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Comparison of Detection Competency Between Cruise Security Personnel Using Simulation Tutoring Software

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This is to certify that the doctoral study by

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Walden University
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Abstract

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EdD, Walden University, 2020

EdS, Walden University, 2012

MS, Towson University, 2009

BS, Columbia Union College, 2001

Dissertation Submitted in Partial Fulfillment

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Abstract

Transportation security threats are constantly changing. Training transportation security personnel to identify these changing threats is vital to the safety of travelers aboard transportation vessels. Although many studies about detection competency and training of screeners at airports have been conducted, a gap in the research literature exists about training security practice in the cruise ship industry. Currently, not all cruise companies require their security employees to use screening tutoring software as part of their onboard training. In an orientation program, a maritime corporation implemented online screening simulation tutoring to train and an assessment tool to measure the detection competency of newly hired security personnel. Guided by Green and Swets signal detection theory, the purpose of this study was to determine if there was a statistically significant difference in the posttraining threat detection competency between security personnel who used the screening tutoring software and those who did not, controlling for pretraining competency. A quantitative comparative research design using archival data was conducted. The difference in posttraining detection competency of a census of 89 trainees, 49 who used and 40 who did not use the simulation, was tested using one-way ANCOVA. Findings indicated that, after controlling for pretraining competency, security personnel who used the screening tutoring software had significantly higher posttraining threat detection competency than personnel who did not use the simulation tutoring software ($p < .05$). Training maritime security personnel to have higher threat detection competency has the potential to create increased security aboard cruise vessels thus promoting positive social change within the maritime industry and community over time.

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Dedication

This degree is dedicated to my immediate and extended families. To my immediate family, thank you for your love and support throughout this journey. I appreciate your sacrifice to ensure that I accomplished my dream. To my husband, Jose, I could not have done this without your love, support, and encouragement. To my kids, David, Marcus, and Jada, thank you for stepping up, you are all amazing, I love you all and I am very proud of you. To my mom, Monica Brewster-Lucien, and dad, Kelvin Lucien who always said education was the key. I love you very much. Mom, I cannot thank you enough for your love, encouragement, praise, and wisdom. This degree is also dedicated to Winston Clarke, my second dad, who played such an important role in my life. To my siblings, nieces, nephews, cousins, in-laws, and friends, I appreciate your support and encouragement throughout the years. This degree is also dedicated to my ancestors, the hard-working women and men of the Lucien, Brewster, Humphrey, and St. Hill families from Trinidad. I would not have been able to be here and accomplish this without your tireless efforts, your broad shoulders, your heads up high, your dedication for betterment, your faith in the future, and your encouragement for the next generation to go further than the previous. I hope I have made you all proud. This degree is not just for me, it is for all of you.

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To my loving husband, kids, and mom, you all are the best. Thank you for stepping up, helping out, staying flexible, and being understanding over the past few years. Your love and unwavering support have allowed me to push harder and go further than ever before. My sincere appreciation to all who helped and supported me throughout this process.

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Chapter 1: Introduction to the Study

Cruising has increased in popularity in the last decade and has become the only way to vacation for many families (Cruise Lines International Association, 2019). Across the globe, the popularity of cruising continues to increase drastically, with an estimated 30 million people cruising in 2019, 12 million more passengers than what the industry experienced in 2009. This demand has increased competition and resulted in cruise companies doubling or tripling their fleet by building new cruise ships, refitting older ships, or acquiring smaller cruise companies. In 2019, approximately 18 new ships debuted and billions more were invested in for future development; the cruising industry plans to meet and exceed the demands of cruise passengers across the world (Cruise Lines International Association, 2019).

Cruise ships have become floating cities, offering a range of destinations and amenities for every class of passenger. One of the newest cruise ships built, Royal Caribbean's Spectrum of the Seas can house more than 4,900 passengers while offering a variety of features including an ice rink and rock climbing (Royal Caribbean International, 2019). The continuous growth of the industry (new ships, more amenities, bigger attractions) increases the demand for more crew members, individuals who are employed to work on board a ship in every level of ship operations. These crew members, according to various maritime regulations, must be trained in a variety of topics and possess different levels of knowledge, skills, and proficiencies, based on their education, prior experiences, position, and responsibilities on board the ship (International Maritime Organization, 2010). One such group of crew members who are dedicated to safety and security onboard cruise ships are referred to as *security personnel* in this study.

Security personnel are responsible for the safety and security for all passengers and crew onboard the ship. They are expected to be knowledgeable in maritime and company policy and regulations, aware of the ship areas that they are working on, vigilant of the people they interact with onboard, and able to screen passengers and passenger baggage for possible threats. Screening of onshore purchases and packages occurs every time passengers and crew embark on the ship; thus, security personnel continuously apply threat detection skills as part of the ongoing screening process.

With transportation security risks constantly changing, ongoing training of transportation security personnel to identify changing security risks is essential (Koller & Schwaninger, 2006). Training and competency of security personnel in threat detection are vital to the success and security of all passengers, workers, and transportation vessels. To support such ongoing learning, some cruise companies require their security personnel to complete an additional online screening tutoring training activity, during a corporate security training program using a x-ray tutoring software. This requirement was guided by a research study from Michel, Mendes, De Ruiter, Koomen, and Schwaninger (2014), who found that airport screeners' detection proficiency increased after the introduction of additional computer based training. The corporate training program used an assessment tool, X-Ray Competency Assessment Test (X-RayCAT), to assess security personnel's detection performance. Between December 2018 and July 2019, the performance of each member of the security team was assessed and compared to corporate objectives at the beginning and the end of the training program. In an attempt to determine if there was a statistically significant difference in the posttraining competency between security personnel who used the screening tutoring software and those who did not, I conducted this study using a quantitative comparative research design and archival data.

Background

The maritime industry has been shaped by the events that have occurred within its historical purview and by other industries such as aviation, healthcare, and the military. Best practices from other industries have been adopted and shaped how the maritime industry trains security personnel to ensure competency in their profession. Several events have occurred within the past century that have shaped industry safety and security training, including the Titanic disaster of 1912 and the September 11th attacks in 2001.

In response to the Titanic disaster, the International Convention for the Safety of Life at Sea (SOLAS) was adopted by the maritime industry in 1914. SOLAS is the safety treaty that outlines the minimum standards in construction, equipment, and operation by which all merchant ships must comply. Flag states, countries to which the ships are registered, are responsible for ensuring compliance with SOLAS guidelines and other industry convention and codes (International Maritime Organization, 2014). Since its induction in 1914, SOLAS has undergone various editions and has had several amendments added to ensure the convention remains current (International Maritime Organization, 2014).

One such amendment, adopted in 1978 by the International Maritime Organization (IMO), was the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW), which addressed the need for consistency of safety standards across the maritime industry. STCW recognized that regulations for certifying training and monitoring of officers and their ratings were local authority decisions, and took the lead on prescribing basic requirements for seafarers to which all flag states must comply. To assist companies and training institutions with planning and preparing for compliance, every regulated training requirement has an enforcement date, which is sometimes two years after the regulation is adopted. To ensure that STCW remains accurate and reflects the changes in the industry amendments are continuously added (International Maritime Organization, 2010).

Another major event that shaped the maritime industry was the September 11th (9/11) attacks that took place in New York City in 2001. The details of this event, whereby aircraft were hijacked and used to destroy infrastructure and kill individuals, resulted in an immediate response by the maritime industry. Thus, the Maritime Security Committee (MSC), a subgroup of the IMO, began to develop measures related to the security of ships and ports, outlining the security standards for ships, seafarers, ports, and shipping companies. The International Ship and Port Security code (ISPS) was adopted in December 2002 by international governing bodies. The ISPS code went into effect in July 2004. ISPS required all ships to be certified and security personnel be certified in security training to be in compliance (Bergqvist, 2014).

Due to all the changes in the industry, a major revision to STCW occurred in 2010. The new Manila Amendments called for additional guidelines and greater clarity into the STCW Convention and Code (International Maritime Organization, 2010). This amendment provides prescriptive guidelines regarding the required knowledge and performance expected of seafarers during training as it relates to the competencies they must hold in their specific positions. The STCW code provided clear expectations listing tables, which states the competency and criteria for evaluating it within most of the major positions onboard a ship (International Maritime Organization, 2010).

To ensure safety and security for the crew, those employed on a ship are not only required to possess a level of fitness and competency to do their job, they must also understand the working practices of the workplace environment. To ensure this level of awareness, a mandatory requirement of all crew is they must complete ship safety familiarization and security awareness training when they join a ship (International Maritime Organization, 2010). STCW went even further to ensure that those having designated security duties obtain the appropriate knowledge and skill. In 2010, STCW prescribed that each crew member who has designated security duties must receive appropriate training and possess the following job-related competencies before assuming their duties on board a ship: “Maintain the conditions set out in a ship security plan, recognize security risks and threats, undertake regular security inspection of the ship, and ensure proper usage of security equipment and systems if any” (International Maritime Organization, 2010, p. 210).

This industry regulation requires that security personnel complete compliance training through various training vendors across the globe, training which incorporates a variety of delivery formats and learning approaches. To ensure more consistent delivery and a greater standard of training, a maritime corporation developed a security training program that not only included designated security training but also included orientation to shipboard and company standards.

Within this maritime corporation's training program, a few companies based in Europe required that their security personnel complete additional screening exercises using a simulated x-ray screening tutoring software in addition to completing the existing orientation curriculum. This x-ray tutoring software is a self-directed passenger bag screening tutoring software that provides users with multiple views of images. The screening tutoring software presents images in which threat items are portrayed. Users must identify if the image is a threat or not. This tutoring software allows users to mimic the detection performance and decision-making skills they perform in their jobs.

Due to the ever-changing threat to transportation vessels across the globe, the simulated x-ray screening tutoring software is used in the aviation industry for airport baggage screeners. Airport baggage screeners have the responsibility of looking at hundreds of passenger's bags every day and identifying if the images portrayed on the x-ray machines contain threats or not. The importance of maintaining threat detection skills is so vital that the European Union (EU) regulation requires airport screeners to complete at least 6 hours of ongoing training every six months (CASRA, 2017). Due to this requirement, countless research studies investigate detection performance among airport baggage screeners as well as the use of tools to support learning and screening performance of screeners from which the maritime industry can learn.

