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Educational Video Offering to Support Nurses' Decision-making in Selecting Appropriate  
Venous Access Devices: An Applied Project

By

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THESIS

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MASTER OF SCIENCE

in

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in the

OFFICE OF GRADUATE STUDIES  
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DAVIS

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2021

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## **Abstract**

**Objectives:** This applied project was undertaken to create and examine the acceptability of an evidence-based educational module in the adult medical surgical units of an academic medical center.

**Methods:** A multimedia education module focused on venous access device selection factors and indications/contraindications using practice guidelines from the Vessel Health and Preservation (VHP) framework. The module interface was designed and developed using an animated video creation platform called Vyond so that nurses could complete the training in approximately 20 minutes at a time of their choosing. The video was accessible to any device with an internet connection and was posted on a variety of video-hosting sites. After completing the educational module, an on-line questionnaire assessing participants' characteristics, knowledge and satisfaction was self-administered using the Qualtrics platform. The links to the video and survey were shared with participants via email. Descriptive statistics were used to summarize participants' characteristics, post-assessment quiz scores, and satisfaction ratings about the animated educational module.

**Results:** Seventy-seven percent of 26 potential project participants responded to the survey (n=20). More than half of the respondents (n=11) completed a previous training related to the topic. All participants achieved 100% correct responses to the six post-knowledge assessment questions and favorably rated their satisfaction with the multimedia educational module.

**Conclusion:** The applied project demonstrated the potential for introducing an animated multimedia technology to meet the nurses' education needs in the acute setting. Developing a concise, innovative, and engaging educational module could result in positive learning outcomes. Further investigation is needed to examine the acceptability of an animated multimedia

educational module in other patient care areas such as critical, emergency or pediatric care, as well as ordering providers, pre-licensure nursing students and emerging clinicians.

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## **Introduction**

Reliable venous access is a cornerstone of modern-day medical care across different settings. Venous access devices (VAD), such as peripheral intravenous catheters (PIV), midline (ML) catheters, peripherally inserted central catheters (PICC), and other central venous access devices (CVAD), essential for safe and effective care of patients, provide a route for intravenous medications and solutions, accurate central venous pressure monitoring, and frequent blood draws (Moureau et al., 2016). Deciding which VAD has the lowest risk can be confusing (Alexandrou et al., 2019; Moureau et al., 2018). The choice of VAD should be based on the clinical needs of the patient and not selected indiscriminately following failure to establish venous access (Alexandrou et al., 2019; Moureau et al., 2018). Poor VAD selection and insertion decisions can lead to potential VAD-related hospital-acquired complications, such as catheter-related bloodstream infection or vein thrombosis (Alexandrou et al., 2019; Moureau et al., 2018).

Of clinicians involved in a patient's venous access care, bedside nurses are at the forefront of intravenous related services and play a vital role in intravenous therapy. Nurses have to be knowledgeable about device selection and make choices based not only on the immediate need for access but also treatment efficiency and the long-term impact of a device on a patient's vessel health (Moureau et al., 2018). A survey reported that 75% of hospital nurses' productive hours were expended providing intravenous therapy-related services (Millam, 1996). These studies indicate opportunities for further training to ensure patient and quality of care related to VAD use.

In-service VAD related trainings are often offered in the hospital to promote safe and effective VAD-related patient care. Extensive literature about task-oriented aspects of VAD care, such as PIV insertion, VAD dressing change, and labeling of intravenous tubing are available to

a bedside nurse (Alexandrou et al., 2012). However, educational opportunities related to addressing critical thinking and best practices, including device selection factors, indications and contraindications for use, that impact VAD placements are often accessible only to vascular access specialty-trained nurses. This leaves a knowledge gap for most nurses (Alexandrou et al., 2012; Chopra et al., 2015; Mattox, 2017; Moureau et al., 2016; Moureau et al., 2018).

Bedside nurses often report a lack of time due to heavy workload associated with high patient acuity as a major contributor to not obtaining new skills and knowledge (Carayon et al., 2005; Curran et al., 2019; O'Shea, 2003). Other factors contributing to the challenge of educating nurses include varied work shifts and a diverse workforce from different generations and educational backgrounds (Atreja et al., 2008). Thus, healthcare organizations and educators must think of innovative strategies to engage acute care nurses in learning.

To foster accessibility and efficiency in delivering educational content, self-directed on-line learning has been widely adopted in continuing professional education requirements (Curran et al., 2019). The use of digital technology can provide a creative delivery of electronic education through multimedia and animation. Animated video creation software is a widely utilized platform for developing e-Learning modules (Vyond, 2021). Animated video storytelling is an effective form of communication that can keep learners engaged with course materials, problem solving and demonstrating competencies (Stratton et al., 2014). Technology-based education can be complementary to traditional classroom learning, text-based printouts, or PowerPoint presentations, and can enhance critical thinking (Stratton et al., 2014).

The selection of an appropriate VAD requires complex decision-making and relevant education for bedside nurses that is often not available. This applied project aimed to develop an educational module to enhance nurses' knowledge about best practices in managing VADs,

including device selection factors, and indications and contraindications for use, that impact VAD placements. As a first step, feedback was obtained from a variety of individuals, some of them expert in providing venous access services. After initial revisions, acceptability of the training module was then pilot-tested in a group of nurses in an acute care setting by assessing their knowledge and satisfaction following to the completion of the educational module.

### **Review of the Literature**

This literature review focused on multiple relevant topics. First, the literature regarding best practices in managing VADs, such as device selection factors, and indications and contraindications for use that impact VAD placements was reviewed. This included examining best practice guidelines supported by the Association of Vascular Access (AVA) and the Infusion Nursing Society (INS). Second, additional articles were included to describe barriers and facilitators of competency training in nursing as well as the benefits of remote training in healthcare/nursing.

### **Venous Access Device (VAD)**

A VAD consists of a hub that provides access to various connectors, a hollow tube divided into one or multiple lumens, and a tip that may terminate peripherally or centrally (Alexander, 2014; Simonov et al., 2015). It is important to gain a thorough understanding of VAD tip location choices as this can determine what medication or infusion can be safely given, the dwell time a VAD can stay in the vein and complication risks (Alexander, 2014; Moureau, et al., 2016; Simonov et al., 2015). See Appendix A for a summary of VAD, insertion placement, tip location, and risks.

