IRB Review Number	300104
Initial Application Approval Date	July 29, 2020
Approval Date of this Review	January 25, 2021
IRB Expiration Date	N/A Revised Common Rule
Level of Review	Exempt
Project Status	Active - Exempt
Risk Level	Minimal Risk
HIPAA Category	No HIPAA

Approved Documents
Approved Email to students
Approved Information letter
Permission from SoNHS to conduct the study with students

The principal investigator (PI) is responsible for all aspects and conduct of this study. The PI must comply with the following conditions of the determination:

1. No subjects may be involved in any study procedure prior to the determination date.
2. Changes that may affect the exempt determination must be submitted for confirmation prior to implementation utilizing the Exempt Amendment Form.
3. The Annual Exempt Form must be submitted 30 days prior to the determination anniversary date to keep the study active or to close it.
4. Maintain all research records for a period of seven years from the project completion date.

If you are offering subject payments and would like more information about research participant payments, please click here to view the UM system Policy on Research Subject Payments: https://www.umsystem.edu/oei/sharedservices/apss/nonpo_vouchers/research_subject_payments

If you have any questions, please contact the IRB at 816-235-5927 or umkcirb@umkc.edu.

Thank you,
UMKC Institutional Review Board

Appendix K

Project Site Approval from UMKC School of Nursing and Health Studies

Copied by Dr. Lindholm from emails: Permission from Dr. Ellis Fletcher, School of Nursing and Health Studies, Associate Dean for Students, to conduct with students, and Dr. Thiem MSN Program Director to include MSN students, and Dr. Barber DNP Program Director to include DNP students.

Appendix L

Screenshots of the Nursing Informatics e-Learning Module

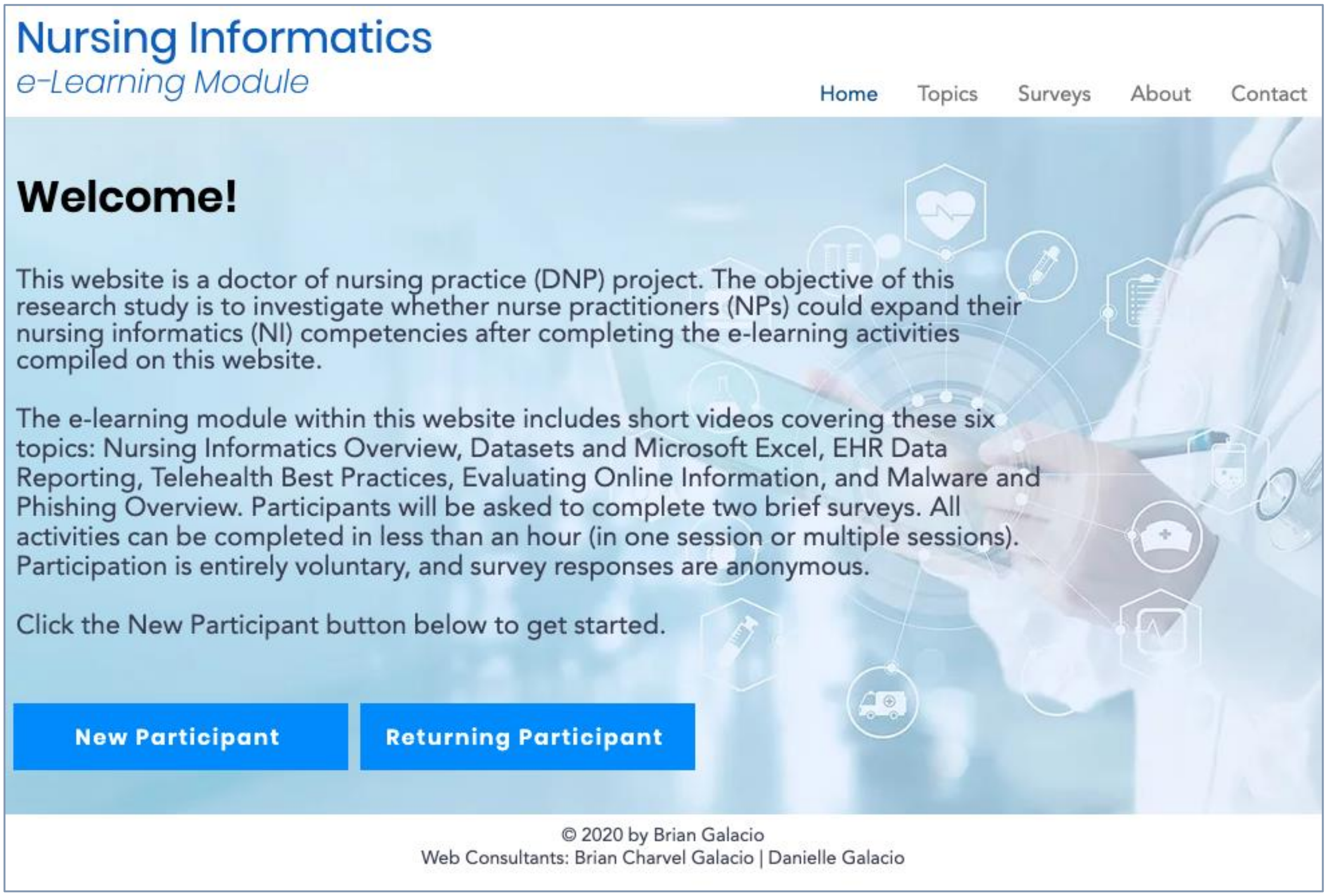


Figure L1. Nursing Informatics e-Learning Module home page. The participant begins the study by clicking the New Participant button to create a Participant ID.

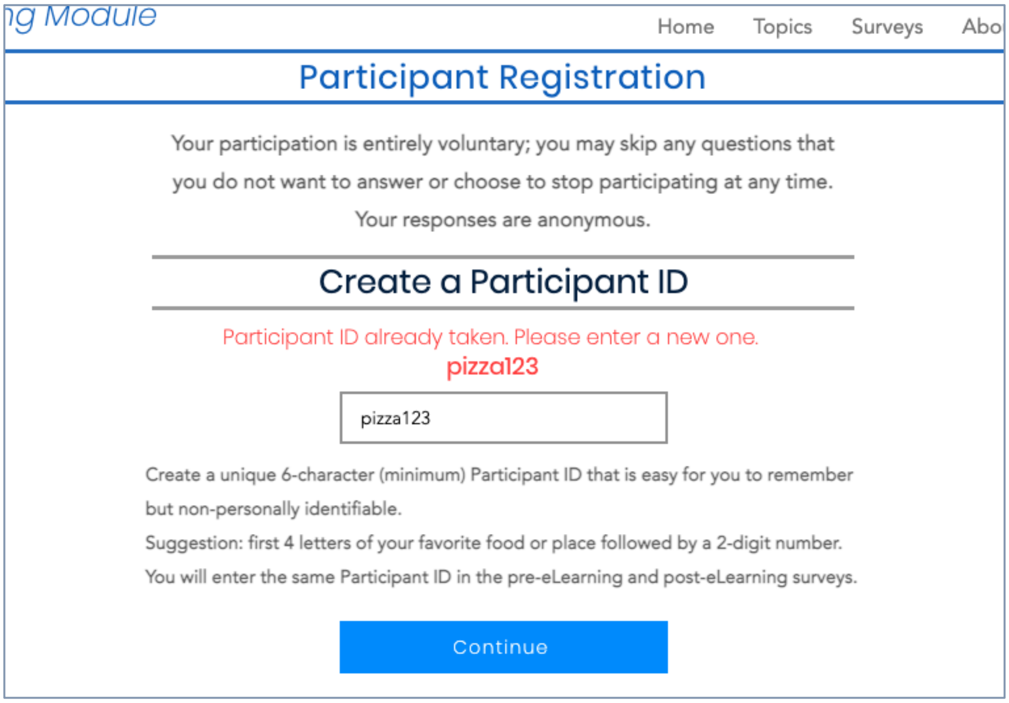


Figure L2. If a Participant ID already exists, the participant is asked to enter a new ID.

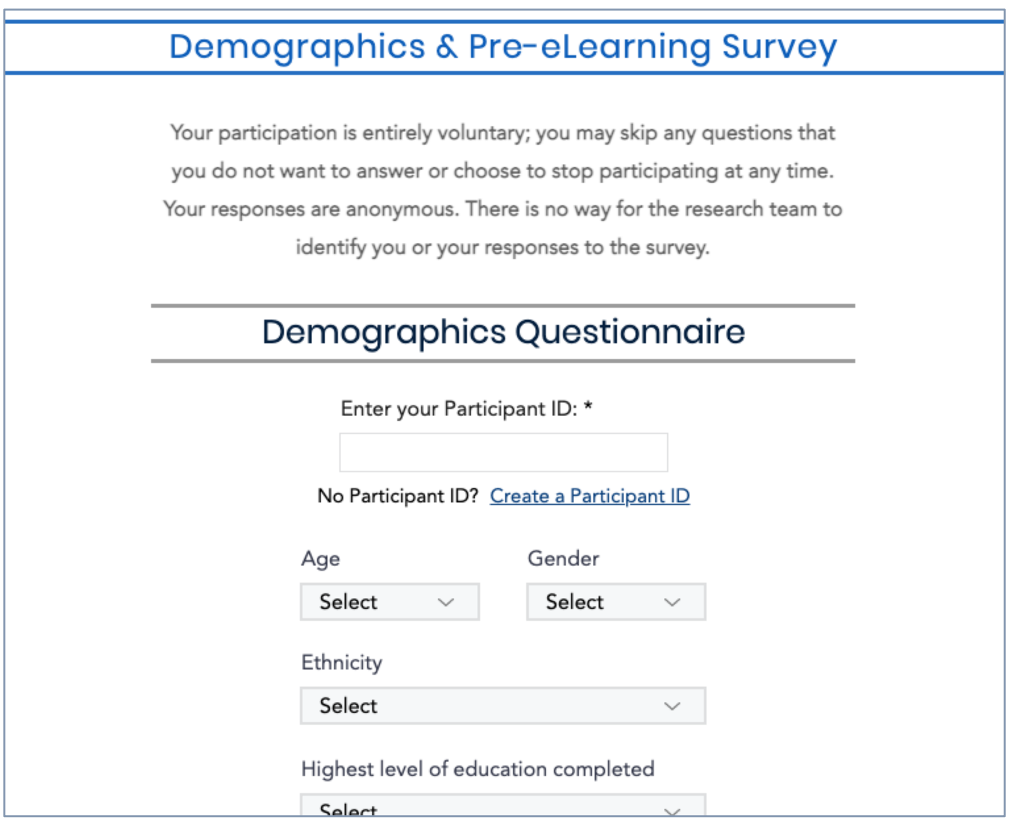


Figure L3. After creating a Participant ID, the participant completes and submits the Demographics Questionnaire and Pre-eLearning Survey.