Problem Statement

With transportation security risks constantly changing, transportation security personnel must be constantly trained to identify changing security risks (Koller & Schwaninger, 2006). Security personnel must maintain ongoing skills and knowledge development in the area of threat detection to ensure the safety of passengers and the vessels they are on. Passenger baggage screening by security personnel is an important part of ensuring the safety of travelers because threat items must be detected and not permitted on the transportation vessel. Numerous studies (Hättenschwiler, Michel, Kuhn, Ritzmann, & Schwaninger, 2015; Hofer, Hardmeier, & Schwaninger, 2006; Koller & Schwaninger, 2006; Schwaninger, 2003; Schwaninger & Hofer, 2004) have been conducted regarding detection competency and training of screeners at airports, but no known studies have focused on screeners working on cruise ships in the maritime cruise ship industry. This gap in research regarding the practice of training and detection competency of screeners who work on cruise ships among maritime companies is a problem for persons and organizations involved in training cruise ship personnel.

Given the lack of evidence in the literature regarding the appropriateness of detection competency training in the maritime industry, corporations and training institutions have implemented varied training programs of their own. Some of these programs include the use of training software to enhance the detection competency of the employees. Yet, despite instituting these training measures, the problem is that there has been no known investigation of the outcomes obtained when using traditional detection competency training without software compared to software supported training.

Purpose of the Study

The purpose of this study was to determine if there was a statistically significant difference in the posttraining competency between security personnel who used the screening tutoring software and those who did not, controlling for pretraining competency. Green and Swets (1966) Signal Detection Theory will serve as the theoretical framework of the study. Archival data from an online assessment platform will be analyzed. A comparative research design study using archival data was conducted.

Research Question and Hypothesis

The research question I used to guide this study was:

Research Question 1 (RQ1): After controlling for pretraining competency, to what extent is there a statistically significant difference in the posttraining threat detection competency between security personnel who used the screening tutoring software and those who did not?

Null Hypothesis ($H_0$1): After controlling for pretraining competency, there was no significant difference between threat detection competency of cruise ship security personnel who used and did not use simulation screening tutoring software during training.

Alternative Hypothesis (H_a1): After controlling for pretraining competency, there was a significant difference between threat detection competency of cruise ship security personnel who used and did not use simulation screening tutoring software during training.

Theoretical Foundation

I used Green and Swets (1966) signal detection theory served as the framework for this study. Signal detection theory posits that a person's ability to detect some stimuli is influenced by the intensity of the stimuli and the state of the individual, both psychological and physical (Macmillan & Creelman, 1991). Signal detection theory provides a means to assess an individual's skillfulness to discern between patterns of information and patterns which contain pertinent and non-pertinent information about a decision. Pertinent decision-making information is called a *stimulus* and *random*, non-pertinent information is called *noise* in signal detection theory (Macmillan & Creelman, 1991). The term noise is used because signal detection theory evolved from detection theory in the field of electronics. Noise referred to the random patterns of frequencies which interfered with electronic signals. Green and Swets (1966) united elements of detection theory, statistical decision-making, and stimulus-response theory to derive signal detection theory in psychophysics. The theory was developed to understand sensory decision-making and human memory. Signal detection theory can be used to analyze experimental data to make yes or no decisions amidst ambiguous stimuli. Stimuli are either a known process (the signal) or random (noise). Signal detection theory has been applied by researchers of psychology to "separate the ability of the subject to differentiate between classes of events from motivational effects or response biases" (Pastore & Scheirer, 1974, p. 945).

The purpose of this study was to determine if there was a statistically significant difference in the posttraining competency between security personnel who used the screening tutoring software and those who did not, controlling for pretraining competency. In this study, I measured screening detection performance based on the algorithm of signal detection theory. More details about the theoretical framework are presented in the section titled Theoretical Foundation in Chapter 2 of this study.

Nature of the Study

This study was a quantitative comparative design and was quasi-experimental in nature. A quantitative design is appropriate when numbers are used to measure phenomena (Rovai, Baker, & Ponton, 2014). A comparative design is fitting for studies that compare two or more groups (MacMillan & Schumacher, 2010). The study was quasi-experimental because the effect of an intervention on performance was measured but without randomized assignment to groups.

A simulated x-ray screening tutoring software has been incorporated into a corporate training program for some, but not all, security personnel trainees. For a period of 7 months, a detection assessment tool was also added to the program. Participants of this study were security personnel hired between December 2018 and July 2019, who completed the corporate training program.

The independent variable for this study was a grouping variable. Participants were categorized into two groups, participants who used and who did not use the simulated x-ray screening tutoring software during orientation training. The simulated x-ray screening tutoring software was used by the intervention group. The software provides x-ray images with and without items, which may be a threat to the security and safety of passengers aboard a cruise ship. Trainees must select if the image has no threat (OK) or is threatening (not OK). In the program, participants who were required to complete tutoring logged into the software and complete screening practice exercises for approximately 20 minutes daily.

The dependent variable was detection competency, a continuous variable scaled between 0 and 100 measuring performance on the X-Ray CAT assessment after the training. X-Ray CAT measures participants' responses and reports a detection performance score along with a hit and false alarm rates. The control variable was the detection competency score of trainees before the training.

Definitions

Competency: Competency is an individual's ability to complete a task using his/her knowledge, skills, and behavior (Hughes, Zajac, Spencer, & Salas, 2018; US Department of Education, N. C. F. O. E. S., 2002). It is a combination of the individual's capabilities, including knowledge, skills, attitude, and values, that work together to complete a specific task successfully (Mutale Mulenga & Kabombwe, 2019). Learning professionals within many industries have used competency to establish standards to which learning and performance can be measured against. Competency has been used to measure employee's readiness to do their jobs in the workplace for many years and used to set workplace performing standards for individual positions throughout many industries.

Assumptions

I made three assumptions in this study. My first assumption was that the program facilitator who operated and managed the orientation training program from which the assessment data were retrieved did so with fidelity. My second assumption was that security personnel who were required to complete The simulated x-ray screening tutoring software actually did so. My final assumption was that training participants were assigned into groups by the training administrator based on company requirements.

Scope and Delimitations

This study was delimited in scope in several ways. I studied the orientation training program for only one global cruise ship corporation. No other maritime or other transportation organizations were included. Only newly hired security personnel who were oriented between December 2018 and July 2019 were included in the study. Excluded were personnel who did not have the opportunity to complete the assessment and simulation software due to availability.

Limitations

There were several limitations to the study design and methods, which may have influenced outcomes.

Internal validity was limited by a lack of control over the amount of time participants, who were required to complete the simulated x-ray screening tutoring software intervention, spent in this self-directed activity. If additional screening exercises were availed to trainees during the orientation program, internal validity would be influenced by the presence of additional and unaccounted for simulation screening tutoring software (Heale & Twycross, 2015). I accepted these factors as limitations to the study because they limited internal validity.

External validity was limited due to a lack of random sampling, the moderate number of participants in the study, and the relative time period in which the study was conducted. Group composition may influence results. I could not control for the hiring practices by the different cruise companies of the corporation. Additionally, newly hired trainees enter orientation with various levels of experience. I used ANCOVA procedures to account for any pretest differences of the trainees (Heale & Twycross, 2015).

I did not control for *confounding variables* that may have included a trainee's previous work experience performing screening tasks on x-ray machines. Because the companies had different hiring practices, the security personnel hired had different work backgrounds. Some individuals may have had experience with security working at an airport where screening would have been required. Other individuals may have had experience working in a police force. Additionally, some may have had experience serving as security guards at commercial buildings in their home country.

Significance

This study was significant to various stakeholders. The study provided original insight into the performance of security personnel within the corporation. It also tested the viability of using training simulation in the maritime industry to ensure security personnel are prepared for their job onboard a cruise ship. With the growing numbers of passengers traveling on cruise ships, passengers represent the largest stakeholder group.

Significance to Security Personnel

This study was significant to security personnel because of the potential for the simulation software to improve their level of screening performance. Screening performance was required for security personnel to remain employed by the corporation. The corporate security orientation training program was industry-certified to deliver the level of performance required for security personnel in the maritime industry. The orientation training program supports performance in screening for threat identification. The level of screening performance was a critical element of the overall performance of security personnel so they can perform their duties on board a ship.

Significance to the Corporation

Study data may lead to corporate adoption or elimination of the simulated x-ray screening tutoring software. The data may have the potential to inform the various cruise companies within the corporation to make more informed decisions about how best to enhance security screening performance for their security personnel. If the simulation group performed better than the non-simulation group, more licenses could be purchased to ensure that all security personnel can participate in simulation screening software exercises within the program. If the simulation group does not perform better than the non-simulation group, the simulation screening software exercises may be removed from the orientation training program.

Significance to the Maritime Industry

The findings of this study may impact how Maritime Designated Security Duties (DSD) training is delivered within the industry for several operating cruise lines. Changes may occur if there are differences in the performance between security personnel who use and do not use the screening software during the orientation training program. The cruise ship companies, maritime training companies, and governing bodies known as flag states may adopt or recommend the use of simulation software for ongoing threat detection competency training.

Summary

The maritime industry has learned and adopted many safety and security practices from other industries, particularly the aviation industry. The use of a screening simulation tutoring software has already been implemented in the aviation industry to support baggage screeners' detection performance. Schwaninger (2003) and other researchers (Hättenschwiler et al., 2015; Koller & Schwaninger, 2006) have conducted studies in the aviation industry that looked at the use of computer-aided online screening training and measured detection performance to validate screeners' learning results. Some cruise companies have identified the value of incorporating screening simulation for training newly hired security personnel. This study fills a gap in the research about security training because I examined one maritime corporation that has implemented simulated x-ray screening tutoring software and assessment into its orientation program which support employees of several cruise companies. I conducted a comparative research study of newly hired security personnel's detection performance competency. The research compared those who used and did not use a simulated x-ray screening tutoring software during the security training orientation program.

In Chapter 2, I will review the literature related to this study. After an introduction, I will present the literature search strategy and resources I used to inform this study. I also provide details about Green and Swets (1966) signal detection theory and the framework I used to guide the study. I will present and summarize literature related to topics of competency in corporate training, simulation technology in training, and learning performance that is transferred to the workplace.