The classification of whether a VAD is a peripheral or a central line is based on the catheter tip location. The distal veins of the arm are the entry point of the peripheral VAD and

referred to as “peripheral line” because it has a tip that stays within the peripheral veins (Alexander, 2014; Moureau, et al., 2016; Simonov et al., 2015). VADs in this category include PIV, ultrasound-guided peripheral intravenous access (USGPiV), and midline (ML). Conversely, a VAD that either enters peripherally or centrally and with a tip terminating in a central vein is often referred to as a “central line” (Alexander, 2014; Moureau, et al., 2016; Simonov et al., 2015). The lower one-third of the superior vena cava (SVC) or the cavo-atrial junction (CAJ) is the North American standard of optimal central tip placement (Johnston et al., 2014). A centrally inserted central catheter (CICC) is directly inserted into an individual’s neck, chest, or groin veins (Moureau, et al., 2016; Simonov et al., 2015). A peripherally inserted central catheter (PICC) is a type of CVAD that is inserted peripherally with tip terminating centrally. An implanted chest port is surgically inserted under the skin, commonly in the chest area, and the tip ends in a central vein (Simonov et al., 2015).

There are many types of VADs with different tip locations. It is important that nurses have an understanding of how each VAD, including tip location, works along with its risks and limitation, to support decision making in selecting the most appropriate VAD.

### **Best Practice related to VAD Management**

Without venous access devices, treatment in acute care settings would not be possible, yet these same devices carry inherent risks and have the potential to cause harm (Chopra et al., 2015; Moureau et al., 2018; Moureau, 2019; Simonov et al., 2015). Literature suggested that cursory decision making with regards to VAD selection may result in an increase of VAD-related complications (Chopra et al., 2015; Moureau et al., 2018; Moureau, 2019; Simonov et al., 2015). However, mindful and intentional approach in the selection of the most appropriate

device can have a positive, long-term impact on patients' vessel health (Moureau et al., 2018; Moureau, 2019).

The Vessel and Health Preservation (VHP) model developed by Nancy Moureau and a multidisciplinary team of vascular access experts outlined an organized approach to initiating and managing vascular access and the administration of intravenous medications and treatments from a patient's admission through completion of therapy (Moureau et al., 2018; Moureau, 2019). The model utilizes evidence-based practices within four quadrants of medical care: assessment/selection, insertion, management, and evaluation of vascular access devices (Moureau et al., 2018; Moureau, 2019).

The VHP model emphasizes assessment of patient history, comorbidities, contraindications, available veins, diagnosis, and duration of therapy (Moureau et al., 2018; Moureau, 2019). These factors help determine the level of risk, the selection of an appropriate device, and the most qualified inserter (Moureau, 2019). Education for clinicians inserting and managing the devices is an overarching theme of the VHP model and is incorporated into all four quadrants of care (Moureau et al., 2018; Moureau, 2019). The model aims to improve quality of care, reduce risks associated with VADs, and increase patient satisfaction and efficiency in the use of healthcare resources (Moureau et al., 2018; Moureau, 2019). A vital component of the VHP framework is to develop an education plan for staff departments and units regarding adverse outcomes or practice deficiencies, guidelines, and recommendations to make sure that practices are evidence-based and applied consistently. (Gorski, 2019).

The VHP process was designed to guide the clinician to choose the VAD with the lowest risk for the patient (Moureau et al., 2016). The following are important considerations when selecting the most appropriate venous access device: (1) characteristics of the medication or

infusate, (2) estimated duration of therapy, (3) indications for VAD, (4) device and treatment risk factors, (5) patient treatment plan, (6) an acute versus chronic patient condition such as renal status, (7) vein characteristics, and (8) evaluation of patient risk factors (Moureau et al., 2016).

See Appendix A for the selection factors and major considerations.

### **Adverse Outcomes Associated with Inappropriate VAD Management**

Best practices for managing venous access devices (VAD) include appraising each device and considering its related complications (Moureau et al., 2016; Simonov et al., 2015). In the United States, there are approximately 300 million PIV catheters inserted annually (Rupp et al., 2017), and there are more than five million CVADs inserted per year (McGee et al., 2003). It has been reported that as many as 90% of all hospitalized patients will receive a PIV insertion, the most common invasive procedure patients experience (Helm et al., 2015). Central venous access device usage continuously increased to exceed seven million units annually (iData Research, 2020). PICC accounts for 2.7 million of the vascular access use market share (iData Research, 2020).

Given the prevalence of PIV and CVAD use, hospital acquired adverse events associated with VAD have been frequently reported, including infections, thrombophlebitis, infiltration, extravasation, and vein thrombosis (Alexander, 2014; Dychter et al., 2012). It was estimated that more than 700,000 preventable healthcare associated infections (HAIs) occur annually in the U.S (Klevens et al., 2007). These HAIs result in 75,000 deaths and \$28 to \$45 billion in extra health care costs (Scott, 2009). According to the Centers for Disease Control and Prevention's (CDC) 2017 Morbidity and Mortality Weekly Report (MMWR), approximately 120,000 cases of Staphylococcus Aureus blood stream infections can be attributed to invasive devices, such as

VADs (Kourtis et al., 2019). Hospital-acquired bloodstream infections were reported as the eighth leading cause of death in the U.S. (Wenzel et al., 2001).

Two of the more severe and expensive complications associated with central venous access device use are central line associated bloodstream infections (CLABSIs) and deep vein thrombosis (DVT) (Simonov et al., 2015). The Comprehensive Unit Based Safety Program: Stop Blood Stream Infection (BSI) campaign, a nationwide CLABSI initiative, estimated that a CLABSI case costs around \$16,500 per patient (Agency for Healthcare Research and Quality [AHRQ], 2013). The cost associated with DVT is estimated at \$15,973 per episode (Zohourian et al., 2019). See Appendix A for a listing of venous access related complications and corresponding definitions, signs, and symptoms.

### **Barriers and Facilitators of Competency Training in Nursing**

Healthcare and the provision of safe care are complex and ever changing. Nurses are expected to provide comprehensive care that meets a patients' complex and diverse needs (Fukada, 2018). To accomplish this, it is important for nurses to improve their professional and clinical competence, and utilize it in daily practice (Fukada, 2018; Gervais, 2016)). The American Nurses Association (ANA) defined nursing competency as the ability to take action by combining knowledge, skills, values, beliefs, and experience acquired as a nurse (ANA, 2010).