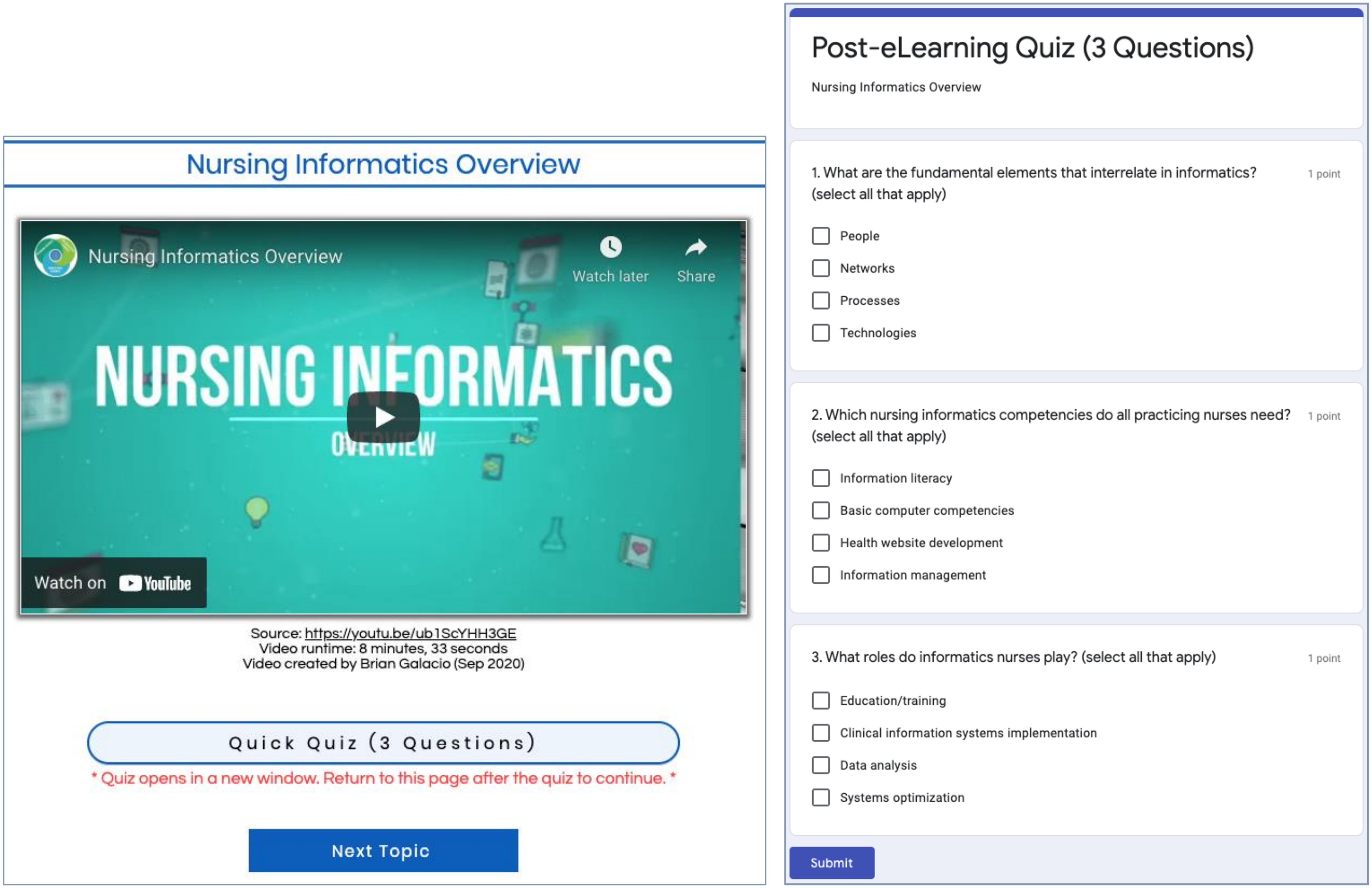
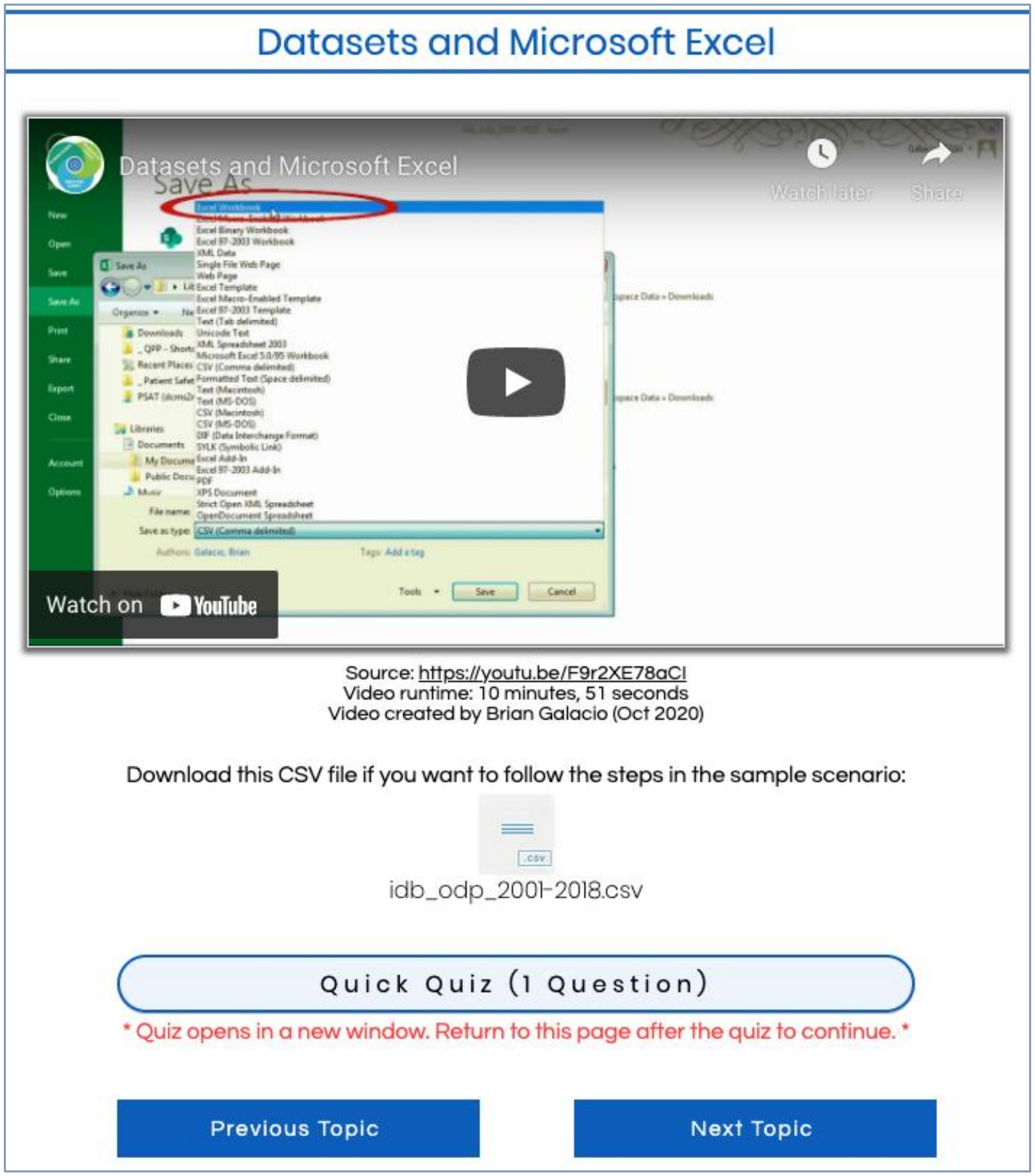


Figure L4. Nursing Informatics Overview page (left) and related post-eLearning Quiz (right).



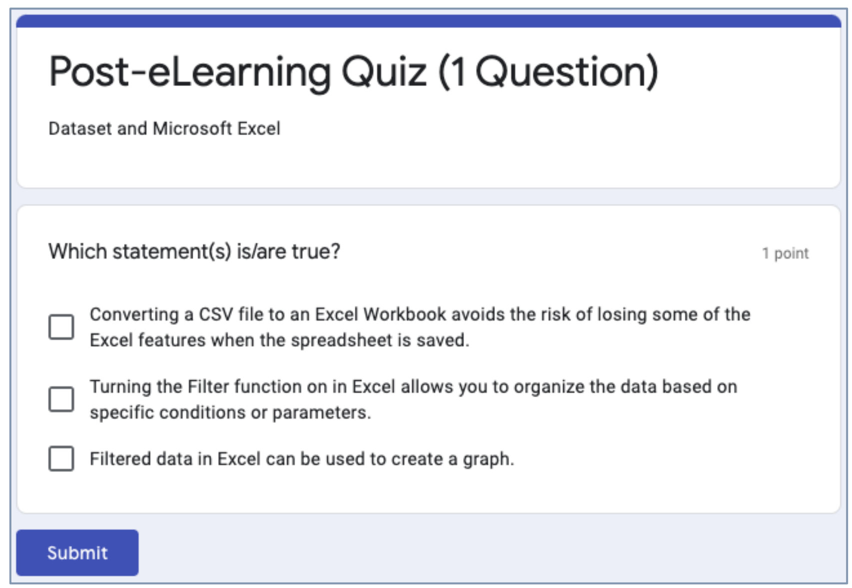
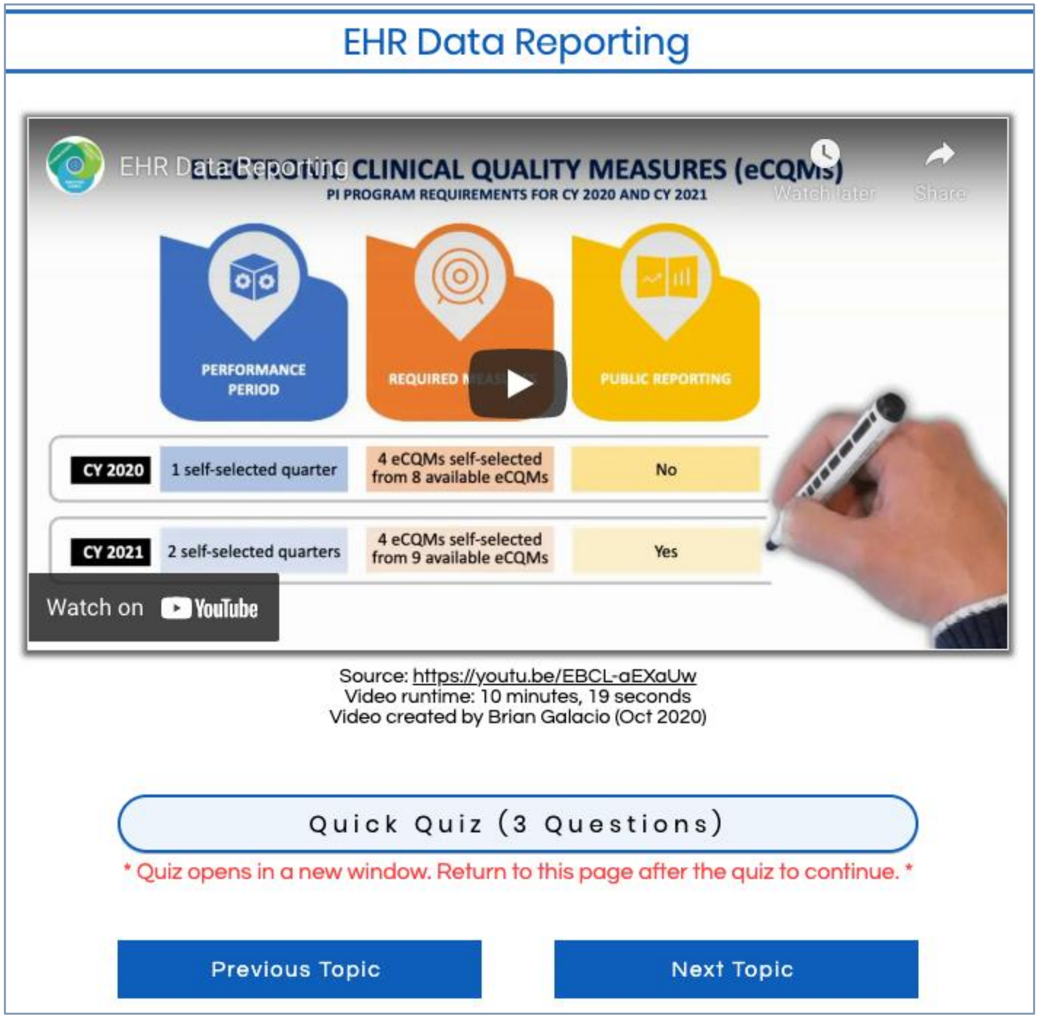


Figure L5. Datasets and Microsoft Excel page (left) and corresponding Post-eLearning Quiz (right).