Chapter 2: Literature Review

Many studies (Hättenschwiler et al., 2015; Hofer et al., 2006; Koller & Schwaninger, 2006; Schwaninger, 2003; Schwaninger & Hofer, 2004) have been conducted about detection competency and training of screeners at airports, but no known studies have focused on screeners working on cruise ships. This gap in the research regarding security practice is a problem for the maritime cruise ship industry. A maritime corporation has implemented an online screening performance assessment and simulated x-ray screening tutoring software to evaluate the detection competency of newly hired security personnel within a screener orientation training program. But, not all cruise companies within the corporation require their employees to use this tutoring software for training.

With transportation security risks constantly changing, transportation security personnel must be constantly trained to identify changing security risks (Koller & Schwaninger, 2006). Training and competency of security personnel in threat detection are vital to the success and safety of all passengers, workers, and transportation vessels. To support such ongoing learning, some companies require their security personnel to complete additional x-ray training. To assess the detection performance of all training participants, an x-ray assessment tool was used by a particular training program to track detection performance before and after the program. The purpose of this study was to determine if there was a statistically significant difference in the posttraining competency between security personnel who used the screening tutoring software and who did not, controlling for pretraining competency.

The results from various studies on computer software or simulations used to support learners in skill development have shown that learning occurred and skills increased. One type of study was of airport screeners' screening detection competency which increased when they had training support aid of a computer software system that allowed them to simulate detection performance over a period of time (Hättenschwiler et al., 2015). What was not known was the impact of computer-aided training support on cruise ship screeners' screening detection competency. Thus, the result of this study will provide insight into the use of a computer-aided simulation screening tutoring software in supporting threat detection competency of cruise ship security personnel.

In this chapter, I will present my literature review. My search strategy is presented first, followed by a detailed description of Green and Swets (1966) signal detection theory I used as the theoretical framework. I will also present information regarding the literature related to key concepts and variables.

Literature Search Strategy

I searched for scholarly articles in academic and professional fields written in the last five years, between 2015 and 2020, with the objective of gaining a deeper understanding of how simulation technology was used within learning environments to prepare employees for their jobs. I conducted academic searches within several databases, including ERIC, Academic Search Complete, ProQuest, and ScienceDirect (Elsevier) using the following keywords: *training evaluation, effective training, workplace learning, learning transfer, training transfer, experiential learning, simulation training, technology-based training,* and *security screening*. I also searched in professional training and cruise industry literature in Chief Learning Officer, Training Industry Report, Maritime Executive magazines, and related sites on the internet.

Theoretical Foundation

Green and Swets (1966) signal detection theory was the framework that guided this study. Signal detection theory posits that a person's ability to detect stimuli is influenced by the intensity of the stimulus and the state of the individual, both psychological and physical (Macmillan & Creelman, 1991). Signal detection theory was used to assess a person's ability to discern between patterns of information, with particular attention on patterns that contain pertinent and non-pertinent information about a decision. Pertinent decision-making information was categorized as either direct or random. Non-pertinent information is called noise in signal detection theory. The term noise was used because signal detection theory evolved from detection theory in the field of electronics (Macmillan & Creelman, 1991). Noise referred to the random patterns of frequencies which interfered with electronic signals. Green and Swets (1966) mixed elements of three theories—detection, statistical decision-making, and stimulus-response—to derive signal detection theory in psychophysics. The development of signal detection theory increased understanding of sensory decision-making and human memory and applied to study yes or no decision-making amidst ambiguous stimuli (Macmillan & Creelman, 1991). Stimuli are either a known process (the signal) or random (noise). Signal detection theory has been applied by researchers of psychology to "separate the ability of the subject to differentiate between classes of events from motivational effects or response biases" (Pastore & Scheirer, 1974, p. 945).

For this study, signal detection theory was best suited to measure the threat detection competency variable. Threat detection is essential to the security and safety of cruise ships. Security personnel must be able to observe bags or packages during the screening process and quickly detect objects that may serve as potential risks. Furthermore, personnel must be able to assess situations that may pose potential risks to passengers or the cruise ship and determine if further investigation is required. Personnel competency in detecting risk and making decisions as a result of the identified risk is vital to the success of the maritime industry.

Abdi (2009) explained that in an experiment, the observer responds either yes or no to stimuli that may or may not be present. Table 1 presents the four types of responses in signal detection theory. A *yes* decision and response to a signal which was real and present is referred to as a hit. A *no* decision and response to a signal which was not real or present is referred to as a miss. A *yes* decision and response to a signal which was absent is called a false alarm. A *no* decision and response to a signal which was absent is referred to as a correct rejection. Signal detection theory has been applied in areas of human behavior, x-ray diagnosis, and decisions about educational program effectiveness, the topic of this evaluation (Abdi, 2009).

Table 1

Signal Detection Theory: Possible Types of Responses

	No	Yes
Signal Absent	Correct Rejection	False Alarm
Signal Present	Miss	Hit

The selection of the signal detection theory accurately aligned with this study because the assessment tool implemented in the training program measures the screening detection competency of the newly hired security personnel. The x-ray tutoring software used by some program participants also focused on screening performance. Thus, the detection of signal and respective responses outlined within the signal detection theory aligned with the detection of threats and responses required to be completed by the security personnel.

The x-ray tutoring software was designed to assist security personnel with detection performance skills (CASRA, 2017). The online tutoring software was based on scientific studies of brain processing and took into account the perception of visual information (CASRA, 2017). The x-ray tutoring works upon an adaptive algorithm, using a participant's responses to tailor the images that appear during their training sessions. The tutoring system has 256 images. Approximately one-half of images contain a threat. Threats displayed within transportation baggage fall within four categories: knives, improvised explosive devices (IEDs), guns, and other. Participants respond to each image as "OK" when the bag contains no banned item, or "NOT OK" when the bag contains banned items and receive appropriate feedback based on that response (Koller & Schwaninger, 2006, p. 400).

Signal detection theory was used to address the research question that guided this study. The research question asked if, after controlling for pretraining competency, to what extent was there a statistically significant difference in the posttraining competency between security personnel who used the screening tutoring software and those who did not. The result of this study builds upon the existing theory as it applies to simulation screening tutoring software to train security personnel in the maritime industry. No prior studies have considered this question.

Literature Review Related to Key Concepts and Variables

In this section, I discuss the key concepts and variables of the literature review which are: (a) competency in corporate training, (b) simulation technology in training, (c) learning competency transferred to the workplace, (d) training alone, (e) skill decay, (f) duration of nonuse, (g) the degree of overlearning, (h) task characteristics, (i) original learning and testing methods, (j) retrieval conditions, (k) instructional strategy and training approach, (l) individual differences, and (m) assessment and evaluation of training. A summary and conclusion section complete the chapter.

Competency in Corporate Training

The delivery of training can be found within every industry, as training programs are created to prepare, support, and develop skill sets of employees. Training consists of planned activities that are systematically delivered to promote competency through the acquisition of knowledge, skills, and attitudes so they can be applied in other environments (Garfolo & L'Huillier, 2016; Salas, Tannenbaum, Kaiger, & Smith-Jentsch, 2012). The U.S. Department of Education’s National Postsecondary Education Cooperative (NPEC) Working Group defines competency as “a combination of knowledge, skills, and abilities (KSAs) needed to perform a specific task” (2002, p.7). When designed, developed, and delivered correctly, training can produce higher performance among employees.

Bandura (1997) shared that the most effective way to cultivate performance was through mastery of experiences, in which learners attain success through accomplishments. He noted, however, that learning success was achieved when learners experience obstacles and setbacks within the experience, allowing them to learn from the mistake and how to manage failure (Bandura, 1997). Noe, Clarke, and Klein (2014), noted the importance of promoting mastery within training by preparing learners to apply what they have learned within challenging situations that encourage trainees to work through errors. Using these strategies, learning development teams can incorporate and foster learning environments in which learners have opportunities to practice what they know, attempt new challenges, receive immediate feedback, repeat training, and expand on their knowledge of that topic.

Salas, Tannenbaum, et al. (2012) observed that there was an association between the extent to which an organization supports newly-trained employees and their use and maintenance of skills. Therefore, the decisions made by leadership about the overall importance of training within the organization can either facilitate or hinder a learning employee's ability to apply new skills and knowledge in the workplace, thereby impacting the effectiveness of training. As organizations continue to invest in training programs to maintain and increase employees' knowledge and skills, it should be essential for them to understand how the support provided to learners within the learning environment impacts the overall success of training (Anderson, 2014; Noe et al., 2014; Senge, 2013).

Salas, Tannenbaum, et al. (2012) and Noe et al. (2014) suggested that organizations can employ a variety of techniques to ensure training success. These suggestions include (a) ensuring that training addresses the needs of the workforce, (b) maximizing learning with job-related training, (c) increasing employee's motivation to learn, (d) using technology wisely to support learning, (e) promoting continuous learning and (f) investing in meaningful training projects. Having a clear purpose for training and communicating the expectations for training programs can ensure that training initiatives align with organizational goals and are relevant to employee development. Salas, Weaver, and Shuffler (2012) noted the importance of clarifying to learners what knowledge and skills are required for immediate job performance versus what knowledge and skills can be accessed or learned at another time.

The orientation training program studied was designed to mimic knowledge, skills, responsibilities, and, where possible, the onboard ship environment to support the development of personnel's security competency and prepare them for their jobs. The orientation training program consists of a variety of learning modules that introduce security personnel to topics and then embeds activities and practical exercises that allow participants to apply what they have learned. These learning exercises are then repeated throughout the program within varying scenarios so that security personnel can connect the applicability of the topic or skill to various situations. Throughout the program, instructors provide input and feedback on the overall performance of individual security personnel for each activity.