While nurses are expected to acquire knowledge in the care of vascular access devices and incorporate learnings into their work, there are challenges to teaching this critical thinking skill. In a large qualitative study conducted by Ward and Wood, they identified barriers that prevent education and training of healthcare staff caring for cancer patients including time, accessibility, and staff motivation (Ward et al., 2000). Finding time to attend a training or participate in an educational activity was a significant barrier for staff particularly with staffing

shortages, increased work load and patient acuity (Ward et al., 2000). Access is necessary if education and training are to reach the staff it is targeting (Ward et al., 2000). In order to maximize accessibility, education needs to be flexible and tailored to the needs of the learner (Ward et al., 2000). Staff motivation was found to be associated with the delivery of the education (Ward et al., 2000). The findings suggested that greatest staff motivation when education and training is practical, delivered by experienced staff with updated experience, patient-focused and considered to be a good use of their time (Ward et al., 2000).

A reliable vascular access is critical in the provision of safe care. The synthesis of best evidence into clinical practice for patients requiring vascular access is difficult (INS, 2016). Advances in technology and devices in the vascular access field are constant (Girgenti et al. 2013). Even though national standards and guidelines are updated and reviewed regularly, knowledge translation in actual hospital settings through policies and procedures is a constant and time-consuming challenge (INS, 2016). As a result, direct care nurses often gain knowledge on aspects of VAD care while at work, gleaning or picking up on information, knowledge and skills that may or may not be accurate, evidenced-based, or current (Lockman-Samkowiak et al., 2015). When passed on from nurse to nurse, these practices become an acceptable “tradition” or “culture,” which can result in suboptimal care (Lockman-Samkowiak et al., 2015).

The Infusion Nursing Society (INS, 2011), under standard six of the Infusion Nursing Standards of Practice, prescribed that a nurse needs to be competent in the safe delivery of infusion therapy within the scope of practice. The organization also asserted that nurses are responsible and accountable for attaining and maintaining ongoing competence with infusion therapy (INS, 2011).

Based on these requirements, it is vital for healthcare organizations to create knowledge mobilization and competency trainings, through an education program that is evidence-based and can promote nurses' active participation in VAD-related learnings. Several studies supported that implementation of systems-based nursing staff education, evidence-based policies, and protocols could positively affect desired outcomes such as CLABSI rate reductions (Munoz-Price et al., 2015; Williams, 2015; Young et al., 2006).

### **Benefits of Remote Training in Healthcare/Nursing**

The use of web-based multimedia formats in health professions education has risen dramatically in the past decade. This learning format provides nurses with the flexibility to access information and instruction at any given time or place (Rouleau, et al., 2017; Walker et al., 2006). Remote learning and training can be cost-effective, reduces travel time to cover geographical distance to a classroom, and can allow learners to learn at their own pace and from the place of their choice (Clark et al., 2016; Cook et al., 2008; Walker et al., 2006). It also promotes a learner-centered approach to adult education where learners are viewed as independent, autonomous and self-directed (Curran, et al., 2019).

The use of mobile technology in competency and skill-based learning activities has made remote learning possible and has been associated with positive outcomes (Bloomfield, et al., 2008). For example, a study compared the effects of computer-assisted learning compared to conventional teaching method when teaching first year nursing students about methods of handwashing Bloomfield, et al., 2008). The study found that technology-based learning was an effective alternative to classroom education (Bloomfield, et al., 2008). Interactive multimedia education was operationalized as transmitting of information or knowledge to learners using computer technologies through a combination of texts, audio, still images, animation, and video

(Im et al., 2014; Prober et al., 2013). Multimedia education is also widely used to developing eLearning modules through storytelling videos, which is an effective form of communication that keeps learners engaged with course materials and with content can be tailored based on the needs of the learners (Rouleau, et al., 2017; Stratton et al., 2014).

## **Methods**

This applied project developed an evidence-based, multimedia educational module about best practices for managing VADs and pilot-tested nurses' acceptability of the on-line module, in the acute care setting. Approval of the applied project was exempt by the institutional review boards at the UC Davis and UCSF.

### **Setting**

This applied project was pilot-tested in the adult medical-surgical units of a 796-bed academic medical center located in the Bay area of Northern California. There are approximately 2,500 registered nurses employed at the hospital. All nurses provide VAD care including PIV insertion and management. However, the institution does not provide clinical in-services related to critical thinking and best practices for device selection, or provide teaching regarding indications and contraindications for use that impact VAD placements.

The Vascular Access Specialty Team (VAST) at the hospital maintains a productivity report to identify the prevalence of inappropriate VAD requests requiring alternate VAD placements. The VAD productivity report collects information, such as the ordering department or unit, the reason for new VAD placement, and alternate line placement. From October 1, 2019 to March 31, 2020, the VAST received 3,165 new line requests. Of those, 855 lines (27%) required alternate lines for inappropriate orders/requests, indicating potentially improper use of resources and supplies, procedure delays, interruptions in treatment, VAD-related adverse

outcomes, and additional costs. Notably, half of the inappropriate line requests were nurse-driven over the six months.

### **Development of an Education Module**

Given that a significant amount of inappropriate VAD requests were nurse-driven, it was deemed vital to provide a short competency training on VAD use and management to busy nurses. Guided by the VHP framework, the learning objectives of the training module were to (1) describe national and local adoption rates of VADs along with the prevalence of VAD complications and associated costs; (2) examine central versus peripheral VAD pathways and corresponding complications; (3) discuss factors contributing to device selection; and (4) assess learners' knowledge of device selection factors using case scenarios presented in the module. The module content was organized into four main components according to the learning objectives (see Appendix A).