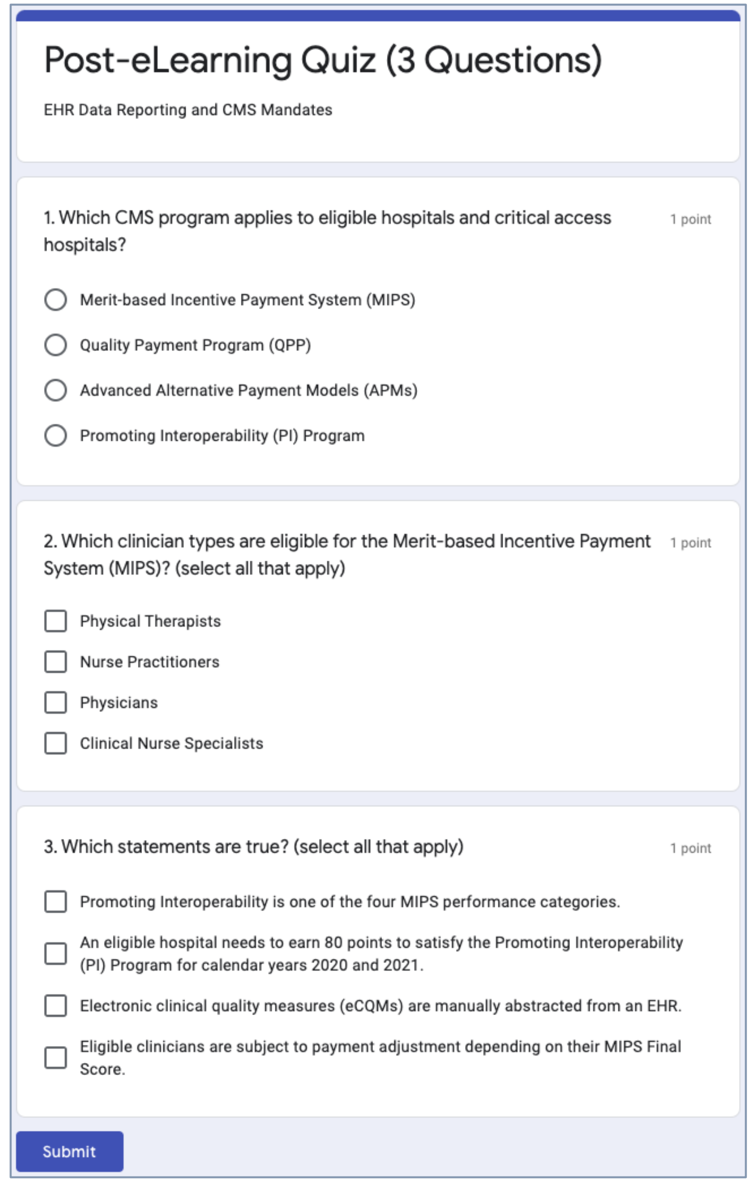


Figure L6. EHR Data Reporting page (left) and related Post-eLearning Quiz (right).

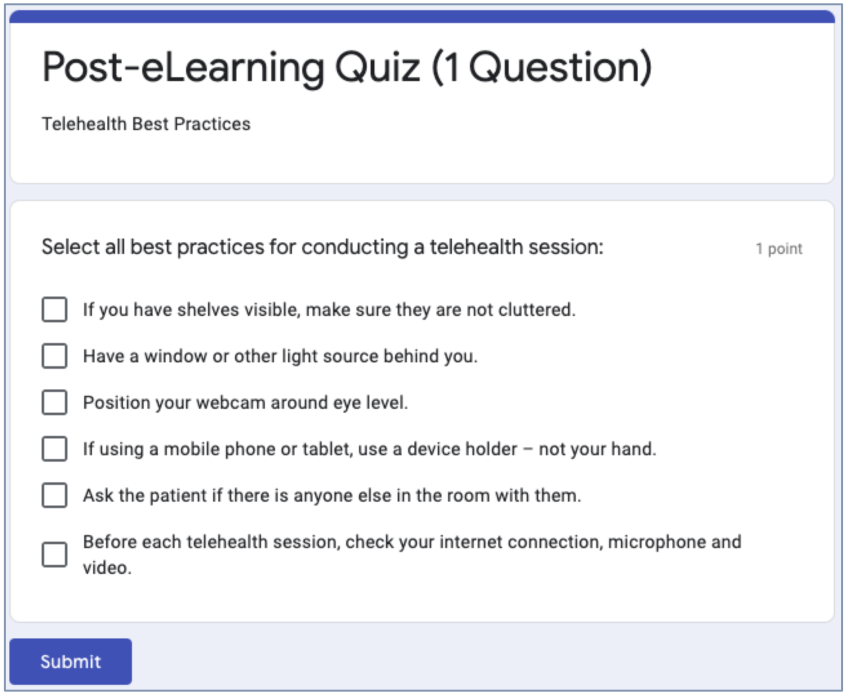


Figure L7. Telehealth Best Practices page (left) and related Post-eLearning Quiz (right).

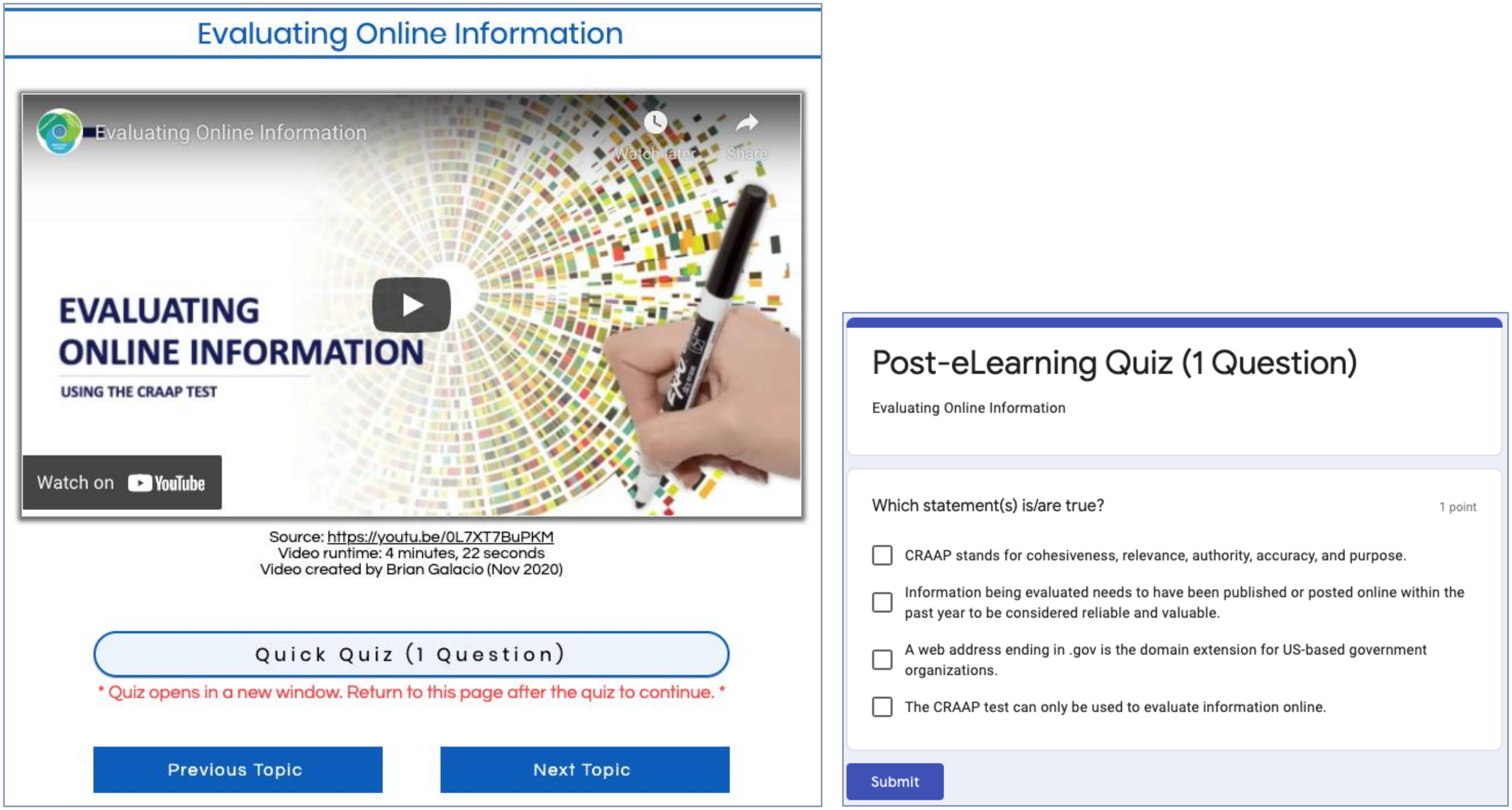
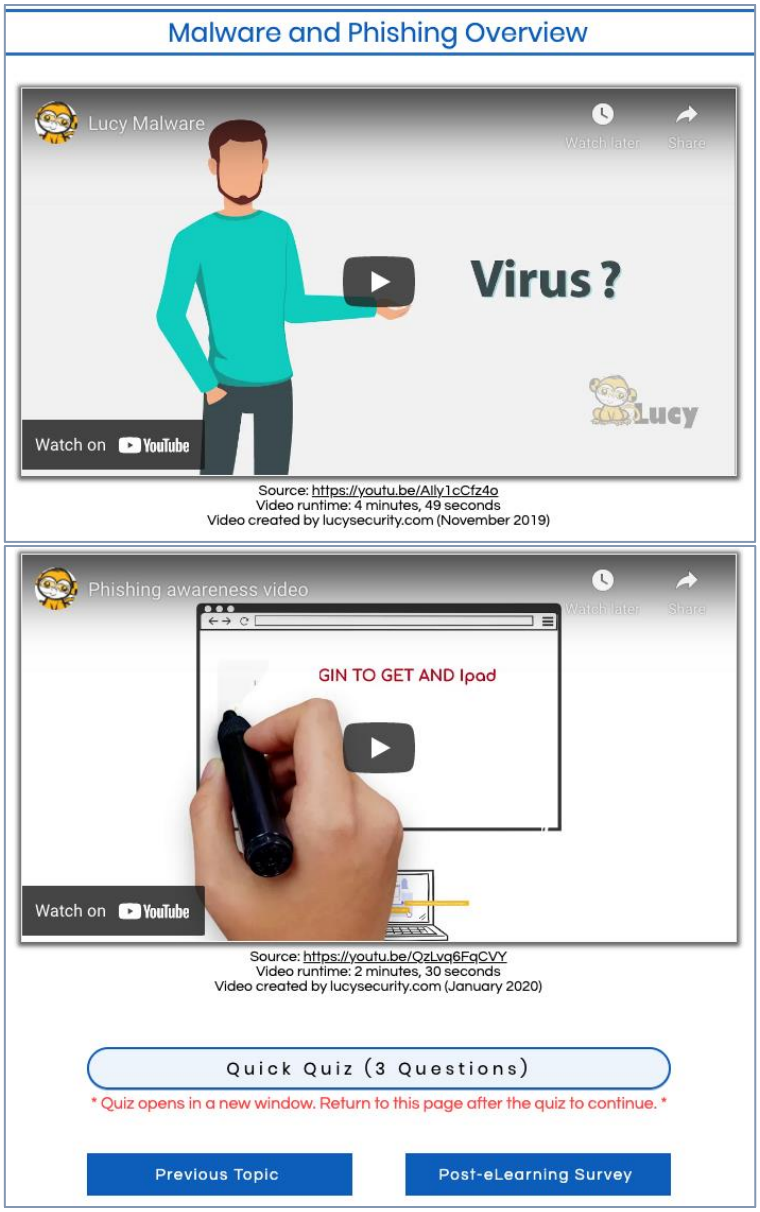


Figure L8. Evaluating Online Information page (left) and related Post-eLearning Quiz (right).