Simulation technology in training. The ability to use simulation technology to provide a safe and controlled environment to teach and assess technical and nontechnical skills of individuals across multiple industries are becoming more popular. Simulations are used to mimic real-world environments ranging in complexity, creating engaging learning experiences to build knowledge, situational awareness and critical thinking (Salas, Rosen, Held, & Weissmuller, 2009). Simulation is also used to introduce learners to equipment, build technical expertise and teach pertinent knowledge and skills while preparing employees for workplace readiness (Jones, Passos-Neto, & Freitas Melro Braguiroli, 2015). Simulation training has been utilized in various industries to allow for learning and assessment to occur in safe learning environments (Noe et al., 2014). Simulation technology has become increasingly popular in teaching and learning because it allows learners to engage in work or emergency activities without exposing employees or the public to high risks (Sellberg & Lundin, 2017). Simulation training has also been used to allow for constant refreshers and additional knowledge creation (Linde & Miller, 2019). By using such technologies, learners can be exposed to stressors and other emergency conditions which can be controlled in learning environments (Sellberg & Lundin, 2017). Simulation provides exposure to controlled conditions that trainees may not experience in their normal work environments (Noe et al., 2014).

In the maritime industry, Deck and Technical Officers use simulators in their learning environments in preparation for their responsibilities on board the ships. The use of simulators does support not only the development of technical skills but also supports the development of non-technical skills. Technical proficiency focuses on the equipment associated with performing the job. While non-technical proficiency focuses on communication, teamwork, situation awareness, and decision making (Sellberg & Lundin, 2017).

Taylor (2017) explained that by making an instructional change from traditional classroom delivery to the incorporation of reconfigurable flat-panel simulation systems into the learning environment, training experiences would be more engaging. From this small change in instructional approach, the Navy observed an increase in learning outcomes. The Navy found that the reconfigurable flat-panel simulation systems fostered greater practical involvement of the learners allowing them to gain a deeper understanding of the mechanics of the system by opening panels, turning off switches, and altering system configurations. The incorporation of simulation in the course led to an immediate increase in student participation from 30% to 90%.

Simulation training was also used for teaching medical students to perform and address medical situations when they occur at the workplace. To address junior doctors' need for greater confidence in resuscitating collapsed patients, the International Medical University implemented a new training approach to the Cardiac Life Support course for students of medicine (Subramaniam, Loo, & Poovaneswaran, 2014). A study to evaluate the students' knowledge of cardiac resuscitation based on the cardiac life support training found that there was a significant difference in knowledge of medical students after completion of the new cardiac life support training program, which used a high-fidelity manikin and assessments instead of the traditional approach. As a result of that study, the university permanently adopted the approach of the new training course, including simulation and assessment, as its program to teach Cardiac Life Support. Additionally, the university planned to incorporate the higher fidelity manikin and other technology to simulate medical concepts and tasks to support teaching.

Simulations are used within flight schools to allow trainees to be introduced to complex conditions they may or may not experience during their job. To prepare trainees for their responsibilities at work, they are exposed to complex situations and challenged to provide a safe environment so they can experience the situation, make decisions, and assess their performance in a practice setting (Boril, Jirgl, & Jalovecky, 2016). A learning process that contains relevant assessment and feedback embedded into the experience builds knowledge and skills. These practical experiences not only assist with building knowledge and skills but also help trainees develop muscle memory to enhance their performance and refresh their knowledge.

Threat protection is a priority for airport screeners to ensure the safety of all travelers. Screeners must be continuously trained to stay current in their knowledge and skills for recognizing non-prohibited items. Studies that examined detection performance training found that the incorporation of computer-based screening software was an effective method to support screeners' knowledge by using various images, and allowed them to practice recognition of threat detection (Hättenschwiler et al., 2015; Hofer et al., 2006; Schwaninger & Hofer, 2004). The study found that the screeners exposed to the training software saw an increase in detection performance skills resulting in a reduction of false alarm reporting. The training software was proven to be an efficient and effective method for increasing the knowledge and skills for airport screeners in multiple studies.

As mentioned earlier, simulation allows for engagement in potentially threatening workplace activities without the risk of workplace consequences. The implementation of the simulation tutoring software within the studied orientation training program, the intervention variable of this study, supports security personnel's knowledge and skill development in a variety of ways without any risk to actual ship environments. The simulation tutoring software provides additional exposure using a combination of images and threats to help trainees build awareness in a variety of scenarios. Security personnel using this simulation software can practice their risk detection competency continuously during the program to build efficacy in their performance. Ongoing feedback from the software as it pertains to their risk detection responses allows for response correction, self-awareness, and development of skills.

Learning Competency Transferred to the Workplace

A critical aspect of training is to ensure that opportunities are given to learners to transfer the knowledge and skills learners have obtained in the learning environment to the work environment (Blume, Ford, Surface, & Olenick, 2017; Drescher, 2014; Hughes, Zajac, Woods, & Salas, 2020; Martin, 2010; Thalheimer, 2018). Learning and development professionals have named this process transfer of learning or training transfer (Salas, Tannenbaum, et al., 2012). Baldwin and Ford (1988) explained that learning transfer was the level at which trainees effectively utilize the attitudes, skills, and knowledge received in the context of training and apply them to the real world. While Salas, Tannenbaum, et al. (2012) explained learning transfer as it relates to training was “the extent to which learning during training is subsequently applied on the job or affects later job performance” (p.77).

As organizations continue to invest in training programs to maintain and increase employees’ knowledge and skills, it is essential to understand how the support provided to learners during and after the learning event impacts the overall success of training transfer. Without the opportunity to practice and apply learning to their job, learners are not likely to remember what they learned. They may perceive the training as irrelevant to their job performance, workplace, or organization. An early commentator on training transfer issues, Mosel (1957) believed that three mandatory conditions should exist to ensure the successful transfer of data and skills taught in training sessions (Noe et al., 2014). First, the trainee should be highly motivated to alter his or her behavior on the job to apply these new skills. Second, the trainee had to learn the content communicated during the training. Third, the content used in training must be applicable in similar situations. Furthermore, the motivation level of trainees should be at a heightened state in training sessions because they are learning to apply knowledge and skills to their jobs.

Training alone. Research in training transfer illustrated that a combination of individual motivation, teaching delivery, ability to practice, timely feedback, and a supportive work environment, following training, supports the learning process. These learning dynamics result in more effective transfer of training to work performance and improved learning retention (Daffron & North, 2011; Drescher, 2014; Grossman & Salas, 2011; Martin, 2010; Mosel, 1957; Salas, Tannenbaum, et al., 2012). These studies also noted that not all practice and feedback are effective; thus, staff efforts to support training must be sure to provide learners many opportunities to practice and provide constructive feedback accordingly. Hands-on learning wherein the learner applies the knowledge immediately and practices the skills through guided experience, has resulted in longer retention of knowledge and skills (Daffron & North, 2006). Thus, for learning transfer to take place, actual learning must have occurred during the initial training so that learners possess the appropriate knowledge and skills to perform.

Studies by Awoniyi, Griego, and Morgan (2002), Drescher (2014), Grossman and Salas (2011) and Salas, Weaver, et al. (2012), examined trainees' reactions to training and training transfer found that trainee's inabilities to apply their learning in practice resulted in a negative transfer into the workplace. Daffron and North (2006) asserted that approximately 10% of what was learned in training was transferred into practice by most learners. Salas, Tannenbaum, et al. (2012) stated that the entire learning process, including what happens before, during and after training, plays a substantial role in whether transfer of training actually occurs in the workplace.

As with all orientation programs, the purpose of the corporate orientation training program for security personnel, the setting of this study, was to introduce individuals to the corporation and prepare them for their role onboard a ship. The ongoing opportunities for skill development as security personnel to practice and apply their knowledge and skill to various scenarios during the program prepares them to step into their role and take on their responsibilities. Successful completion of the program was a validation that security personnel were competent and ready to perform their work responsibilities as expected by the company, meaning that security personnel were prepared to transfer their knowledge and skills, including risk detection passenger screening immediately in the work environment.

It is important to note that several barriers to training transfer were discussed by Daffron and North (2011), Grossman and Salas (2011), and Larsen-Freeman (2013). The barriers identified are: learner's motivation to learn, self-efficacy, experience, content and applicability to the job, method and delivery of information, and transfer of learning to practice. These barriers align with Baldwin and Ford's (1988) training transfer process model, which focuses on learner characteristics, training delivery and design, and working environment. Baldwin and Ford's (1988) findings highlight the importance of providing opportunities for practice and maintenance of knowledge and skills through continuous learning, which decreases the chance of the individual forgetting what was learned (skill decay).

Skill decay. The findings discussed within the training transfer section call attention to the loss of skills and knowledge gained in training due to the inability to practice what was learned in training. This process, known as skill decay, refers to the retention of skills and knowledge of learners after training has occurred (Grossman & Salas, 2011). Studies, in both skill decay and knowledge retention, point to the inability of learners to retain skills and knowledge if they have not practiced their learning following training sessions (Bell et al., 2008; Lawani, Hare, & Cameron, 2014; Linde, & Miller, 2019).

Arthur, Bennett, Stanush, and McNelly (1998) examined the aspects that influence retention of knowledge and skill and found that application of skills was one of the most important factors that impacted retention. Their study called attention to other factors that influence retention and skill decay including (a) length of time in which trainees do not practice knowledge and skills obtained in training; (b) amount of overlearning; (c) characteristics of tasks; (d) pre-learning and testing methods; (e) conditions of retrieval; (f) training approach and instructional design; and (g) differences in individuals. These aspects are further explained in the sections below.

Skill decay is always possible but unlikely for security personnel because they are assigned to a ship where the skills and knowledge can be immediately applied in the environment of work. A security personnel's role onboard was made up of several activities that provide countless opportunities to screen images and areas to detect risk. The repeated application of the risk detection competency supports the retention of this performance.

Duration of nonuse. Studies have revealed that the duration of nonuse positively links to the level in which knowledge and skill are retained by the learner (Arthur et al., 1998; Bell et al., 2008; Daffron & North, 2011; Lawani et al., 2014). Skill decay was dependent on the context, tasks, and situational factors the learner encounters. Other factors, such as lack of practice opportunities or inadequate feedback during practice, influence the level of retention (Daffron & North, 2011). Factors are closely linked to transfer of learning and self-efficacy findings, which conclude that when employees do not practice what they learn or feel efficacious in their ability to perform the task, then the likelihood of the knowledge and skill being transferred into the workplace will be low (Arthur et al., 1998; Bell et al., 2008; Lawani et al., 2014).