### **Creation of the Multimedia Education Module**

The investigator used the video creation software Vyond, previously known as GoAnimate, to produce the multimedia education module (Vyond, 2021). The investigator outlined a storyboard, wrote a narrator script, and created an animated video using a library of pre-animated assets, including characters, actions, templates, props, text boxes, music tracks, and sound effects integrated into the software. The platform also allowed the investigator to upload additional assets, such as audio, video, or image files, to enhance a voice-over narration capability. The design goal of the educational module was for nurses to view the video at any time using internet-capable devices regardless of their location. According to the learning objectives, the narrator script utilized action-oriented verbs, such as ‘describe’, ‘examine’, ‘discuss’, and ‘apply’. The four main components of the module were presented in an animated

multimedia format using print, graphics, audio, and audiovisuals. The movie could be stopped, paused, played back, or fast-forwarded as desired by the learner. The 21-minute video presentation was made accessible via WeTransfer and a shared Google Drive file ([https://drive.google.com/file/d/1HChYvfAXiEIgl7xb50FJ\\_7JtRRB7Yn8D/view?usp=sharing](https://drive.google.com/file/d/1HChYvfAXiEIgl7xb50FJ_7JtRRB7Yn8D/view?usp=sharing)).

See Appendix B for screenshots.

Initial formative feedback was obtained to improve the educational module before sharing it with potential participants. Feedback was then solicited from seven vascular access nurse specialists and five practicing nurses in the same medical center. To obtain this feedback, the questionnaire was sent to the experts and practicing nurses to ask the relevance and accuracy of the training content as well as the appropriateness of visual presentation of the module (i.e., easy to understand, completion time, areas of improvement). After these initial edits, participating nurses were then asked to complete the educational module.

### **Characteristics of content experts and practicing nurses**

All seven experts are members of the UCSF VAST, registered nurses and Vascular Access Board Certified (VA-BC) for five years or more. This VA-BC specialty certification is designed for clinical professionals that actively work and are involved in assessing, planning, implementing, and evaluating the care and needs of patients and clients who require vascular access in the course of their care. The content experts are involved in the development and revision of vascular access policies and procedures in the institution. They are involved in the management of vascular access activities, and the provision of consultation and education to multidisciplinary services pertinent to vascular access care.

All five practicing nurses are adult medical surgical registered nurses for five years or more. They are involved in the management of vascular access activities nurses including PIV insertion and maintenance and care for all other types of VAD.

### **Evaluation of the Education Module**

The potential participants were selected using convenience sampling and approached by the investigator when they requested VAD placements and troubleshooting. Twenty-six nurses were recruited from four medical-surgical units to review the training module. These nurses were recruited from April 10, 2021 to April 24, 2021. The investigator informed the participants that participation was voluntary and no identifiable information would be collected. After doing so, an online survey assessing participants' characteristics, knowledge, and satisfaction was completed (see Appendix C).

The first six questions appraised the participants' educational background, clinical nursing experience, previous training on managing venous access devices, format of previous educational intervention, and if the participants owned any technology devices. Educational background consisted of three choices, including associate degree, bachelor's degree, and master's degree. Clinical nursing experience was a categorical variable with three options that spanned five-year increments. Previous training related to VADs care included four options, including online, live lecture, research article, or other if applicable. The final question asked what technology devices they owned, including a cell phone, computer/desktop, laptop, touchscreen tablet computer, etc. (see Appendix C).

Participants' knowledge was assessed using six true-false questions. These questions focused on their knowledge of the key points presented in the educational video (see Appendix C). Each correct answer was coded as 1, incorrect response was coded 0, and total scores ranged

from 0 to 6. Nurses' satisfaction was examined by modifying a previously validated questionnaire assessing student satisfaction with an online educational program (Maag, 2004). The modified satisfaction survey consisted of six questions prompting participants to rate responses on a five-point Likert scale (1: strongly disagree, 2: disagree, 3: neutral, 4: agree, and 5: strongly agree).

### **Data Analysis**

All survey data were downloaded from the Qualtrics server and stored on the investigator's password-protected computer, which was accessible only to the investigator. All data analysis was conducted using Microsoft Excel. Descriptive statistics were used to summarize participants' characteristics, knowledge, and satisfaction.

## **Results**

### **Feedback from the content experts and the practicing nurses**

The experts commented that the content and information were accurate, correct, easy to read, follow and understand. They remarked that the amount of information and time to complete the module were adequate. They agreed that the content was appropriate for a non-specialty trained RN, practical and relevant. The feedback from the experts focused on reorganizing the video flow, such as stressing the significance and scope of the problem by highlighting VADs in numbers at the beginning of the module to stress the significance and scope of the problem. They suggested moving the clinical scenarios towards the end to allow participants to analyze and apply the concepts learned and/or presented. Some suggested visual and audio changes like streamlining font sizes and colors, adjusting background music, and using better quality illustrations or pictures. One expert's feedback was to include a narrator script or a closed caption on the video for participants who might prefer to read rather than watch or listen. Experts

commented that the creative use of multimedia in the presentation of the topic made learning enjoyable and effective.

The five medical and surgical nurses commented that the content and information were easy to read, follow and understand. They remarked that amount of information and time to complete the module were adequate and that the content was appropriate for a non-specialty trained RN, practical and relevant. They commented that the creative use of multimedia in the presentation of the topic made learning enjoyable and effective. They commented that the use of various clinical scenarios made the learning more practical.

### **Summary of changes made based on feedback**

The video module was updated based on the feedback and recommendations received from the experts and practicing nurses. The learning module was rerecorded, the objectives were revised for clarity, background music audio volume was lowered, topics were rearranged, and most visual, graphics, pictures, and illustrations were updated where possible. A conclusion slide was also added. To address the feedback regarding the inclusion of the narrator script displaying simultaneously with the video is playing, an attempt was made to include the script. The Vyond application utilized for creating the video did not allow space for a narrator script section to be included on the slide. The completed project was then finalized for further testing with nurses.

### **Characteristics of nurses who completed the educational module**

Of the 26 potential project participants, 20 nurses completed all the tasks, resulting in a response rate of 77%. As shown in Table 1, the majority of participants (65%) were registered nurses with adult medical and surgical experience for 10 years or more. Of the participants, 85% had a Bachelor of Science in Nursing, and 15% had a graduate level degree. Fifty-five percent had previous training on the topic of best practices in managing VAD selection, and 45% did not.

Of those who had a previous training, the majority reported their training was completed via live lecture (36%) followed by online formats (27%), research articles (18%), or other (18%). All nurses reported owning one or more electronic devices.