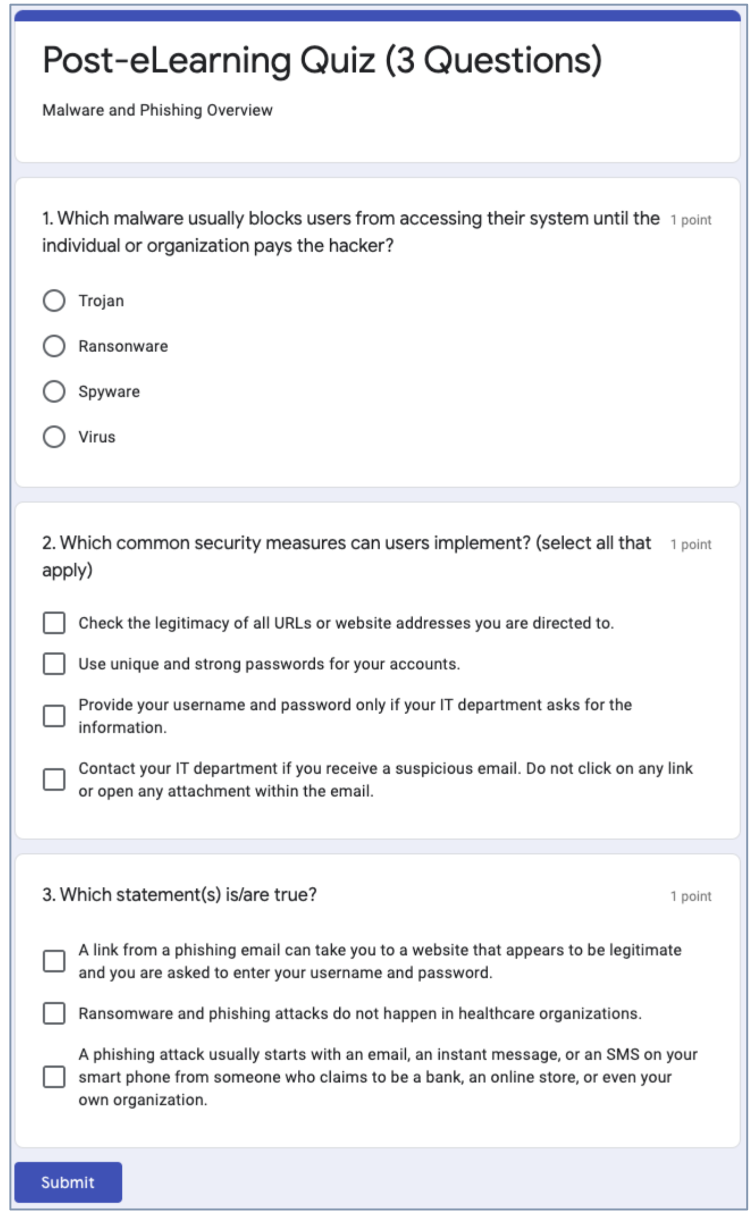


Figure L9. Malware and Phishing Overview page (left) and corresponding Post-eLearning Quiz (right).

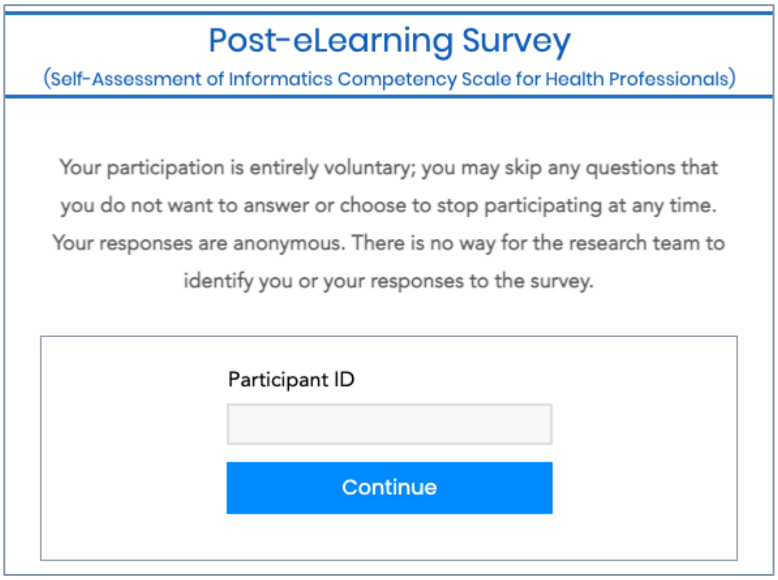


Figure K10. Participant enters Participant ID before completing the Post-eLearning Survey.

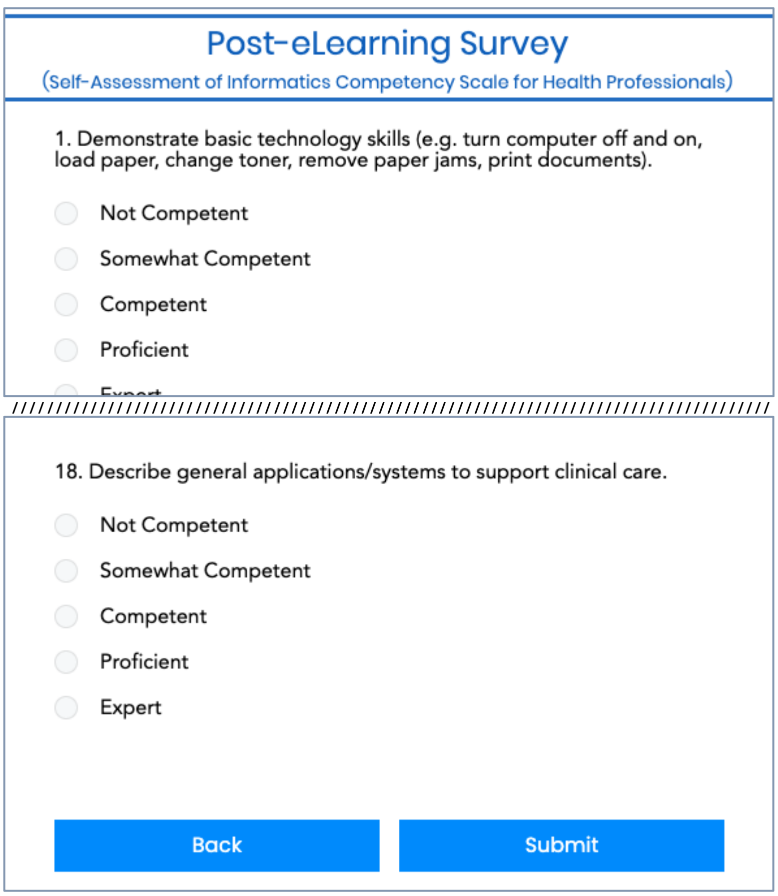


Figure L11. Participant completes and submits the Post-eLearning Survey.

Appendix M

Information Letter

****

Hello, my name is Brian Galacio, DNP (c), MSN, RN-BC. I am a University of Missouri-Kansas City (UMKC) student. I am conducting a research study about expanding the informatics competencies of nurse practitioners (NPs) and nurses studying to become NPs through the implementation of an online learning module in nursing informatics.

If you choose to participate in this study, you will be asked to complete a brief survey before and after the online learning activity. The surveys would take roughly 5 minutes to complete; and the learning activities would take approximately 60 minutes.

Your participation is entirely voluntary; you may skip any questions in the demographic questionnaire or surveys that you do not want to answer or choose to stop participating at any time.

Your responses will be anonymous; there is no way for the research team to identify you or your responses to the survey.

If you have any questions about the research study, please contact Brian Galacio at . If you have questions or concerns about your rights as a research participant, you can call the UMKC Research Compliance at 816-235-5927.

If you want to participate in this study, please follow this link: www.NIeLearning.com and click the New Participant button.

****

Appendix N

Logic Model

Inquiry (PICOTS): In (P) nurse practitioners and nurses training to become nurse practitioners, does (I) online learning in nursing informatics, compared to (C) no intervention, (O) expand informatics competencies (T) post-completion of the learning activities (S) on the Nursing Informatics e-Learning Module website?

Inputs	Intervention(s)	Outputs	Outcomes — Impact		
	Activities	Participation	Short	Medium	Long
Evidence, Sub-topics 1. Nursing informatics competencies 2. Nursing informatics competency assessment 3. Online learning and online learning module implementation **Major Facilitators or Contributors** 1. Support from CANP Bay Area Chapter 2. Support from UMKC DNP Faculty 3. Accessibility of the online learning module **Major Barriers or Challenges** 1. Lack of participation leading to small sample size 2. Participant attrition 3. Participants' lack of motivation and time to complete the study	**EBP intervention which is supported by the evidence in the Input column** Implementation of an online learning module in nursing informatics **Major steps of the intervention (brief phrases)** 1. Design and build of the online learning module 2. Pre-intervention self-assessment of NI competencies 3. Completion of the online learning module in NI 4. Post-intervention self-assessment of NI competencies 5. Data analysis	**The participants (subjects)** Practicing NPs and nurses training to become NPs **Site** CANP North Bay Chapter, UMKC School of Nursing and Health Studies, and LinkedIn **Project Time Frame** Dec 2020 to Mar 2021 **Consent or assent Needed** Yes **Other person(s) collecting data (Y/N)** No **Others directly involved in consent or data collection (Y/N)** No	(Completed during the DNP Project timeline) **Outcome(s) to be measured** **Primary:** Improved informatics competency scores **Secondary:** Collection of informatics competency data of an under-researched population **Measurement tool** Self-Assessment of Informatics Competency Scale for Health Professionals **Statistical analysis to be used** 1. Descriptive (frequencies, percentages, and means) 2. Related-samples Sign test	**Outcomes to be measured** Enhanced and expanded NI competencies as evidence by increased competency assessment scores from pre-intervention to post-intervention	**Outcomes (potential)** - Improved healthcare quality - Enhanced efficiency, effectiveness, and safety in healthcare delivery - Decreased healthcare expenditures

Appendix O

Permission to Use Measurement Tool

COLUMBIA UNIVERSITY
MEDICAL CENTER

SUNMOO YOON, PHD, MS
622 W. 168TH STREET PH 9
TEL: 2123007081
SY2102@CUMC.COLUMBIA.EDU

June 18, 2020

Brian Galacio, MSN, RN-BC
bg5nv@umsystem.edu
(916) 471-9587
School of Nursing and Health Studies
University of Missouri - Kansas City

This email confirms the permission to use SANICS and the updated tool. The attachments include both SANICS and the updated SANICS.

For the original SANICS, total score ranges from 30 to 150, and 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 intervention and analyze delta.

An updated version for all healthcare providers is also available at J Interprof Care. 2015;29(6):579-86. If you're interested in, please fill out a request form
https://docs.google.com/forms/d/1peGMMFV3mufep8_iUDZy5xBJhD58-jHG0nDyKzvqVDA/edit
Thank you for your request.