Duration of nonuse was unlikely because, upon successful completion of the orientation training program, security personnel are assigned to ships where they apply their knowledge and practice their skills under supervision by a more experienced security personnel employee. The continuous opportunity to screen passengers and receive feedback from a more experienced person supports their continuous learning.

The degree of overlearning. Arthur et al. (1998) explained that as training goes beyond the knowledge and skills required for initial proficiency of the job or task, overlearning can occur. An increase in repetition and practice with the inclusion of relevant feedback assists the learner with building confidence in a particular area. Arthur et al.'s (1998) findings complement studies conducted on the topic of self-efficacy, which established a positive relationship between performance on the job and self-efficacy (Bandura & Edwin Locke, 2003).

Overlearning was not a factor because the orientation training program was designed to provide security personnel with the competencies needed to perform their role onboard the ship at an entry-level. The learning exercises within the program allow for repeated application and a higher level of efficacy in performing the various security tasks. The simulation tutoring software supports self-directed learning, provides immediate feedback and allows for reflection and self-correction.

Task characteristics. Task characteristics relate to the complexity and level of tasks, which are further categorized by researchers in the field as closed-loop/open loop, physical/cognitive, natural/artificial, and speed/accuracy tasks (Arthur et al., 1998). Arthur et al. (1998) further explained these categories to promote understanding in these areas: (a) Closed-loop refers to ongoing responses which do not have specified beginning and ending such as problem-solving; (b) Open-loop refers to subjective responses that do not have concrete responses; (c) Physical tasks refer to tasks requiring actions to be performed such as force and strength; (d) Cognitive tasks relate to mental processing such as problem-solving; (e) Natural tasks are related to more common inheritance of individuals which may promote more interest and motivation; (f) Artificial tasks which relate to non-context related tasks such as balancing; and (g) Speed refers to the time used to complete a task, while accuracy was the rate of error which occurs within the task completion process. Arthur et al. (1998) found the following task characteristics have supported the most knowledge retention and the least amount of skill decay: speed, natural, physical, and closed-loop tasks.

The task characteristics of security training as it relates to risk detection have high levels of difficulty and complexity because security personnel need to be able to identify threats to passengers by identifying suspicious objects. Screening for threats also requires speed and accuracy because security personnel must act quickly and analyze items to identify whether an object is a risk or not. Screening tutoring software supports and promotes the development of risk detection competency.

Original learning and testing methods. Original learning and testing methods refer to the approach used within training to identify the trainee’s original level of knowledge and skill and then assessing those same knowledge and skills sometime after training. The test method used, either recall or recognition, has been found to impact the learning score of trainees. Recalling an event will result in more skill fade than if the learner was required to recognize that the event occurred (Arthur et al., 1998).

Two software packages met original learning and testing methods. The assessment software was used to measure the detection competency of the security personnel who attended the orientation training program. The security personnel were assessed at the beginning of the program and again at the end of the program. While the screening tutoring software supports the original learning of risk detection and allows for practice.

Retrieval conditions. Retrieval conditions speak to the similarity between the learning environment and working environment when training conditions are similar to work conditions (e.g., simulations, scenarios, role play, and hands-on activities) retention of trainees are increased. Study findings of retrieval conditions align with the findings of other research about training (Salas, Weaver, et al., 2012) and transfer of learning (Daffron & North, 2011).

In the present environment, retrieval conditions are similar because the orientation training program was designed to introduce topics and tasks that mimic what occurs in the work environment. All learning activities are embedded in a scenario that enables security personnel to apply knowledge and skill. The tutoring software provides retrieval conditions of screening, which supports the development of risk detection competency.

Instructional strategy and training approach. Incorporating relevant instructional strategies were vital to the effectiveness of training as well as the retention of the learner (Salas, Weaver, et al., 2012). Approaches to learning design within the learning environment support diverse learners so they acquire new skills and knowledge.

The overall instructional strategy and training approach to the orientation training program was that of ship security preparedness. With the inclusion of relevant content, learning activities, practical exercises and technology to support learning, security personnel are introduced and can become proficient in their skills before their first day onboard. The screening tutoring software provides ongoing development of risk detection knowledge and skill to security personnel.

Individual differences. Individual differences have been found in studies of skill decay to have the same influence on learning as in studies of self-efficacy (Arthur et al., 1998). The personal characteristics of an employee affect the motivation of that employee, resulting in greater involvement and persistence in training and a greater ability to transfer skills and knowledge into the workplace (Chang & Chiang, 2013). Arthur et al. (1998) reported that skill decay was greater over a period of nonuse for those employees that possess low ability in learning. Arthur et al.'s (1998) findings complement the findings of self-efficacy studies by Cherian and Jacob (2013) and Lai and Chen (2012) which found that employees with low self-efficacy are unlikely to obtain as much during training, and consequently, perform lower in the workplace. Thus, evidence points toward the imperative that companies implement various methods to foster learning and performance within the workplace.

The design of the training program allows for the individual differences of learners as a variety of instructional strategies are applied to ensure security personnel have multiple ways to obtain new knowledge and apply their skills. As it relates to risk detection, all students have opportunities to perform screening tasks with an x-ray machine to build higher efficacy in detection. Additionally, some security personnel may use the tutoring software for additional practice. Upon completing the training program, security personnel transfer their knowledge and skills to the workforce.

Assessment and evaluation of training. A report by Training Industry Magazine found that increasing the training program's effectiveness was an important priority for corporate leaders (Training Mag, 2014). Despite the millions of dollars spent on training each year, the effectiveness of most training programs on trainees' performance and organizational improvement is seldom measured (Bächmann, Abraham, & Huber, 2019). A 2014 survey of chief learning officers found that 75% of learning leaders were not satisfied with the current measurement of existing training programs and there was a need for a well-designed system to measure posttraining effectiveness (Association for Talent Development, 2014). Without the understanding that training was a process by which learning occurred through the acquisition of new knowledge and skills, many companies may continue to have unsuccessful training programs (Salas, Tannenbaum et al., 2012).

Kirkpatrick's evaluation model was created to holistically measure training with multiple measurements to be conducted within the training process (Kirkpatrick & Kirkpatrick, 2005). Kirkpatrick posited that by measuring training programs, stakeholders could gain better insight into the impact of the various training programs that occur within their organizations. Kirkpatrick's evaluation model was established in 1959 with four levels of measurement: (a) Reaction – satisfaction of learners regarding the learning experience; (b) Learning – ensuring information was obtained by learners; (c) Behavior – determining whether the information can be applied within the workplace; and (d) Results – whether the training resulted in a change within the organization (Kirkpatrick & Kirkpatrick, 2005). In 1996, Phillips added the concept of a fifth principle, return on investment (ROI), which refers to measuring the benefits of training against the cost of training (Phillips, 1996). Measuring learning at these levels ensures that proper training support and investment are allotted appropriately.

Salas, Tannenbaum et al. (2012) explained that effective training occurs when learners are provided with ways to learn knowledge, skills, and attitudes (KSA) in various delivery methods, including instruction, demonstration, practice, and feedback using a targeted and systematic learning approach. Without the proper support in place, there was no guarantee that individuals who attended the training would perform differently in their actual workplace. Thus, effective learning occurs when learners can recall and apply the information obtained within training to their workplace, portraying higher levels of performance as a result of the skills and knowledge gained from training (Baldwin & Ford, 1988).

Salas, Weaver et al. (2012) outlined four elements to be included in training to support learning transfer: (a) the delivery of information using the appropriate method; (b) the demonstration of behavior, cognition and attitude that learners must exhibit; (c) ways for learners to practice the desired skills, behaviors, and knowledge; and (d) provide constructive feedback to learners. If learning was indeed the desired result of each training program, much emphasis should be given not only to the fact that training has been completed but also that knowledge and skills were retained and the ability to transfer that skills and knowledge to the work environment.

This study, however, only focused on measuring the impact of training on security personnel's detection performance as a result of completing the corporate security training program. Detection performance assessment using the X-Ray CAT system ensures that the performance of security training personnel's screening competency can be measured. Further assessment would need to be conducted with actual job sites in subsequent evaluations.

Summary and Conclusions

To perform any job well, an individual must possess knowledge, skills and behavior that are relevant to job performance. Companies often offer training to assist with the development of these competencies for individuals doing the job. Training can be delivered through a variety of methods to assist with expanding knowledge and understanding the content, building skills to complete tasks, and implementing experiences to reinforce behavior. Various studies have shown that the opportunity to practice training in a setting which allow for errors to be made and feedback to be given without any risk to the organization; as well as the ability to practice training that mimics the workplace environment supports greater competency for the task being performed by an individual. The training and competency of security personnel in threat detection are essential to the security of the cruise industry. The implementation of the screening tutor within the corporate training program allows for security personnel to practice the task of screening items, mimicking the performance of looking at x-ray screens and responding based on if they believe the screened image illustrates a threat or does not include a threat. The usage of the screening tutoring software is only required by a couple of companies involved in the program. The implementation of a screening assessment tool to assess the detection performance of all training participants was also incorporated into the training program for all participants.

The use of simulated x-ray screening tutoring software has already been proven to be a successful tool for airport screeners. Understanding the software's effectiveness to support ongoing threat detection competency for cruise ship security personnel will expand the knowledge in this discipline. A gap in the research about security practice was filled by adding a study about the use of simulation tutoring software in the maritime industry.

The next section outlines the methodology used to evaluate the outcomes of using or not using the screening software within the orientation training program. The methodology provides details of the research design and approach, setting and sample, intervention and instrumentation, data collection and analysis, the assumptions, limitations, scope and delimitations, and the protection of participants' rights.

Chapter 3: Research Method

Many studies (e.g., Hättenschwiler et al., 2015; Hofer et al., 2006; Koller & Schwaninger, 2006; Schwaninger, 2003; Schwaninger & Hofer, 2004; Sterchi, Hättenschwiler, & Schwaninger, 2019) have been conducted about detection competency and training of screeners at airports, but no known studies have focused on screeners working on cruise ships, a gap in the research about security practice which is a problem for the maritime cruise ship industry. To evaluate the detection competency of newly hired security personnel within a security orientation training program, a maritime corporation has implemented an online screening performance assessment and online screening simulation tutoring software. But not all operating companies within the corporation require their employees to use the tutoring software for training.