**Table 1**

*Demographics (n=20)*

Characteristics	<i>N</i>	<i>%</i>
Registered Nurse Experience		
< 5 years	5	25
6 – 10 years	2	10
>10 years	13	65
Medical Surgical Nursing Experience		
< 5 years	5	25
6 – 10 years	2	10
>10 years	13	65
Educational Background		
Bachelors’ of Science in Nursing (BSN)	17	85
Graduate level (MS or MSN)	3	15
Previous training related to topic		
Yes	11	55
No	9	45
What format?		
Online	6	27
Live lecture	8	36
Research article	4	18
Other	4	18
Device ownership		
Cell phone	19	95
Desktop	14	68
Laptop	19	95
Touchscreen tablet	10	53
E-book reader	3	16

## Knowledge

All nurse participants answered the six statement post-assessment quiz correctly (100%).

These questions were asked to assess participants' understanding of the key concepts of the module and if the learning objectives were met.

**Table 2***Post-assessment Quiz (n=20)*

True/False Question	%
Reliable vascular access devices are important for the delivery of infusion, medication, blood products, blood draws, and venous pressure monitoring.	100
It is important for the nurse to know the indication and duration of the therapy to advocate for the most appropriate device.	100
A peripheral line is a vascular access device that enters and has a tip that ends in the peripheral vein such as PIV, USGPIV and midline.	100
A central line is a vascular access device that either enters peripherally such as a PICC; or centrally such as an implanted chest port, tunneled or non-tunneled lines in the neck, chest or groin and has a tip ending in a central vein.	100
Nursing is considered the largest healthcare profession, therefore is optimally positioned to promote vessel health preservation and prevent venous access related adverse outcomes.	100
In order to advocate for the most appropriate venous access device for a patient, it is important to know which of the following? Choose all that apply.	
Type of infusate or medication	
Duration of treatment	
Device and treatment risk factors	
Patient treatment plan	
Patient condition	
Vein characteristics	
Patient risk factors	
All of the above	100

**Nurses' Satisfaction**

As shown in Table 3, all but one participant were satisfied with the educational content and presentation format. Twenty participants commented that learning objectives were clearly defined and met satisfactorily. Some participants received previous training related to the topic and found the module to be a good review, while others without prior training reported the need to include the module in hospital mandatory classes or during new employee orientation or on-boarding. One participant preferred a live or instructor-led class.

The last question of the survey asked for any additional comments regarding the education module. This question received 13 responses which were grouped into five common themes,

including engagement, format, accessibility, behavior change, and learning. All participants reported that the module captured and sustained their attention. Some participants commented that positive engagement was achieved because the critical thinking scenarios were commonly observed at point of care and allowed them to reflect on practice. Most participants reported that the multimedia format was visually appealing, and a better method to receive learning content due to the creative use of audiovisual, pictures of human anatomy and devices, and storytelling over text, printed manuscript and PowerPoint presentations. Another theme that emerged was accessibility. Some participants appreciated that module was easily accessed through the link provided and they were able to watch the video at the time of their choosing on any device with an internet connection. The play, pause and repeat feature of the video made it easy to play back to content when they needed to focus on and write down notes. Some participants reported that this module will lead them to apply practice changes and perform a mindful approach when managing VADs. .

**Table 3***Participants' Satisfaction (n=20)*

	Neutral n (%)	Strongly Agree or Agree n (%)
The educational video is appropriate for the intended audience (Adult Medical Surgical Acute Care Nurse)?		20 (100)
The educational video graphics, voice over and texts are appropriate and easy to read or understand.		20 (100)
The module was of sufficient length or time to provide a quick content overview.	1(5)	19 (95)
The module was an efficient way to learn critical thinking skills about venous access device selection factors among adult medical surgical patients.		20 (100)
I will be able to use what I learned in the education module in my daily practice.		20 (100)
I really enjoyed learning the material in this way.	1(5)	19 (95)

**Discussion**

The purpose of this project was to create an evidence-based, multimedia educational module in managing VADs, including selection factors, and indications and contraindications for use in an acute care setting. The project recognized the use of innovative strategies that promote engagement in educating nurses beyond the traditional lecture and web-based education styles in order to improve acute care competency. The project recognized that there are hurdles in educating adult medical surgical nurses, such as years of experience and educational diversity, high acuity in patient care settings, advances in technology and devices, and little to no formal VAD related curricula or educational tools for clinicians in training or practice exist. The value of furnishing an alternative to traditional methods of learning were key focus of this project.

### **Considerations for developing an evidence-based, multimedia educational module**

The Vyond application did not allow for closed captioning the script; therefore, the video may not be an effective tool for future participants who have hearing or visual disabilities. Other software applications, like Panopto, may be more useful. Similar to Vyond, Panopto is a video platform capable of video management, recording and editing, live streaming, video searching of similar videos in the Panopto library, and closed captioning features (Panopto, 2020). The versatility of Panopto can allow future participants with hearing or visual impairments to learn about the topic without barriers or impediments.

### **Utility of the Education Module**

In general, the nurse participants positively rated their satisfaction with educational module. The participants agreed that the educational video was enjoyable, that it was appropriate for the intended audience, that it was a sufficient length, and that it was useable. The majority of the participants were experienced medical surgical nurses and had previous trainings with VAD-related care. These backgrounds may have impacted the participants' responses as the content could have been seen as a review or supplement to information with which they were already familiar. Participants without prior training related to the module expressed the need for a more structured learning or during new employee orientation or on-boarding. Some participants stated that the module kept them engaged since the topic was relevant and practical. Participants' narrative comments demonstrated satisfaction with the multimedia format over print and text heavy information delivery. This may indicate that learners were open to alternative format of instruction delivery.

The efficiency and length of the module were also rated well, which could be seen as participants favoring succinct, brief and concise information that could be watched at a time of their choosing. The demands of patient care may deter the learner from fully concentrating and

committing to the module. Further, continuing education may compete with work hours. These findings may suggest that, in order for nurses to be fully engaged in a learning activity, consideration should be given to time commitments and readiness to learn. Additionally, participants favored the critical thinking scenarios included in the module. This may suggest that application-based scenarios allowed the participants to recall and review the content relevant to their practice.

The majority of the participants had at least six years or more of nursing experience and all participants owned one or more electronic devices, these backgrounds may suggest that nurses are familiar and have adopted with advances in technology to deliver patient care and how they receive learning to keep their practice current. These observations are important to allow educators to design educational experiences compatible with nurses' needs required for safe and quality care.