Sincerely,

Sunmoo

Sunmoo Yoon, RN, PhD, MS
Associate Research Scientist
Division of General Medicine
Department of Medicine
Columbia University
622 West 168th Street, PH9-205
New York, NY 10032

Appendix P

G*Power Calculator

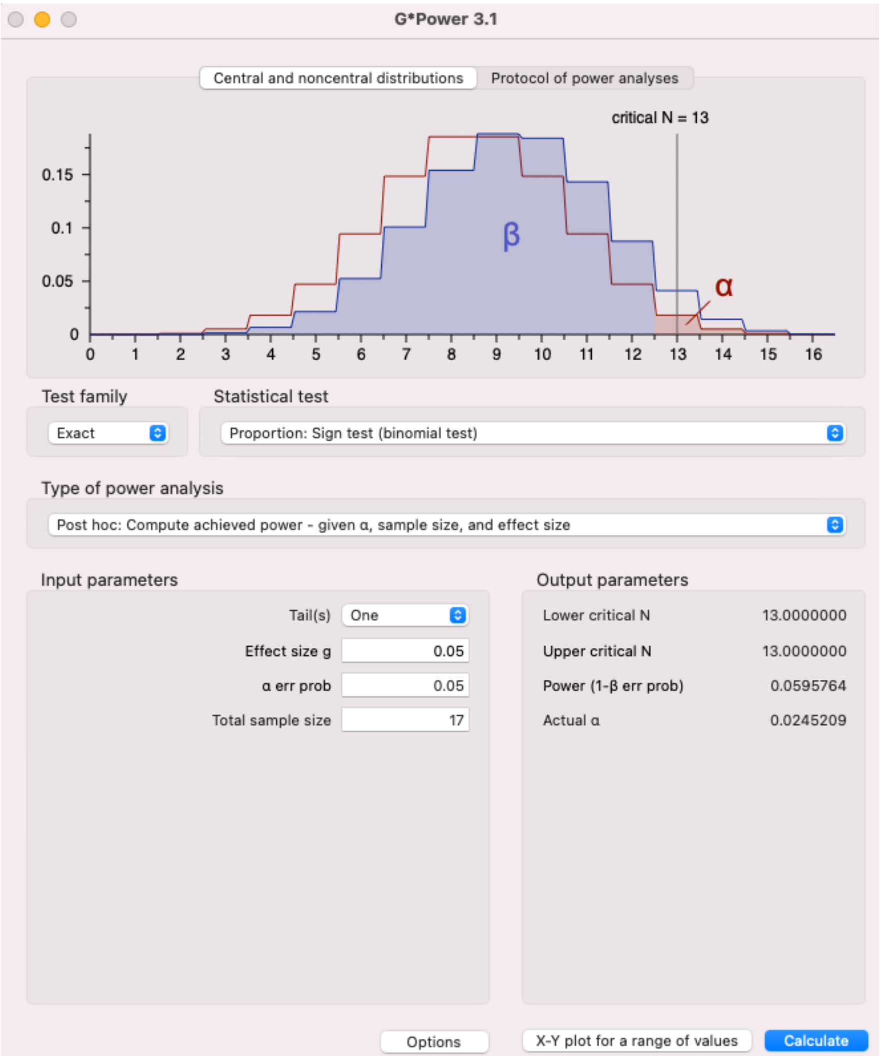


Figure P1. Power calculation with effect size *g* = 0.05

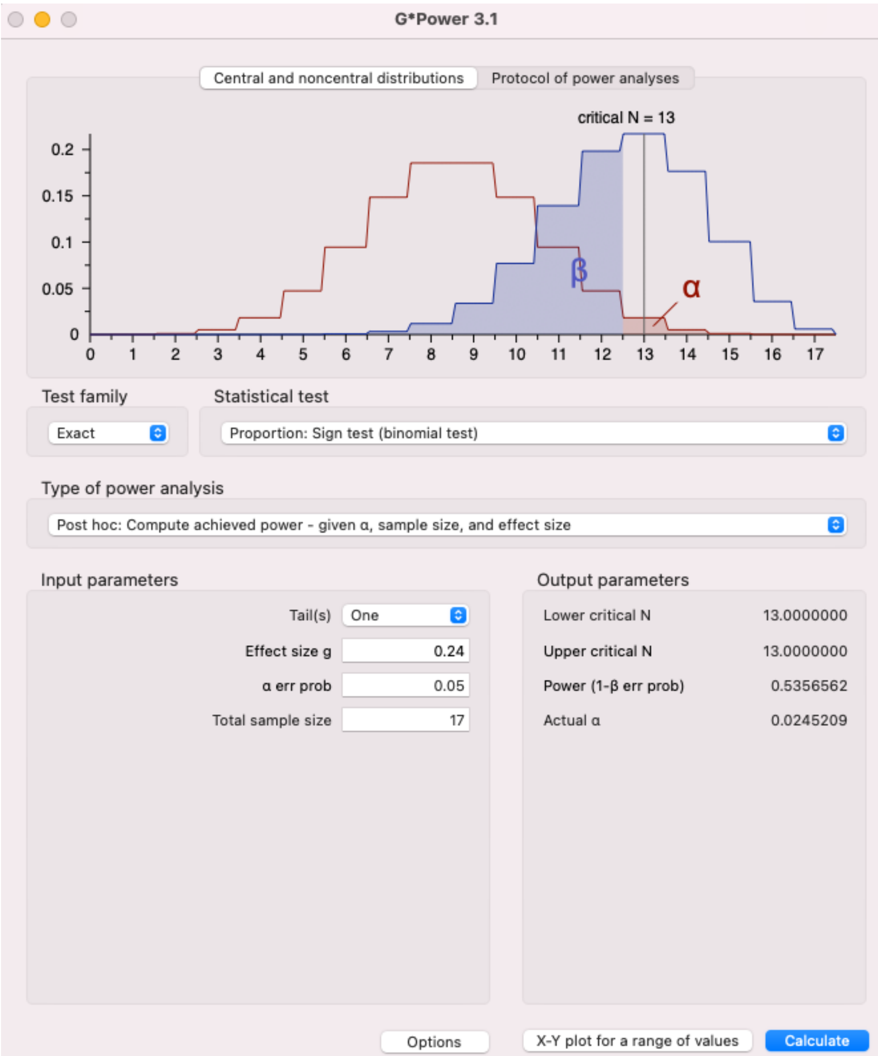


Figure P2. Power calculation with effect size *g* = 0.24

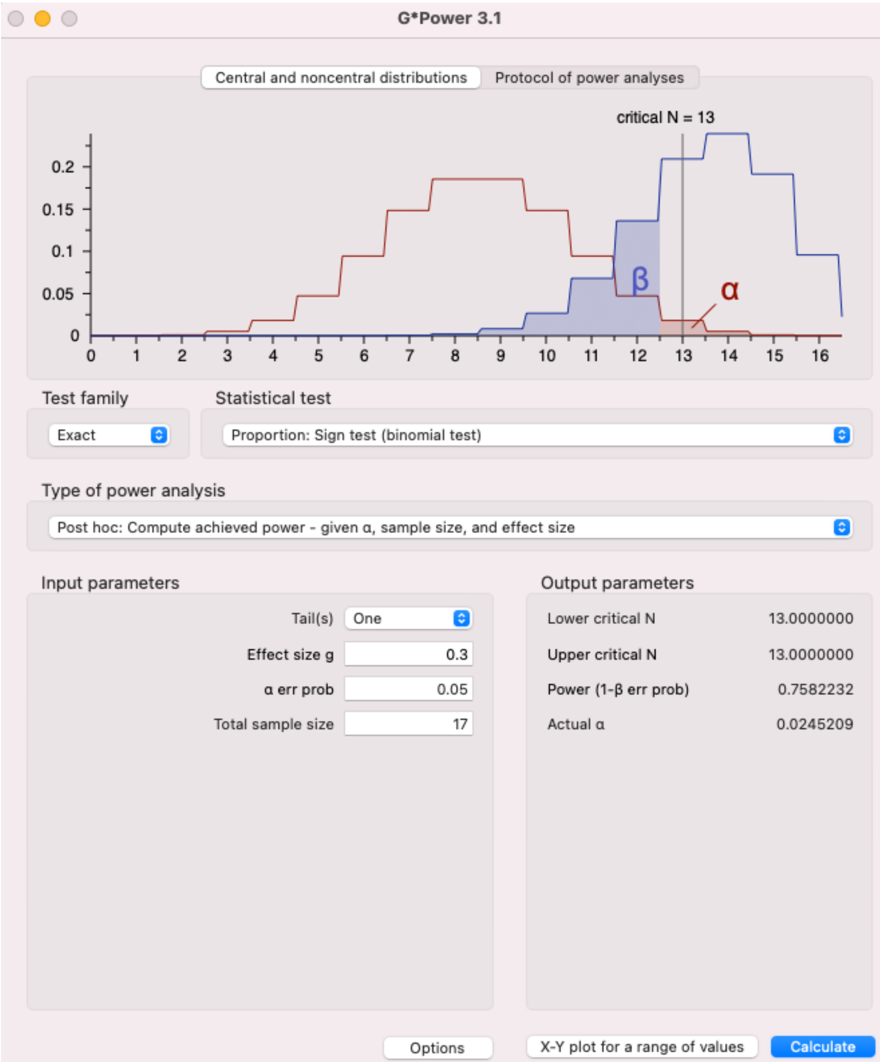


Figure P3. Power calculation with effect size *g* = 0.30

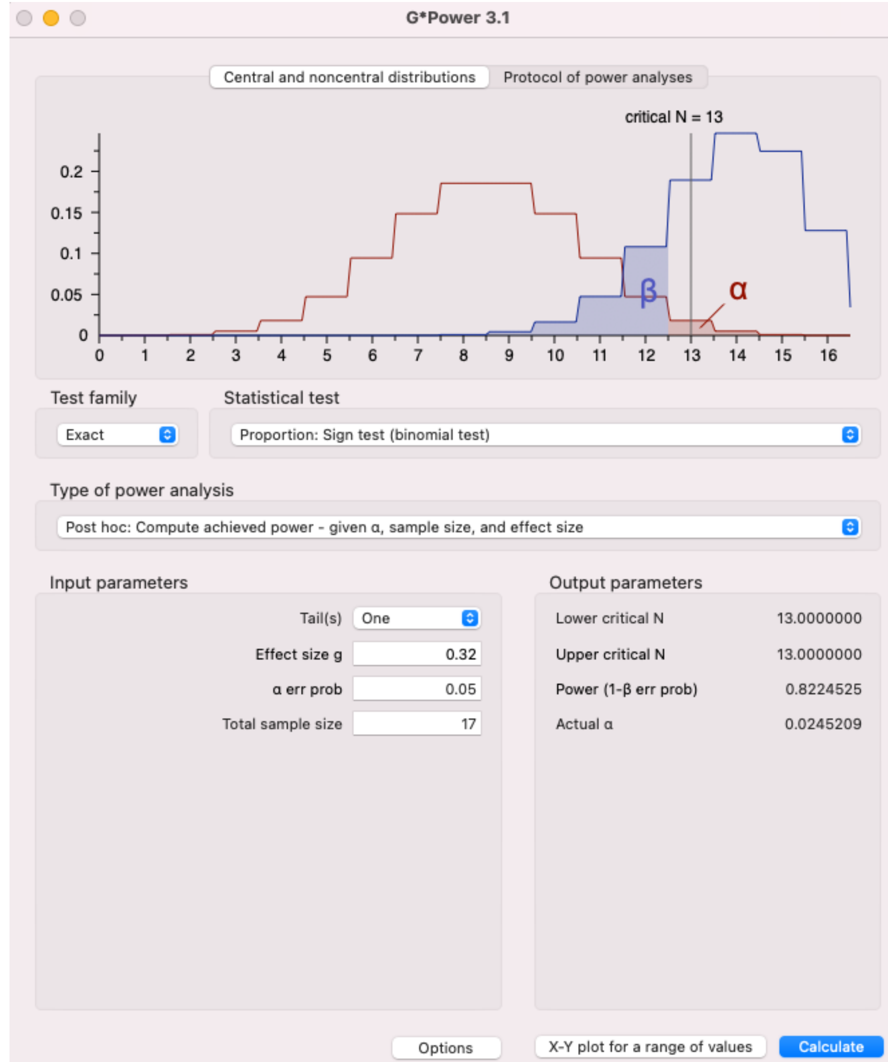


Figure P4. Power calculation with effect size *g* = 0.32

Appendix Q

Variable View in IBM SPSS (Version 26)