The purpose of this study was to determine if there was a statistically significant difference in the posttraining competency between security personnel who used the screening tutoring software and those who did not, controlling for pretraining competency. A comparative research design was conducted to determine whether detection competency differed based on the use of the simulation software during training while controlling for prior detection competency. This study was essential to inform and guide the maritime companies' decisions regarding the adoption of the tutoring software within the corporate training program for all newly hired security personnel.

Chapter 3 contains the research design and rationale of the study and the methodology. The chapter includes (a) the population to which the study was intended for generalization, (b) sampling and sampling procedures, (c) intervention, (d) archival data,

(e) instrumentation and operationalization of constructs, and (f) data analysis plan. It also contains the threats to validity and ethical procedures used to protect subjects.

Research Design and Rationale

This study used a quantitative comparative design approach. Rovai et al. (2014) explained that a quantitative design was appropriate because data is used to measure phenomena. According to MacMillan and Schumacher (2010), a comparative design was fitting for this study because it compared two or more groups. This study was quasi-experimental because the effect of an intervention on performance was measured but without randomized assignment to groups (Rovai et al., 2014). A simulation screening tutoring software was incorporated into a corporate training program for some, but not all, security personnel trainees. Because a detection assessment tool was added to the program for a period of 7 months, from December 2018 to July 2019, only security personnel who attended the program during this time were included in this study.

The independent variable of this study was a grouping variable. Participants were categorized into two groups, participants who used and who did not use the simulation screening tutoring software during orientation training. The simulation screening tutoring software was used by the intervention group. The software provides x-ray images with and without items which are a threat to the safety and security of passengers aboard a cruise ship. Participants must select if the image included a threat (not OK) or did not include a threat (OK). In the program, participants who were required to complete tutoring logged into the software and complete screening practice exercises for approximately 20 minutes daily.

The dependent variable was the detection competency, a continuous variable scale between 0 and 100 which measured the performance on the X-Ray CAT assessment after the training. X-Ray CAT measured participants' responses and reported a detection performance score. The control variable was the detection competency score of trainees before the training.

I examined the existing detection assessment data of training participants of a corporate maritime training program from December 2018 to July 2019 to account for the period to which the assessment software was used in the program. Corporate training administrators measured participants' assessment scores at the beginning and end of the program. All security personnel were expected to complete the assessment during orientation. The independent variable of this study was a grouping variable. Participants were categorized into two groups: those who used and those that did not use the simulation screening tutoring software during orientation training. The dependent variable was the detection competency of these participants after training. The control variable was the detection competency score of trainees before the training. The study design matrix is displayed in Table 2.

Table 2

Study Design Groups

	Competency Assessment	Tutoring Software	Competency Assessment
Group 1	X	X	X
Group 2	X		X

The research question I used to guide this study was:

Research Question 1 (RQ1): After controlling for pretraining competency, to what extent is there a statistically significant difference in the posttraining threat detection competency between security personnel who used the screening tutoring software and those who did not?

Null Hypothesis ($H_0$1): After controlling for pretraining competency, there was no significant difference between threat detection competency of cruise ship security personnel who used and did not use simulation screening tutoring software during training.

Alternative Hypothesis (H_a1): After controlling for pretraining competency, there was a significant difference between threat detection competency of cruise ship security personnel who used and did not use simulation screening tutoring software during training.

A comparative research design determined if there were differences in trainee's detection competency based on the use of the simulation software during training while controlling for prior detection competency.

Methodology

In this chapter, I outline the methods used to conduct this study. First, I discuss the methodology of the study and provide details about the population. I then present the sampling and sampling procedures and the archival data used. Next, I discuss the instrumentation and operationalization of constructs. Finally, I outline the data analysis plan.

Population

The population for this study was all newly hired cruise ship security personnel of the corporation who completed the training program between December 2018 and July 2019. The global corporation included several cruise companies. All security personnel were expected to complete the corporate training program. Based on the employment practices of cruise companies, the population of the crew consisted of both male and female security personnel. Security personnel had various security background experiences. Their age ranged across several age groups, but they were at least 21 years old or older. Security personnel represented various nationalities and possessed different levels of English proficiency, though all personnel were required to be proficient at a minimal level; therefore, language was not considered a limitation for a performance on a visual test.

Sampling and Sampling Procedure

Census sampling results included all available scores of training participants who were registered and completed the corporate security orientation training program from December 2018 to July 2019. The sample was limited to this timeframe because the registration of participants in the program was dependent upon the hiring timeframe of the companies. Lodico, Spaulding, and Voegtle (2010) explained that census sampling is a non-random sampling technique in which the researcher draws from the entire realistic population. Only participants that completed the assessment software in the program during the time of implementation were included in this study.

Every participant who completed the orientation training program during this timeframe was required to complete assessments at the beginning and the end of the program. The availability of tutoring was based on whether or not the particular cruise line required the use of the simulation software in training. For example, cruise companies based in Europe require their security personnel to be oriented through training using the simulation screening tutoring software.

I used G*Power to conduct posthoc power analysis (Faul, Erdfelder, Lang, & Buchner, 2007; Kane, 2020) and calculated the effect size of *F* as an input parameter using calculated partial eta-squared values. The alpha was entered as .05; the sample size was inputted; numerator degrees of freedom was inputted as 1. The number of groups was inputted as 2 with one covariate. For example, if a medium effect was observed, post hoc power would be .64 based on these input parameters (Salkind, 2017).

Intervention

Security personnel hired across the corporation are registered to complete the corporate security training program. Administrative activities were coordinated between administrative staff from cruise companies and the training school. Participants were welcomed as they arrived at the training school, provided with an overview, and given instructions. All participants in the training program completed the same course content, lessons, and activities that made up the corporate orientation training program. One such activity was the completion of the detection performance assessment, which participants completed at the beginning and the end of the program. However, some security personnel hired by a few companies based in Europe must complete additional screening training via the tutoring software, the intervention. Between the first assessment and second assessment of the program, these participants completed an additional 20 minutes per day of screening using an online tutoring software. The other participants whose hiring company was not based in Europe were not required to complete the additional 20 minutes of screening using the tutoring software.

The program instructor was responsible for the communication, management, and facilitation of the various activities within the program, including the setup and oversight of the pre- and post-screening assessment on the X-ray CAT software. The instructor was also responsible for the setup and communication of instruction for activities to be completed on the online simulations screening tutoring software. The outline of the orientation program structure can be reviewed below:

1. At the beginning, the instructor assigned participants into two groups. Each participant was assigned to Group 1 or 2 and given a unique identifier code which was used for logging into the X-Ray CAT program.
    a. Group 1 participants were assigned a code and required to complete the x-ray tutoring software. This group included

participants hired by companies that required the additional training using the online tutoring software to be used.

b. Group 2 participants were also assigned a code. This group included participants hired by companies that did not require additional training. This group did not use the online tutoring software.

2. Group 1 participants were given instructions to complete additional self-directed screening exercises for 20 minutes per day using the x-ray tutoring software. Group 2 did not receive any instructions.
3. All participants completed an assessment at the beginning and the end of the program using X-Ray CAT software. Scores were stored and archived within the online platform.

Archival Data

The screening detection assessment scores were stored in the X-Ray CAT software online platform. A member of the corporate security team, who had administrative permission to the platform, retrieved the archival data from the online platform. Because every program participant received a generic system login for the purpose of completing pre- and post-screening assessments, the exported data from the online platform did not contain any personal information. The archived dataset contained the overall detection performance scores from the assessments taken from the beginning and end of the orientation training program. Upon exporting the archived file to an Excel spreadsheet, the administrative person forwarded the dataset for analysis.

Instrumentation and Operationalization of Constructs

At the beginning and end of the security orientation training program, CASRA's X-Ray Competency Assessment Test was used to assess the detection performance of each participant. The X-Ray CAT is an online program that consists of thousands of images with and without threats. The tutoring system has 256 images. Approximately one-half of images contain a threat. Threats displayed within transportation baggage fall within four categories: knives, IEDs, guns, and other (CASRA, 2017). Participants respond to each image receiving a score, the overall detection performance proficiency was reached with a total score of 70 and status as completed, for this company. Participants used the same username and password to log in and complete the assessments at the beginning and end of the program. The results were exported from the system for data analytics.

Measurement of variables. Both the screening tutoring system and the X-Ray CAT exposed participants to images that may have had any of the four categories of threats for inspection: knives, IEDs, guns, and others. Participants then responded to each image as "OK (contain no prohibited item) or NOT OK (contain prohibited items)" (Koller & Schwaninger, 2006, p. 400). Participants were exposed to over 1,200 images contained in the system, and each response counted toward their total score. The score for each response counted toward the 0–100 detection performance score. Participants received immediate results for each response.

The Hit Rate score was the measurement of the participant accurately judging NOT OK when bags contained a prohibited item. False Alarm rate score was the measurement of the participant inaccurately judging NOT OK when a bag does not contain a prohibited item. The detection performance was calculated based on the hit rate and the false alarm rate.

Data Analysis Plan

A corporate security team member exported the assessment scores from the X-Ray CAT online platform into a spreadsheet and shared the file for future analysis. The archived data were analyzed to identify if there was a statistically significant difference in the posttraining competency between security personnel who used the screening tutoring software and those who did not, controlling for pretraining competency. The research question that guided this study was to determine to what extent there was a statistically significant difference in the posttraining competency between security personnel who used the screening tutoring software and those who did not, controlling for pretraining competency. For this study, posttraining detection competency scores were analyzed for all participants who completed the orientation program.

Data were screened for correctness using descriptive statistics available in IBM SPSS's explore command. Outlying cases, which were +- 3 standard deviations from the mean, were included in the analysis contrary to recommendations of Pagano (2009). A one-way ANCOVA examined the potential screening detection competency differences between security personnel who used and did not use a screening tutoring software within the training program. IBM SPSS 25 was used to analyze the data. The ANCOVA procedure adjusted the means on the dependent variable to what they would be if all subjects scored equally on the CAT, pre-assessment scores. An adjusted mean was reported (Tabachnick & Fidell, 2018).

A one-way ANCOVA was an appropriate statistical analysis because the study calculated the differences between two groups and the dependent variable was measured on a continuous scale (Lund & Lund, 2018; Pagano, 2009). The continuous dependent variable corresponded to detection competency, while the independent variable corresponded to whether or not the screening tutoring software was used. The control variable was the detection competency score of trainees before the training.