### **Limitations of the applied project**

This project was limited to a small convenience sample from one institution. Given that the setting was the investigator's workplace, biases could have been introduced in participants' responses due to familiarity with the investigator. Further there was no pre-assessment quiz administered in this applied project. Having a pre-assessment would have allowed a baseline measure of learners' readiness, interests, and learning profile that would enable educators to determine the success of the educational module.

The applied project focused on one of the four quadrants of the VHP framework. That is, the project targeted to increase nurses' knowledge about the management of a venous access device, focusing on selection factors and indications and contraindications for use. The

remaining three quadrants of the framework which are insertion, management and care, and evaluation were not directly explored.

### **Implications for Future Research**

Future projects can focus on implementing the educational offering to other patient care areas, such as critical or emergency care, which may have differing priorities for vascular access devices. This educational offering can be further tailored to meet the vascular access needs of the pediatric population. Other individuals who could benefit from the education are ordering providers, including medical doctors, nurse practitioners, and physician assistants, who do not have formal training about vascular access. It may also be beneficial for pre-licensure nursing students and emerging clinicians to access this educational offering.

### **Conclusion**

A reliable vascular access is important in the provision of safe care in today's complex healthcare setting. The synthesis of best evidence into clinical practice for patients requiring vascular access is difficult. Even though national standards and guidelines are updated and reviewed regularly, knowledge translation in actual hospital settings through policies and procedures is a constant and time-consuming challenge. The development of a concise educational module in a multimedia format specific to VAD-related issues may contribute to meaningful and positive learning outcomes. Bedside nurses as end-users of VAD, have many competing priorities in any given workday; therefore, making an educational module that is accessible at any time the learner is available can promote enhanced engagement in educational initiatives. Nurses are optimally positioned to promote vessel health preservation and prevent adverse outcomes associated with venous access devices. Therefore, an educational tool that

increases nurses' knowledge can better equip this clinician group to advocate for the most appropriate device for the right indication at the right time.

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## Appendix A: Summary of Educational Module

### I. Background

The purpose of this educational module is to bridge the bedside nurses' knowledge gap about management of VAD including selection factors, and indications and contraindications for use. The VHP model was utilized to present evidence-based guidelines and recommendations. The following provides an outline of the module content, reference table of different VADs, VAD-related complications, and device selection factors.

### II. Module Content Outline

1. Describe national and local adoption rates of VADs along with prevalence of VAD complications and associated costs.
  - a. VADs in numbers
    - i. Annual use of different VADs in the U.S.
    - ii. VAD related complications
    - iii. Bay Area hospital VAD numbers in focus

### *Venous Access Device Related Complications*

Complications	Definition	Signs and Symptoms	Other Considerations
Phlebitis (P) / Thrombophlebitis (T)	P- inflammation of the vessel wall, can be mechanical, chemical or bacterial. T- blood clot inside the vein that causes inflammation.	Both demonstrate pain, redness, swelling, sometimes palpable corded veins and warmth at the affected site.	P- most common complication of peripheral infusion, common precursor to sepsis (Catney et al., 2001).
Infiltration (I) / Extravasation (E)	I- unintentional leakage of non-vesicant solution into the surrounding tissues. E- unintentional leakage of vesicant solution into the surrounding tissues.	Both demonstrate pain, swelling, blanching, cool, tight, stretched or taut skin, can lead to deep pitting edema and impaired circulation.	In extravasation there is burning or stinging sensation, redness preceded by blistering, tissue necrosis and ulceration, may require surgery to manage injury (Dougherty, 2008).
Infection	Colonization of various sources where microbes migrate from catheter insertion site at the skin entry point.	Pain, swelling, inflammation at the insertion site, discoloration of the surrounding area, a purulent discharge may be present.	- Due to the prevalence of PIV catheter use, it is a serious source of catheter-related infections leading to systemic infections. - Appropriate aseptic technique must be observed on insertion.
Central Line Associated Bloodstream Infection (CLABSI)	Presence of same microorganisms isolated from the catheter and blood that is identified by a blood culture	Fever, chills, fatigue, tachycardia, and can cause septic shock and death.	- Line necessity assessment should be done daily. Remove line if not clinically indicated or presence of complications. - Observe strict hand hygiene.

Venous thrombosis (VT)	Superficial or deep clot due to the presence of an intravenous catheter in a vein.	Swelling, pain, discomfort of affected arm, difficulty with infusion or aspiration.	- Hypercoagulable patients are prone to VT. - In severe cases can lead to pulmonary embolism.
Catheter occlusion	Blockage of a VAD, can be partial or complete from fibrin formation within, around or at the tip of the catheter	Blood may or may not be aspirated. May or may not allow infusion to pass.	Adherence to flushing protocol is vital to maintain line patency.
Catheter migration (M)/ dislodgement (D)	M- movement of greater than 0.5 cm without loss of function even if the tip is no longer in a central position (Egan, 2013). D- accidental removal or movement that resulted in the loss of catheter function (Egan, 2013).	Change in external catheter length, inability to flush or draw from the line.	Requires device replacement, interruption of therapy and an overall safety risk to patients, and costly (Hughes, 2014).

2. Examine central versus peripheral VAD pathways, corresponding complications, the difference between a peripheral versus central venous access, importance to know the distinction.
  - a. Anatomy of a VAD
  - b. Peripheral versus central line - entry point and tip location explained
  - c. Identify which VAD is peripheral and central explained
  - d. Central tip location and clinical importance - CAJ explained

*Reference Table of Vascular Access Devices*

Vascular Access Device	Central /Peripheral	Placement Location	Duration	Common Uses	BSI Risk Per 1,000 catheter days	Thrombosis Risk	Other Notes
PIV/ USGPIV	Peripheral	Peripheral veins, forearm	7-10 days	Intravenous fluids, peripherally compatible medications, blood products	0.06	Virtually no risk	Consider PIV necessity daily.
Midline	Peripheral	Above antecubital area	2-4 weeks	Long-term medications excluding TPN, vesicants, irritants, corrosives	0.3-0.8	Insufficient data	Acts a bridge for patients to complete short term antibiotics or infusions in the outpatient setting
Peripherally Inserted Central	Central	Peripheral arm vein above antecubital	>1 week <3 months	Variety of medications including TPN,	2.4	6.3%	Contraindicated for patients with CKD