SPSSData_030521.sav [DataSet2] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	Participant	String	13	0		None	None	13	Left	Nominal	None
2	BasicTechSkillsPRE	Numeric	2	0	Basic Tech Skills PRE	{0, Not Competent}...	None	12	Right	Scale	None
3	BasicTechSkillsPOST	Numeric	2	0	Basic Tech Skills POST	{0, Not Competent}...	None	12	Right	Scale	None
4	BasicTechSkillsDIFF	Numeric	2	0	Basic Tech Skills DIFF	{0, Not Competent}...	None	12	Right	Scale	None
5	EmailPRE	Numeric	2	0	Email PRE	{0, Not Competent}...	None	12	Right	Scale	None
6	EmailPOST	Numeric	2	0	Email POST	{0, Not Competent}...	None	12	Right	Scale	None
7	EmailDIFF	Numeric	3	0	Email DIFF	{0, Not Competent}...	None	12	Right	Scale	None
8	LitSearchPRE	Numeric	2	0	Lit Search PRE	{0, Not Competent}...	None	12	Right	Scale	None
9	LitSearchPOST	Numeric	2	0	Lit Search POST	{0, Not Competent}...	None	12	Right	Scale	None
10	LitSearchDIFF	Numeric	2	0	Lit Search DIFF	{0, Not Competent}...	None	12	Right	Scale	None
11	AggregatedDataPRE	Numeric	2	0	Aggregated Data PRE	{0, Not Competent}...	None	12	Right	Scale	None
12	AggregatedDataPOST	Numeric	2	0	Aggregated Data POST	{0, Not Competent}...	None	12	Right	Scale	None
13	AggregatedDataDIFF	Numeric	3	0	Aggregated Data DIFF	{0, Not Competent}...	None	12	Right	Scale	None
14	ComputerasToolPRE	Numeric	2	0	Computer as Tool PRE	{0, Not Competent}...	None	12	Right	Scale	None
15	ComputerasToolPOST	Numeric	2	0	Computer as Tool POST	{0, Not Competent}...	None	12	Right	Scale	None
16	ComputerasToolDIFF	Numeric	2	0	Computer as Tool DIFF	{0, Not Competent}...	None	12	Right	Scale	None
17	ClinicianInvolvementPRE	Numeric	2	0	Clinician Involvement PRE	{0, Not Competent}...	None	12	Right	Scale	None
18	ClinicianInvolvementPOST	Numeric	2	0	Clinician Involvement POST	{0, Not Competent}...	None	12	Right	Scale	None
19	ClinicianInvolvementDIFF	Numeric	3	0	Clinician Involvement DIFF	{0, Not Competent}...	None	12	Right	Scale	None
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21	DatasetPOST	Numeric	2	0	Dataset POST	{0, Not Competent}...	None	12	Right	Scale	None
22	DatasetDIFF	Numeric	2	0	Dataset DIFF	{0, Not Competent}...	None	12	Right	Scale	None
23	StructuredLanguagePRE	Numeric	2	0	Structured Language PRE	{0, Not Competent}...	None	12	Right	Scale	None
24	StructuredLanguagePOST	Numeric	2	0	Structured Language POST	{0, Not Competent}...	None	12	Right	Scale	None
25	StructuredLanguageDIFF	Numeric	3	0	Structured Language DIFF	{0, Not Competent}...	None	12	Right	Scale	None
26	ProtectDataPRE	Numeric	2	0	Protect Data PRE	{0, Not Competent}...	None	12	Right	Scale	None
27	ProtectDataPOST	Numeric	2	0	Protect Data POST	{0, Not Competent}...	None	12	Right	Scale	None
28	ProtectDataDIFF	Numeric	2	0	Protect Data DIFF	{0, Not Competent}...	None	12	Right	Scale	None
29	EvaluateOnlineInfoPRE	Numeric	2	0	Evaluate Online Info PRE	{0, Not Competent}...	None	12	Right	Scale	None
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31	EvaluateOnlineInfoDIFF	Numeric	2	0	Evaluate Online Info DIFF	{0, Not Competent}...	None	12	Right	Scale	None
32	ApplyRelevantInfoPRE	Numeric	2	0	Apply Relevant Info PRE	{0, Not Competent}...	None	12	Right	Scale	None
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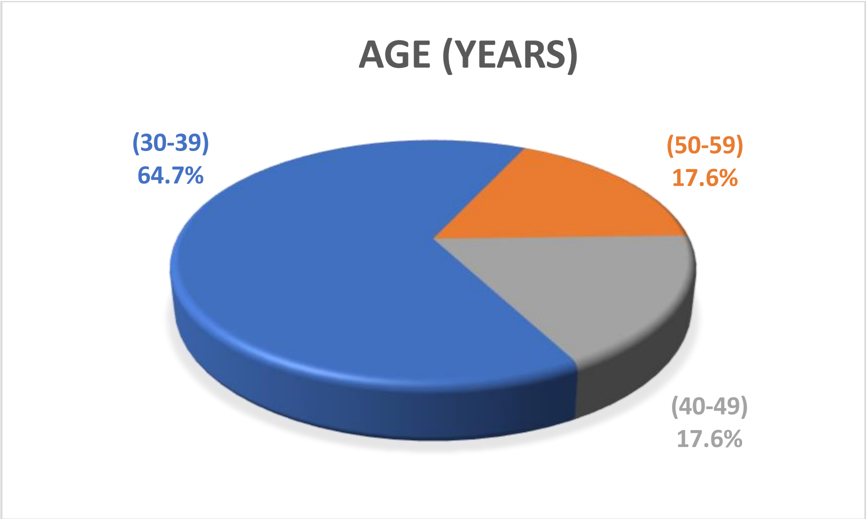
55	AppsSystemsDIFF	Numeric	2	0	Apps / Systems DIFF	None	None	12	Right	Scale	None

Data View | Variable View

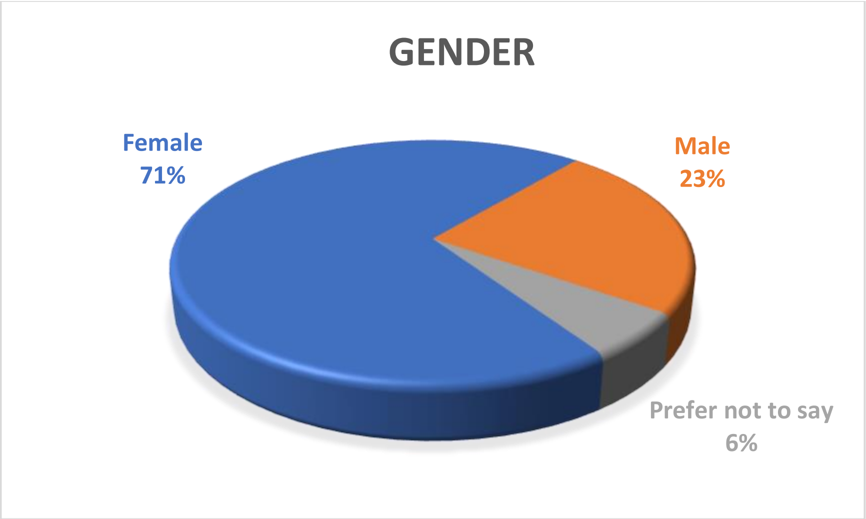
Appendix R

Participants' Demographic Data

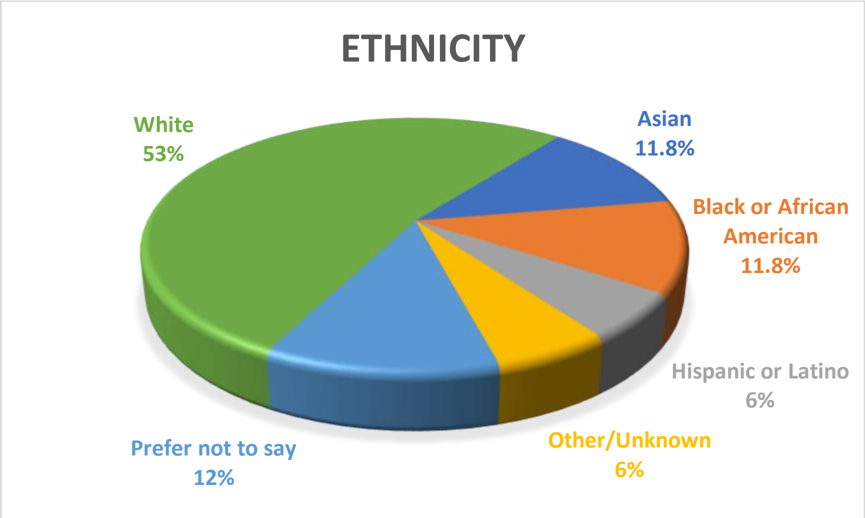
AGE (years)	Frequency	Percent
30-39	11	64.7
40-49	3	17.6
50-59	3	17.6
Total	17	100.0



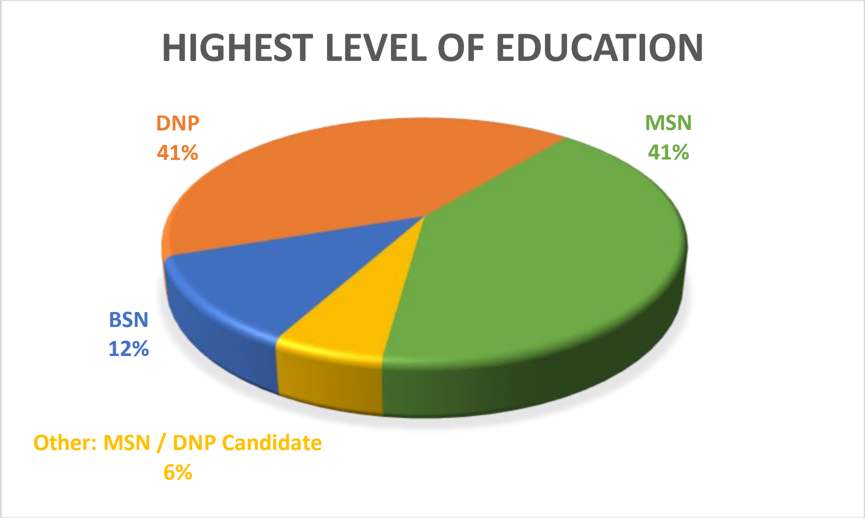
GENDER	Frequency	Percent
Female	12	70.6
Male	4	23.5
Prefer not to say	1	5.9
Total	17	100.0



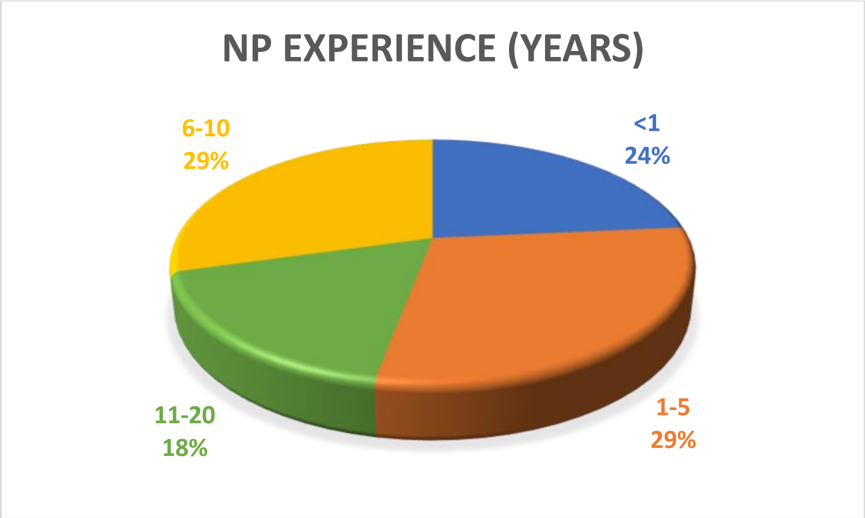
ETHNICITY	Frequency	Percent
Asian	2	11.8
Black or African American	2	11.8
Hispanic or Latino	1	5.9
Other/Unknown	1	5.9
Prefer not to say	2	11.8
White	9	52.9
Total	17	100.0



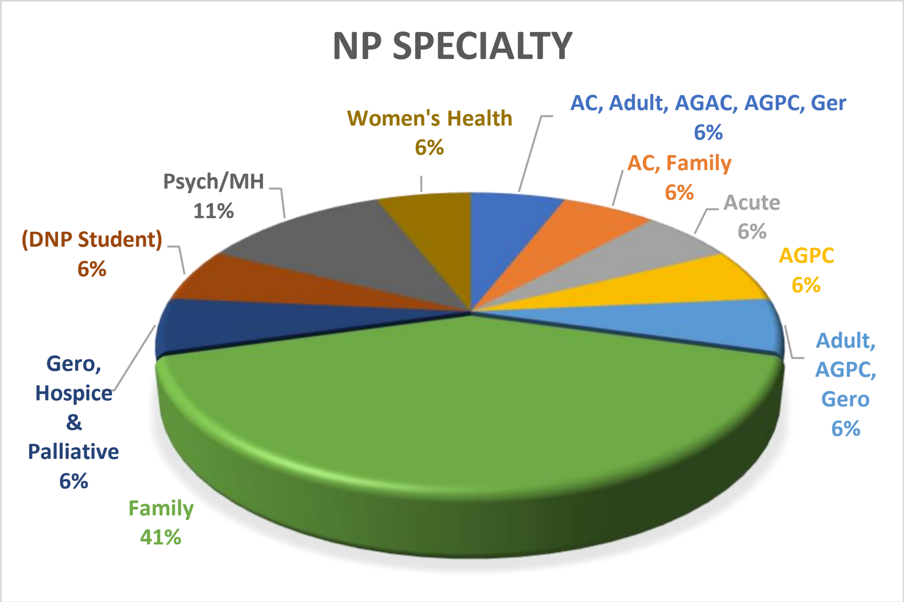
HIGHEST LEVEL OF EDUCATION COMPLETED	Frequency	Percent
BSN	2	11.8
DNP	7	41.2
MSN	7	41.2
Other: MSN / DNP Candidate	1	5.9
Total	17	100.0