Assumptions associated with the use of one-way ANCOVA included the following: one dependent variable measured at a continuous level, one categorical factor (i.e., independent variable) with two or more categories, one within-subjects factor (independent variable) with two or more categories, no presence of significant outliers, a normal distribution of the dependent variable, homogeneity of variances, homogeneity of covariances, and sphericity. Each of these assumptions is presented in the context of this study. Prior to analysis, the assumption of normality was tested using the Kolmogorov-Smirnov statistic, and the assumption of homogeneity of variance was tested using Levene's Test of Equality of Error Variances (Lund & Lund, 2018).

The overall model was interpreted for statistical significance of differences between the two groups. The probability of *F* was interpreted using a .05 level of significance. Partial eta-squared was used to interpret the effect size (Laerd Statistics, 2019). Effect size values were interpreted using Cohen's (1988) values: 14 = large effect;

.06 = medium effect; and .01 = small effect. Partial eta-squared was the same as eta-squared for models with one independent variable (Laerd Statistics, 2019).

Threats to Validity

The X-Ray Competency Assessment Test (X-Ray CAT) was administered to all participants in this study. The assessment was taken at the beginning and the end of the program. Validity and reliability of the instrument are discussed below in detail.

Validity

Koller and Schwaninger (2006), measured content, construct, and criterion validity of the X-Ray CAT. Accurate measurement by the instrument assured content validity. Intention of measurement was the concern of construct validity (Heale & Twycross, 2015). Criterion validity was the extent to which an instrument in various settings produce a consistent or stable pattern of precise results (Rovai et al., 2014).

Content validity. Content validity for the CASRA's X-Ray Competency Assessment Test was based on the use of Smiths-Heimann Hi-Scan x-ray images of prohibited items and passenger bags (Koller & Schwaninger, 2006). Smith-Heimann is a trusted global leader in the provision of security tools to airports, airlines, and authorities with various detection solutions (Smith Detection Inc., 2018). The collection of Smith-Heimann images was comprised of images submitted and vetted by a collaboration of experts. Experts include aviation airport specialists, university professionals, and state police. The collection of images used in the tutoring simulation software and detection assessment software was a result of an international collaboration between Smith-Heimann and Security Training International (Schwaninger, 2003). Images provided by

Smiths-Heimann are continuously updated, so security personnel were trained and assessed on the latest threats using CASRA's screening simulation software tutoring programs.

Construct validity. Detection performance was measured by an individual's response to identify if a threat existed within the x-ray image on the X-Ray CAT online platform. Performance on the assessment was calculated by a formula presented by Koller and Schwaninger (2006). The formula measures a combination of a hit (correctly found threat objects) and false alarm rates (incorrectly reporting a threat object).

Criterion validity. Several studies were conducted about the validity of the X-Ray CAT to increase learners' screening performance. The studies determined that the simulation software increased detection screening performance (Halbherr, Schwaninger, Budgell, & Wales, 2013; Michel et al., 2014; Schwaninger, 2003). Michel et al. (2014) found that there was an increase in performance after using the tutoring software for a 3-month period. A study to evaluate the effectiveness of the x-ray tutor found an increase in threat detection performance between the first test and the end of the respective time period for various groups (Schwaninger, 2003). Halbherr et al. (2013) also found annual improvement in aviation security screeners' detection performance using the X-Ray CAT software.

Reliability

The X-Ray CAT software is a common method used to measure detection competency of airport security screeners for the last several years (Halbherr et al., 2013; Schwaninger, 2003; Sterchi et al., 2019). To test the reliability of the X-Ray CAT software, Koller and Schwaninger (2006) calculated both Guttman's split-half and Cronbach Alpha coefficients. The study found both coefficients measures had high reliability ($\geq .80$). The X-Ray CAT software was found to be reliable (Koller & Schwaninger, 2006).

Ethical Procedures

As a matter of hiring practices, cruise ship security personnel are over the age of 21; no minors were involved in the study. Archival data were used for this study so there was no risk of harm or injury to participants and no need for voluntary participation or consent from the participants. Privacy was the one minimal risk present to participants of this study; however, the general username ID used by participants to log into the assessment platform to complete the screening assessments ensured that I could maintain the confidentiality and anonymity of participants. No personal identifiers were included within the archival dataset to mitigate privacy risks. The IRB approval number for this study is 02-26-20-0244955.

Summary

CASRA's X-Ray CAT online assessment tool was incorporated into the training program from December 2018 to July 2019. Security personnel who attended the training program during this time completed an assessment at the beginning of the program and then again at the end of the program. The performance results of the security personnel during this time were exported from the online database and used for data analysis. I used SPSS software to conduct a one-way ANCOVA to test the null hypothesis, address the research question, and examine the potential screening detection competency difference between security personnel who used and did not use a screening tutoring software within the training program. Risks of ethical concerns for the completion of this study are minimal because I used archival data without personal identifiers. In Chapter 4, the results of this study, including the data collection details and statistical results are provided.

Chapter 4: Results

The purpose of this study was to determine if there was a statistically significant difference in the posttraining competency between security personnel who used the screening tutoring software and those who did not, controlling for pretraining competency.

The research question I used to guide this study was:

Research Question 1 (RQ1): After controlling for pretraining competency, to what extent is there a statistically significant difference in the posttraining threat detection competency between security personnel who used the screening tutoring software and those who did not?

Null Hypothesis ($H_0$1): After controlling for pretraining competency, there was no significant difference between threat detection competency of cruise ship security personnel who used and did not use simulation screening tutoring software during training.

Alternative Hypothesis (H_a1): After controlling for pretraining competency, there was a significant difference between threat detection competency of cruise ship security personnel who used and did not use simulation screening tutoring software during training.

In Chapter 4, I present the results of the analysis. I provide an overview of data collection and the intervention fidelity. A summary concludes this chapter and I present an introduction to Chapter 5.

Data Collection

A cruise corporation offering a corporate training program implemented an intervention of an online screening tutoring software. They also implemented an assessment software into the training program to assess security personnel's detection competency. Every participant who completed the corporate training program from December 2018 to July 2019, the only time period when the assessment software was implemented into the training program were included in this study. As part of the training program, all 89 participants completed a detection competency assessment at the beginning and the end of their training. I used archival data of these assessments to conduct this study.

The participants included both men and women, all over the age of 21. The sample included participants representing countries throughout the world who may or may not have previous security, military, or law enforcement experience in their countries of origin. Participant characteristics reflect the hiring practices applied by all companies within the corporation. All individuals hired for entry-level security responsibilities must complete the corporate security orientation training program before joining the ship. For these two reasons, I consider external validity strong enough to share results with company decision-makers as representative of the population of security personnel working at the cruise companies.

The 89 security personnel participants were assigned into two groups based on the training requirements of their respective company: 49 participants were assigned to Group 1, and 40 were assigned to Group 2. Group 1 participants completed the online screening tutoring software. Group 2 participants did not. The size of the census was 37 more participants than the 52 required for adequate power of the statistical test, as presented in Chapter 3.

Intervention Fidelity

This study was based on archival data from an intervention and implemented into a corporate training program of cruise companies. The intervention for this study was that of an online screening tutoring software. The intervention proceeded as planned and outlined in Chapter 3, without adverse events. During the intervention, all program participants who were registered to complete the program were required to complete an X Ray-CAT assessment at the beginning and the end of the training program. To complete the X Ray-CAT assessment, participants previewed images on the screen and responded with a YES or NO response based on their assessment of the existence of a threat in the image presented.

The program was facilitated by the instructor, who provided instructions to the participants regarding expectations of them during the training program. Based on hiring experience and company expectations, some participants were instructed to complete an additional self-study exercise using an online screening tutoring software throughout the program. The instructor also instructed participants to complete an assessment at the beginning and end of the program while using a general username and password for the assessment system. Outside of the communication of these expectations, creation of username and passwords, and overall system support, no further administrative oversight was used to facilitate the completion of the tutoring program.

Results

In this section, I present descriptive statistics to characterize the sample, the assumptions of the ANCOVA statistical procedure employed to test the null hypothesis are evaluated and report statistical findings. A summary of the results concludes this section.

Census Characteristics

Between December 2018 and July 2019, 89 program participants were registered to complete the program and required to complete an X Ray-CAT assessment at the beginning and the end of the training program. Of the 89 security personnel participants, 49 were part of the intervention group, Group 1 (55% of the census), and 40 were part of the nonintervention group, Group 2 (45% of the census). Intervention Group 1 completed the online screening tutoring software. The mean score of posttraining was .08 points higher for the intervention group (M = .72, SD = .07) compared with the nonintervention Group (M =.64, SD =.13), as shown in Table 3.

Table 3

Posttraining Unadjusted and Adjusted Means, Standard Deviations, and Standard Errors

		Unadjusted		Adjusted	
	N	*M*	*SD*	*M*	*SE*
Intervention Group (1)	49	0.724	0.074	.731	.012
Non-Intervention Group (2)	40	0.638	0.131	.630	.014

Note: *N*= Number of Participants, *M*= Mean, *SD* = Standard Deviation, *SE* = Standard Error

Evaluation of ANCOVA Assumptions

I used analysis of covariance (ANCOVA) to determine if there was a statistically significant difference between means of the two independent groups, adjusting means to what they would have been if all participants scored identically on the covariate as recommended by Tabachnick and Fidell (2018). The use of ANCOVA required an evaluation of 10 statistical assumptions (Laerd Statistics, 2015). The first four of 10 assumptions were met through the design of the study: (a) a continuous dependent variable, (b) the independent variable was categorical with two independent groups, (c) a continuous covariate variable and (d) observations were independent of each other. I evaluated the other six assumptions in IBM SPSS. Results of the evaluation of assumptions are explained below based on Laerd Statistics (2015) guidance.

Assumption 5. The assumption of a linear relationship was met. A moderate linear relationship between posttraining scores of each group was observed through visual inspection of a scatterplot. The relationship was confirmed by a Pearson correlation (r =.460). Figure 1 contains the scatterplot used to interpret this assumption.