Catheter (PICC)		area, advanced to large central vein		vesicants, irritants, corrosives			stage 2b or higher
Centrally Inserted Central Catheter (CICC)	Central	Inserted above or below clavicle area	>1 week <3 months	Same as PICC, central venous pressure measurement, intensive care, trauma & emergent settings	2.3	1.3%	Given lower rates of DVT than PICC, preferred in ICU & hypercoagulable conditions
Tunneled CICC	Central	Inserted in any large vein of the arm, chest, neck or groin percutaneously	>3 months to years	Centrally compatible medications, used for patients with CKD stage 2b or greater when a PICC is indicated	Insufficient data	Insufficient data	May be better when insertion site and puncture site are not identical which may increase risk of infection

3. Discuss factors associated with the device selection
  - a. Characteristics of medication or infusate
  - b. Estimated duration of therapy
  - c. Indications for VAD
  - d. Device and treatment risk factors
  - e. Patient treatment plan
  - f. Patient condition - chronic versus acute renal status
  - g. Vein characteristics
  - h. Patient risk factors

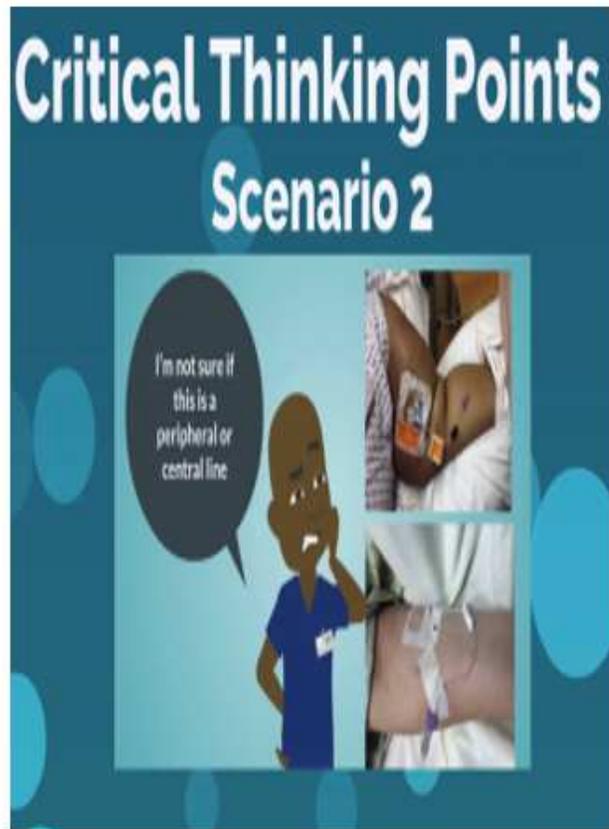
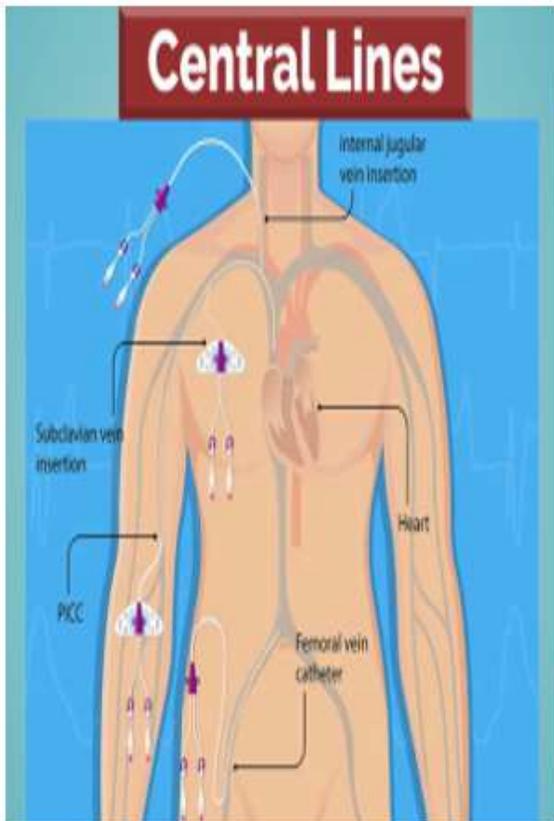
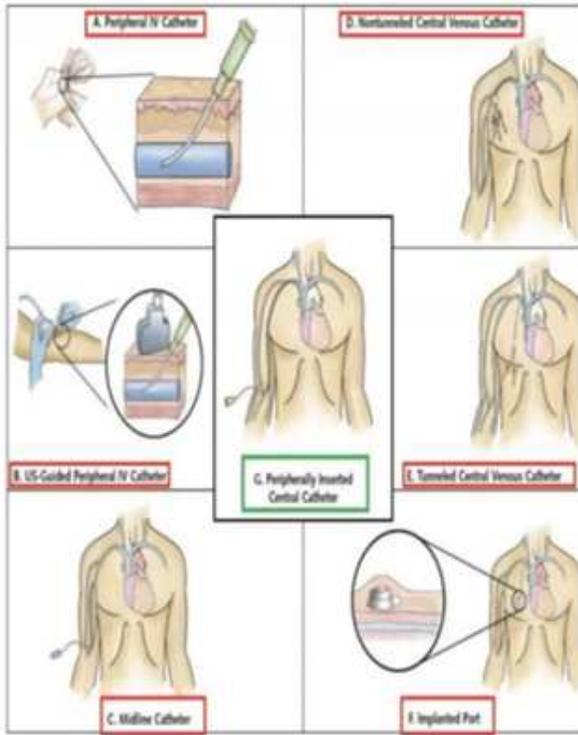
### *Vascular Access Device Selection Factors*

Parameter	Major Considerations
Characteristic of medication or infusate	- Medication pH, viscosity, and temperature may damage vessels. -Vesicants and irritants should always be administered into larger, central veins
Duration of therapy	-Peripherally compatible medications up to 4 weeks can be given to PIV, USGPIV or midline. -Vesicant or irritant medications regardless of duration should be given via a central venous access device. -Vessel thrombosis or phlebitis increase over time with catheter in place.
Indication for device	-Frequent phlebotomy or blood sampling -Difficult intravenous access -TPN -Chemotherapy -Vesicant and/or irritant medications -Central venous pressure monitoring
Device and treatment risk factors	-VADs may come in single or multiple lumens, although multiple lumens allow for multiple functions, it also allows for various sources of adverse outcomes.