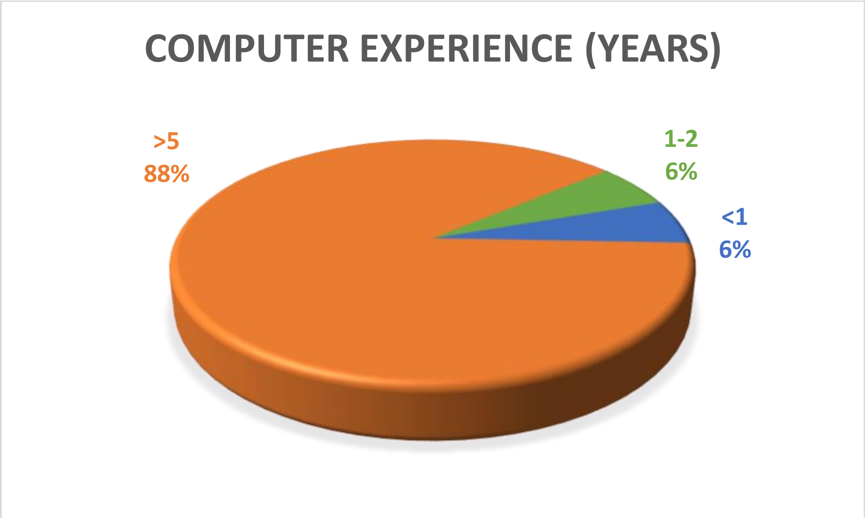
NP EXPERIENCE (years)	Frequency	Percent
<1	4	23.5
1-5	5	29.4
11-20	3	17.6
6-10	5	29.4
Total	17	100.0



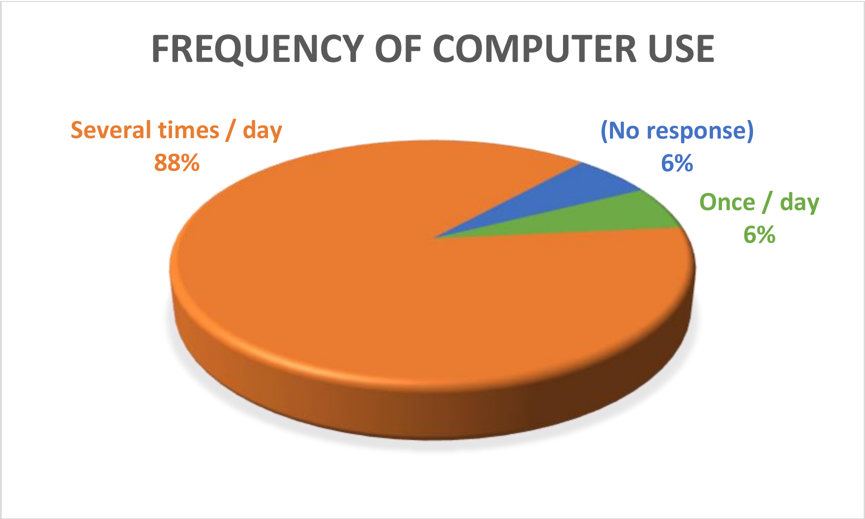
NP SPECIALTY	Frequency	Percent
["Acute Care","Adult","Adult-Gerontology Acute Care","Adult-Gerontology Primary Care","Gerontology"]	1	5.9
["Acute Care","Family"]	1	5.9
["Acute Care"]	1	5.9
["Adult-Gerontology Primary Care"]	1	5.9
["Adult","Adult-Gerontology Primary Care","Gerontology"]	1	5.9
["Family"]	7	41.2
["Gerontology","Hospice and Palliative Care"]	1	5.9
["Other: DNP Student"]	1	5.9
["Psychiatric/Mental Health"]	2	11.8
["Women's Health"]	1	5.9
Total	17	100.0



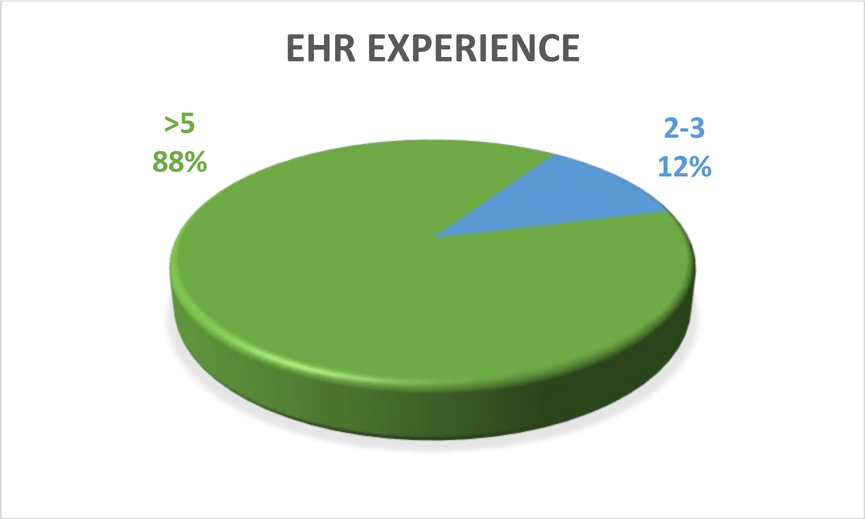
COMPUTER EXPERIENCE	Frequency	Percent
<1	1	5.9
>5	15	88.2
1-2	1	5.9
Total	17	100.0



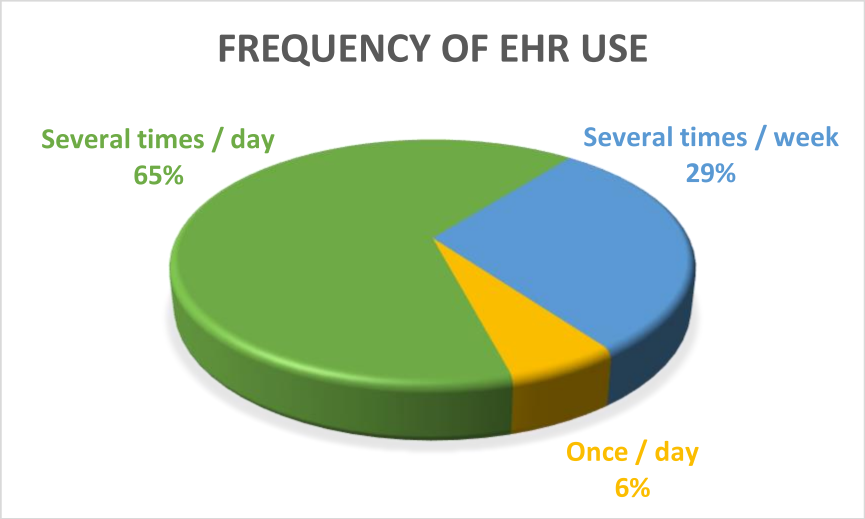
FREQUENCY OF COMPUTER USE	Frequency	Percent
(No response)	1	5.9
Once / day	1	5.9
Several times/day	15	88.2
Total	17	100.0



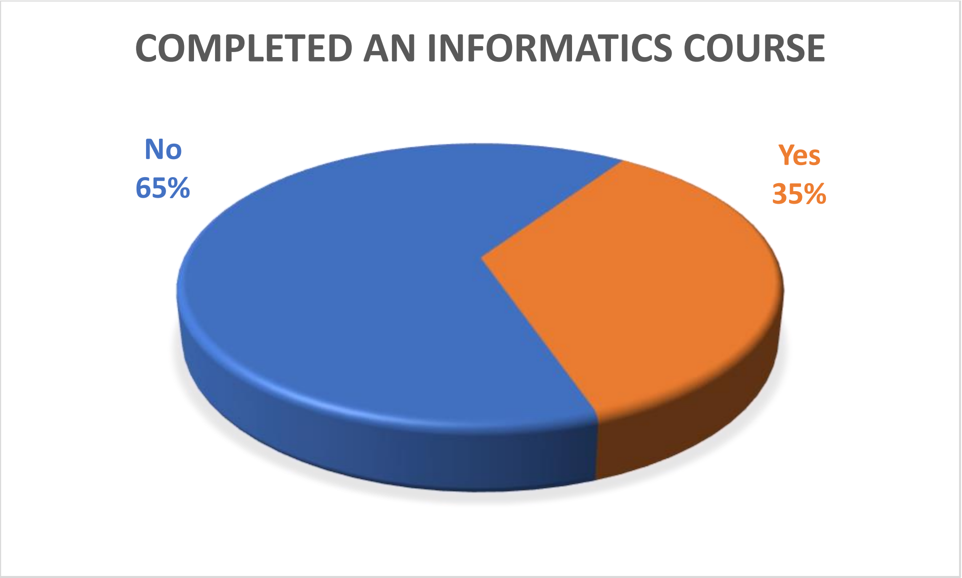
EHR EXPERIENCE (years)	Frequency	Percent
>5	15	88.2
2-3	2	11.8
Total	17	100.0



FREQUENCY OF EHR USE	Frequency	Percent
Once / day	1	5.9
Several times/day	11	64.7
Several times/week	5	29.4
Total	17	100.0

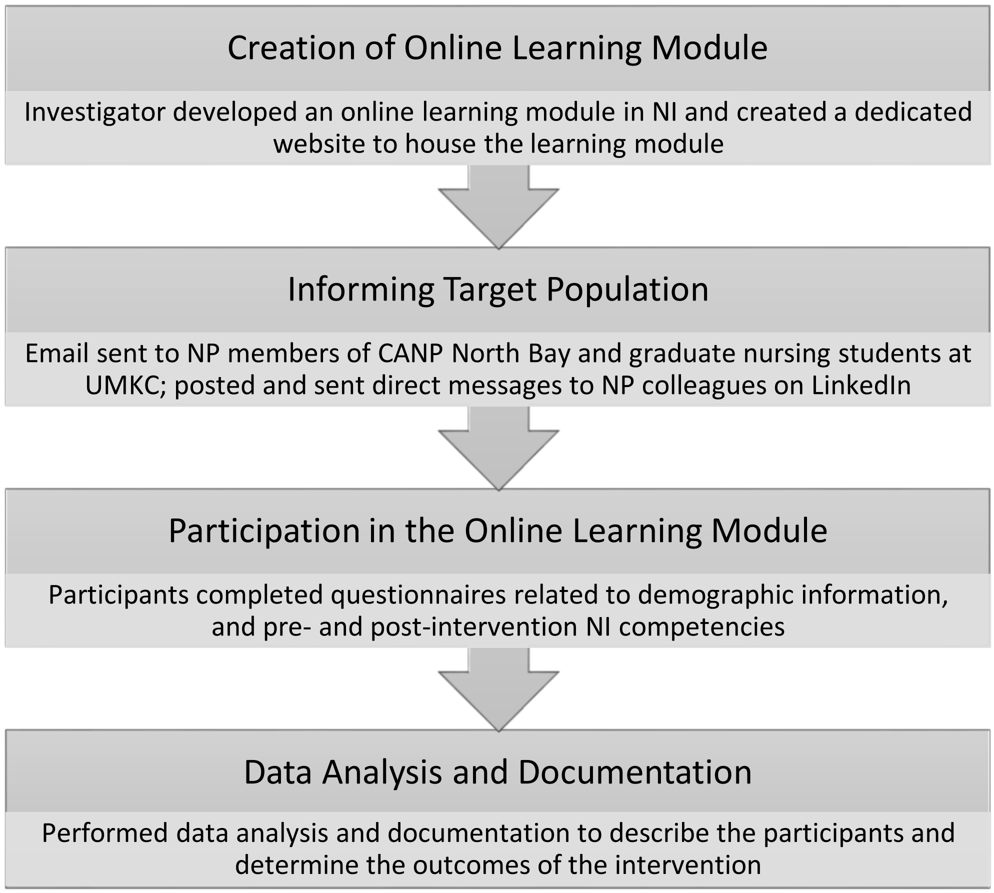


COMPLETED AN INFORMATICS COURSE IN THE PAST?	Frequency	Percent
No	11	64.7
Yes	6	35.3
Total	17	100.0