	<p>-In general, use of smaller gauge catheter is preferred to prevent complications.</p> <p>-Larger catheter diameter may be needed for specific clinical need (rapid infusion in trauma or emergent setting, blood transfusion)</p>
Patient treatment plan	<p>-Generally used in the inpatient setting.</p> <p>-Commonly used now for outpatient or home settings for infusions of fluids, medications, antibiotics, chemotherapy</p>
Patient condition	<p>-Early establishment of appropriate VAD should be considered for patients with chronic conditions like sickle cell, cystic fibrosis, short gut syndrome.</p> <p>-Renal clearance required for patients with CKD stage 3b or higher. Upper arm veins should be preserved for possible hemodialysis and creation of arteriovenous graft or fistula (Hoggard, 2009, Lok et al., 2020).</p>
Vein characteristics	<p>-Vein should be adequate in size to accommodate the size and length of the catheter.</p> <p>-Vessel that is tortuous, have bifurcation or thrombosis make placement difficult and should be avoided.</p> <p>-Vessel evaluation through observation, palpation or visualization with ultrasound can enhance successful placement.</p>
Patient risk factors	<p>-Intact skin acts as a natural occlusive barrier for the body, preventing bacterial entry.</p> <p>-Skin conditions like abrasions, rashes, psoriasis, burns, allergy to cleansing agents, long term steroid use, elderly skin should be considered.</p> <p>-Patient's history of mastectomy, lymphadenopathy, chest or neck surgery, upper extremity amputation, presence of arteriovenous shunts or fistulas can limit venous access placement.</p>

4. Apply critical thinking using the device selection factors to scenarios presented in the video.
  - a. Scenario 1 - Where's my line? I can't see it on CXR.
  - b. Scenario 2 - What kind of line is this? Peripheral or central?
  - c. Scenario 3 - Mrs. Smith Case
  - d. Scenario 4 - Mr. Jones Case
  - e. Scenario 5 - Mr. Cruz Case
  - f. Scenario 6 - Mr. Black Case
5. Conclusion

**Appendix B: Example Screenshots of the Education Module**



## Appendix C: . Survey Questionnaire

### 1. Demographic Questions

- 1.) Please state your educational background.
  - a. Associate's Degree Nurse (ADN)
  - b. Bachelor of Science in Nursing (BSN)
  - c. Graduate Level (MS or MSN)
- 2.) Please state the number of years you have worked as a registered nurse.
  - a. Less than 5 years
  - b. Between 6 – 10 years
  - c. Greater than 10 years
- 3.) Please state the number of years you have worked as a medical surgical nurse.
  - a. Less than 5 years
  - b. Between 6 – 10 years
  - c. Greater than 10 years
- 4.) Have you had any previous training related to the topic?
  - a. Yes
  - b. No
- 5.) If yes, in what format? (Select all that apply)
  - a. Online
  - b. Live lecture
  - c. Research article
  - d. Other
- 6.) Do you currently own any of the following devices? (Select all that apply)
  - a. Cell phone
  - b. Computer (desktop)
  - c. Laptop
  - d. Touchscreen tablet computer
  - e. E-book reader
  - f. Other (please specify)

### 2. Post-Assessment Quiz

- 1.) Reliable vascular access devices are important for the delivery of infusion, medication, blood products, blood draws and venous pressure monitoring.
  - a. True
  - b. False
- 2.) It is important for the nurse to know the indication and duration of the therapy to advocate for the most appropriate device.
  - a. True
  - b. False
- 3.) A peripheral line is a vascular access device that enters and has a tip that ends in the peripheral vein such as PIV, USGPIV and midline.
  - a. True
  - b. False

- 4.) A central line is a vascular access device that either enters peripherally such as a PICC; or centrally such as an implanted chest port, tunneled or non-tunneled lines in the neck, chest or groin and has a tip ending in a central vein.
  - a. True
  - b. False
- 5.) Nursing is considered the largest healthcare profession, therefore is optimally positioned to promote vessel health preservation and prevent venous access related adverse outcomes.
  - a. True
  - b. False
- 6.) In order to advocate for the most appropriate venous access device for a patient, it is important to know which of the following? Choose all that apply.
  - a. Type of infusate or medication; Is it peripherally or centrally compatible?
  - b. Duration of treatment; For peripherally compatible medications less than 30 days – PIV, USGP IV or midlines should be used. For vesicant or irritant medications, for any duration of therapy – central venous access should be used.
  - c. Device and treatment risk factors such as number of lumen, gauge or catheter size.
  - d. Patient treatment plan; Is access needed for antibiotics, fluids or chemotherapy for home, skilled nursing facility or other hospital?
  - e. Patient condition such as renal or kidney status, presence of AV fistula/graft, chronic conditions like cystic fibrosis and sickle cell, history of mastectomy or lymph node removal.
  - f. Vein characteristics; Is the vein healthy, big, straight or long enough to accommodate the catheter?
  - g. Patient risk factors like non-intact skin, immunocompromised or suspicion of infection or bacteremia.
  - h. All of the above.

### 3. Satisfaction with Education Module

- 1.) The educational video is appropriate for the intended audience (Adult Medical Surgical Acute Care Nurse).
  - a. Strongly disagree
  - b. Disagree
  - c. Neutral
  - d. Agree
  - e. Strongly Agree
- 2.) The educational video graphics, voice over and texts are appropriate and easy to read or understand.
  - a. Strongly disagree
  - b. Disagree
  - c. Neutral
  - d. Agree
  - e. Strongly agree

- 3.) The module was of sufficient length or time to provide a quick content overview.
  - a. Strongly disagree
  - b. Disagree
  - c. Neutral
  - d. Agree
  - e. Strongly agree
- 4.) The module was an efficient way to learn critical thinking skills about venous access device selection factors among adult medical surgical patients.
  - a. Strongly disagree
  - b. Disagree
  - c. Neutral
  - d. Agree
  - e. Strongly agree
- 5.) I will be able to use what I learned in the education module in my daily practice.
  - a. Strongly disagree
  - b. Disagree
  - c. Neutral
  - d. Agree
  - e. Strongly agree
- 6.) I really enjoyed learning the material in this way.
  - a. Strongly disagree
  - b. Disagree
  - c. Neutral
  - d. Agree
  - e. Strongly agree
- 7.) Do you have any additional comments or suggestions regarding the education module? (Free text)