Appendix S

Intervention Flow Diagram



Appendix T

Data Collection Template

	Basic Tech Skills PRE	Basic Tech Skills POST	Basic Tech Skills DIFF	Email PRE	Email POST	Email DIFF	Lit Search PRE	Lit Search POST	Lit Search DIFF	Aggregated Data PRE	Aggregated Data POST	Aggregated Data DIFF
2	4	4	0	4	4	0	3	3	0	2	3	1
3	4	4	0	4	4	0	2	2	0	0	1	1

	Computer as Tool PRE	Computer as Tool POST	Computer as Tool DIFF	Clinician Involvement PRE	Clinician Involvement POST	Clinician Involvement DIFF	Dataset PRE	Dataset POST	Dataset DIFF	Structured Language PRE	Structured Language POST	Structured Language DIFF
2	4	4	0	3	4	1	2	3	1	2	4	2
3	2	2	0	2	2	0	0	1	1	1	1	0

	Protect Data PRE	Protect Data POST	Protect Data DIFF	Evaluate Online Info	Evaluate Online Info	Evaluate Online Info	Apply Relevant	Apply Relevant	Apply Relevant	Documentation PRE	Documentation POST	Documentation DIFF	Educ. Materials PRE	Educ. Materials POST	Educ. Materials DIFF
2	4	4	0	4	4	0	4	4	0	4	4	0	4	4	0
3	2	3	1	2	3	1	2	3	1	4	4	0	1	1	0

	Decision Support PRE	Decision Support POST	Decision Support DIFF	Advocacy PRE	Advocacy POST	Advocacy DIFF	Content Expert PRE	Content Expert POST	Content Expert DIFF	Monitoring System PRE	Monitoring System POST	Monitoring System DIFF	Apps / Systems PRE	Apps / Systems POST	Apps / Systems DIFF
2	2	4	2	4	4	0	4	4	0	4	4	0	4	4	0
3	1	1	0	1	1	0	0	0	0	0	0	0	1	1	0

Appendix U

Statistical Analysis Results

Table U1

Related-Samples Sign Test Per Dependent Variable (Significance Level = .05) Calculated Using IBM SPSS (Version 26)

	Descriptive Statistics						Median	Related-Samples Sign Test		
Dependent Variable		**N**	**Mean**	**Std. Deviation**	**Min**	**Max**	**Median**	**Summary** *a. The exact p-value is computed based on the binomial distribution because there are 25 or fewer cases.*		**Exact Sig / 2 (1-sided test)**
1. Demonstrate basic technology skills (e.g. turn computer off and on, load paper, change toner, remove paper jams, print documents).	Basic Tech Skills PRE	17	3.53	0.800	1	4	4.00	Total N	17	
	Basic Tech Skills POST	17	3.59	0.795	1	4	4.00	Test Statistic	1.000[a]	
	Basic Tech Skills DIFF						0.00	Standard Error	0.500	
								Standardized Test Statistic	0.000	
								Asymptotic Sig.(2-sided test)	1.000	
								Exact Sig.(2-sided test)	1.000	0.500000
2. Use e-mail	Email PRE	17	3.65	0.702	2	4	4.00	Total N	17	
	Email POST	17	3.71	0.588	2	4	4.00	Test Statistic	1.000[a]	
	Email DIFF						0.00	Standard Error	0.500	
								Standardized Test Statistic	0.000	
								Asymptotic Sig.(2-sided test)	1.000	
								Exact Sig.(2-sided test)	1.000	0.500000
3. Conduct on-line literature searches (e.g., PubMed).	Lit Search PRE	17	3.06	0.748	2	4	3.00	Total N	17	
	Lit Search POST	17	3.18	0.728	2	4	3.00	Test Statistic	2.000[a]	
	Lit Search DIFF						0.00	Standard Error	0.707	
								Standardized Test Statistic	0.707	
								Asymptotic Sig.(2-sided test)	0.480	
								Exact Sig.(2-sided test)	0.500	0.250000

4. Use applications to manage aggregated data (e.g., Excel, database, statistical software).	Aggregated Data PRE	17	1.71	1.359	0	4	2.00	Total N	17	
	Aggregated Data POST	17	2.47	1.068	0	4	3.00	Test Statistic	11.000[a]	
	Aggregated Data DIFF						1.00	Standard Error	1.658	
								Standardized Test Statistic	3.015	
								Asymptotic Sig.(2-sided test)	0.003	
								Exact Sig.(2-sided test)	0.001	0.000488
5. Recognize that the computer is only a tool to provide better [discipline name here] care and that there are human functions that cannot be performed by computer.	Computer as Tool PRE	17	3.29	0.772	2	4	3.00	Total N	17	
	Computer as Tool POST	17	3.47	0.717	2	4	4.00	Test Statistic	2.000[a]	
	Computer as Tool DIFF						0.00	Standard Error	0.707	
								Standardized Test Statistic	0.707	
								Asymptotic Sig.(2-sided test)	0.480	
								Exact Sig.(2-sided test)	0.500	0.250000
6. Recognize the value of clinician involvement in the design, selection, implementation, and evaluation of applications, systems in health care.	Clinician Involvement PRE	17	3.06	0.748	2	4	3.00	Total N	17	
	Clinician Involvement POST	17	3.18	0.728	2	4	3.00	Test Statistic	3.000[a]	
	Clinician Involvement DIFF						0.00	Standard Error	1.000	
								Standardized Test Statistic	0.500	
								Asymptotic Sig.(2-sided test)	0.617	
								Exact Sig.(2-sided test)	0.625	0.312500
7. Extract data from clinical data sets (e.g., Clinical data warehouse, Minimum Data Set).	Dataset PRE	17	1.53	1.281	0	4	1.00	Total N	17	
	Dataset POST	17	2.59	0.795	1	4	3.00	Test Statistic	11.000[a]	
	Dataset DIFF						1.00	Standard Error	1.658	
								Standardized Test Statistic	3.015	
								Asymptotic Sig.(2-sided test)	0.003	
								Exact Sig.(2-sided test)	0.001	0.000488
8. Incorporate structured languages into practice (e.g., ICD9 or 10 codes, CPT codes, diagnoses codes).	Structured Language PRE	17	2.06	1.249	0	4	2.00	Total N	17	
	Structured Language POST	17	2.18	1.286	0	4	3.00	Test Statistic	2.000[a]	
	Structured Language DIFF						0.00	Standard Error	0.866	
								Standardized Test Statistic	0.000	
								Asymptotic Sig.(2-sided test)	1.000	
								Exact Sig.(2-sided test)	1.000	0.500000

9. Describe ways to protect data.	Protect Data PRE	17	2.06	1.298	0	4	2.00	Total N	17	
	Protect Data POST	17	3.29	0.849	1	4	3.00	Test Statistic	11.000[a]	
	Protect Data DIFF						1.00	Standard Error	1.658	
								Standardized Test Statistic	3.015	
								Asymptotic Sig.(2-sided test)	0.003	
								Exact Sig.(2-sided test)	0.001	0.000488
10. Assess accuracy of health information on the Internet.	Evaluate Online Info PRE	17	2.53	1.068	0	4	3.00	Total N	17	
	Evaluate Online Info POST	17	3.47	0.514	3	4	3.00	Test Statistic	11.000[a]	
	Evaluate Online Info DIFF						1.00	Standard Error	1.658	
								Standardized Test Statistic	3.015	
								Asymptotic Sig.(2-sided test)	0.003	
								Exact Sig.(2-sided test)	0.001	0.000488
11. Identify, evaluate, and apply the most relevant information.	Apply Relevant Info PRE	17	2.65	1.057	0	4	3.00	Total N	17	
	Apply Relevant Info POST	17	3.47	0.624	2	4	4.00	Test Statistic	10.000[a]	
	Apply Relevant Info DIFF						1.00	Standard Error	1.581	
								Standardized Test Statistic	2.846	
								Asymptotic Sig.(2-sided test)	0.004	
								Exact Sig.(2-sided test)	0.002	0.000977
12. Use application to document patient care.	Documentation PRE	17	3.06	0.899	2	4	3.00	Total N	17	
	Documentation POST	17	3.24	0.831	2	4	3.00	Test Statistic	3.000[a]	
	Documentation DIFF						0.00	Standard Error	0.866	
								Standardized Test Statistic	1.155	
								Asymptotic Sig.(2-sided test)	0.248	
								Exact Sig.(2-sided test)	0.250	0.125000
13. Identify, evaluate and use electronic patient education materials appropriate to language and literacy level at the point of care.	Educ. Materials PRE	17	2.76	1.091	1	4	3.00	Total N	17	
	Educ. Materials POST	17	2.88	1.054	1	4	3.00	Test Statistic	3.000[a]	
	Educ. Materials DIFF						0.00	Standard Error	1.000	
								Standardized Test Statistic	0.500	
								Asymptotic Sig.(2-sided test)	0.617	
								Exact Sig.(2-sided test)	0.625	0.312500

14. Use decision support systems, expert systems, and aids for differential diagnosis.	Decision Support PRE	17	2.59	1.004	1	4	3.00	Total N	17	
	Decision Support POST	17	2.94	0.899	1	4	3.00	Test Statistic	4.000[a]	
	Decision Support DIFF						0.00	Standard Error	1.000	
								Standardized Test Statistic	1.500	
								Asymptotic Sig.(2-sided test)	0.134	
								Exact Sig.(2-sided test)	0.125	0.062500
15. Act as an advocate of system users, including patients and colleagues.	Advocacy PRE	17	2.35	1.320	0	4	2.00	Total N	17	
	Advocacy POST	17	2.71	1.105	1	4	3.00	Test Statistic	4.000[a]	
	Advocacy DIFF						0.00	Standard Error	1.000	
								Standardized Test Statistic	1.500	
								Asymptotic Sig.(2-sided test)	0.134	
								Exact Sig.(2-sided test)	0.125	0.062500
16. Participate as a content expert to evaluate information and assist others in developing information structures and systems to promote their area of practice.	Content Expert PRE	17	2.00	1.541	0	4	2.00	Total N	17	
	Content Expert POST	17	2.24	1.437	0	4	2.00	Test Statistic	3.000[a]	
	Content Expert DIFF						0.00	Standard Error	0.866	
								Standardized Test Statistic	1.155	
								Asymptotic Sig.(2-sided test)	0.248	
								Exact Sig.(2-sided test)	0.250	0.125000
17. Applies monitoring system appropriately according to the data needed.	Monitoring System PRE	17	1.71	1.532	0	4	1.00	Total N	17	
	Monitoring System POST	17	1.88	1.536	0	4	2.00	Test Statistic	3.000[a]	
	Monitoring System DIFF						0.00	Standard Error	0.866	
								Standardized Test Statistic	1.155	
								Asymptotic Sig.(2-sided test)	0.248	
								Exact Sig.(2-sided test)	0.250	0.125000
18. Describe general applications/systems to support clinical care.	Apps / Systems PRE	17	1.94	1.391	0	4	2.00	Total N	17	
	Apps / Systems POST	17	2.18	1.334	0	4	2.00	Test Statistic	3.000[a]	
	Apps / Systems DIFF						0.00	Standard Error	0.866	
								Standardized Test Statistic	1.155	
								Asymptotic Sig.(2-sided test)	0.248	
								Exact Sig.(2-sided test)	0.250	0.125000

Table U2

Pretest-Posttest Difference Medians by Informatics Competency Areas