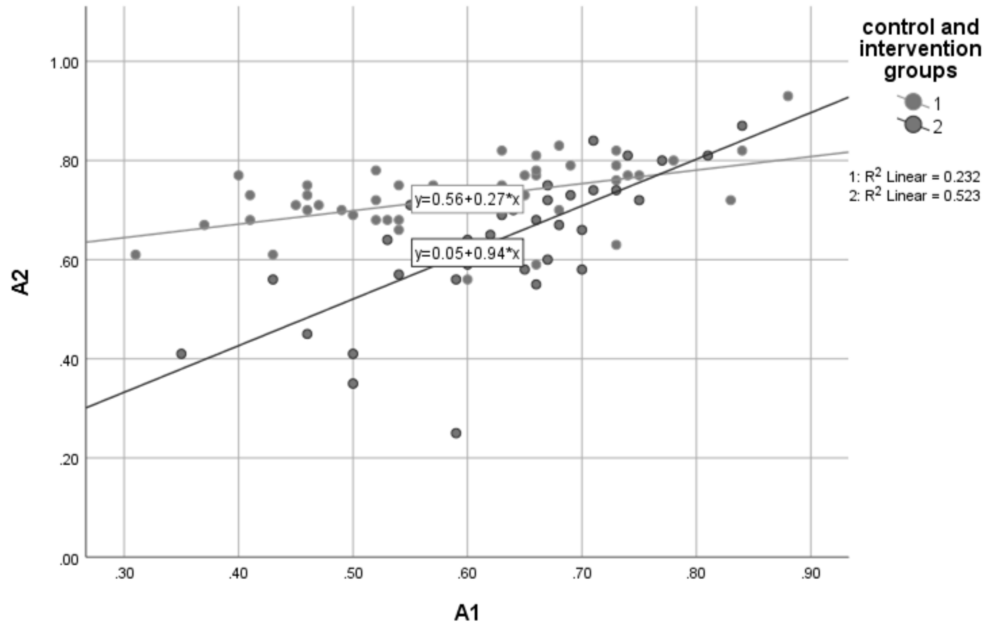

Figure 1. Grouped Scatterplot of Posttraining by Pretraining by Control Group (2) and Intervention Group (1).

Assumption 6. The assumption of homogeneity of regression slopes was violated at $F(1,85) = 19.418$, $p = .000$). There was a statistically significant interaction between the covariate and independent variable. Analysis using ANCOVA proceeded despite violation of the homogeneity of regression slopes because the assumption of homogeneity was irrelevant in this nonexperimental study. The main categorical independent variable was observed and not manipulated. The independence assumption between the covariate and independent variable was irrelevant (Keppel & Wickens, 2004).

Assumption 7. The assumption of normality for the distribution of observations for each group of the independent variable was violated using the Shapiro-Wilk test for normality (Intervention Group p = .008; Nonintervention Group p = .002). Analysis using ANCOVA proceeded despite violation of normality because ANCOVA is robust in regards to violations of normality when the numbers within each group are nearly equal (Rovai et al., 2014).

Assumption 8. The assumption of homoscedasticity, equal error variances, was met based on a visual inspection of the standardized residuals scatterplot against the predicted values. Figure 2 presents the standardized residuals scatterplot used.

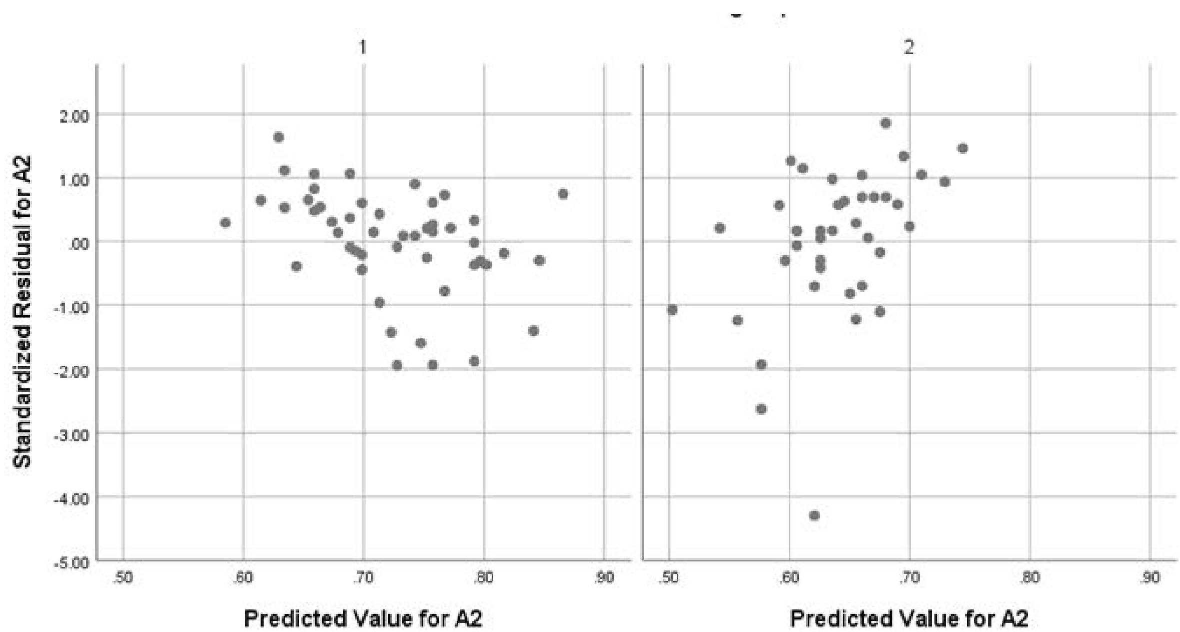

Figure 2. Standardized residuals for A2 by Predicted Value for A2 by control and intervention groups

Assumption 9. The assumption of homogeneity of variances was met with a statistically significant *p*-value greater than .05. The statistical significance was p =.106, as assessed by Levene's test for equality of variances.

Assumption 10. The assumption of no outlying observations was met based on a visual inspection of the standardized residuals, which revealed no significant outliers beyond +-3 standard deviations of the mean. Of the ten assumptions of ANCOVA, eight assumptions were met and two assumptions were violated. Grace-Martin (2020) explained that when using a categorical independent variable and a continuous covariate variable there are sometimes violations within the ANCOVA analysis. Keppel and Wickens (2004) shared violations were also present because analysis was based on observed data of pre-existing groups and not randomized manipulated conditions. Thus, despite violations were accepted and the results of ANCOVA presented.

Analysis of Findings

To address the research question of this study, I conducted an ANCOVA analysis. The research question that guided this study was, after controlling for pretraining competency, to what extent was there a statistically significant difference in the posttraining threat detection competency between security personnel who used the screening tutoring software and those who did not. The null hypothesis was rejected. Findings showed the security personnel who completed the security orientation program using the screening tutoring software (Group 1) scored statistically significantly higher in the posttraining threat detection competency assessment. After adjustment for pretraining, there was a statistically significant difference in posttraining competency between both groups, $F(1, 86) = 30.162$, $p < .05$, partial $\eta 2 = .000$. The detection competency score was statistically significant for the intervention Group 1 (adjusted M =.73) compared to the non-intervention Group 2 (adjusted M =.63). Based on the results of the ANCOVA, the null hypothesis was rejected.

Summary

A nonexperimental quantitative research methodology using archival data compared the threat detection competency scores of security personnel who used the screening tutoring software and those who did not within a corporate training program. The independent variable of this study was a grouping variable and categorized security personnel who used and who did not use the simulation screening tutoring software during orientation training. During the orientation training program, the intervention group used the screening tutoring software. The dependent variable was threat detection competency, which measured performance on the X-Ray CAT assessment after the training. The control variable was the threat detection competency scores of trainees before the training.

The corporation obtained the archival data of the assessment scores from the training program. The dataset consisted of 89 participants who completed the corporate security orientation training program from December 2018 to July 2019: 49 participants who were included in the intervention group and 40 participants who were included in the non-intervention group.

This study employed ANCOVA for analysis of the research question posed by this study, which was after controlling for pretraining competency, to what extent is there a statistically significant difference in the posttraining threat detection competency between security personnel who used the screening tutoring software and those who did not. The results of the analysis revealed that security personnel who completed the security orientation program using the simulation screening tutoring software scored .08 points higher compared with their counterparts who did not. The intervention Group 1 mean score (M = .72) was statistically significant ($p < .05$) and greater than the non-intervention group 2 mean score (M =. 64). Based on the results of the ANCOVA, the null hypothesis was rejected.

In Chapter 5, I discuss the interpretation of the findings from this chapter. I also outline the limitations of the study and provide recommendations for other researchers to build on the findings of this study. I present the implications of this study for individuals, the organization, and society.

Chapter 5: Discussion, Conclusions, and Recommendations

Chapter 5 is divided into six sections. In the first section, I summarize the study, including its purpose. I highlight the interpretation of the findings of this study and its limitations in sections two and three. In the fourth section, I make recommendations for advancement and pursuit of further research in the vital area of threat detection security. I discuss the implications of the study and impetus for social change in section five and offer a conclusion in section six.

Introduction

The purpose of this study was to determine if there was a statistically significant difference in the posttraining competency between security personnel who used the screening tutoring software and those who did not, controlling for pretraining competency. The research question guiding this study was: after controlling for pretraining competency, to what extent was there a statistically significant difference in the posttraining threat detection competency between security personnel who used the screening tutoring software and those who did not? I analyzed archival data from corporate training program sessions held between December 2018 and July 2019.

Interpretation of the Findings

To determine if there was a statistically significant difference between two security personnel training groups' posttraining detection competency scores, controlling for pretraining scores, I conducted a one-way ANCOVA statistical analysis. In this study, the continuous dependent variable was the posttraining threat detection competency scores measured by the X-Ray CAT software; the independent variable was the screening tutoring software, and the control variable was the pretraining detection competency score of trainees. Group 1 completed the corporate training program with additional training using screening tutoring software, while Group 2 completed the training program only. Both groups completed the detection competency assessment at the beginning and the end of the program.

The results of this analysis showed that participants in Group 1, the intervention group, had higher detection competency based on the mean. Group 1's mean score was .72, while Group 2's mean score was .64. The difference of .08 was statistically significant ($p < .05$) and so the null hypothesis was rejected. I calculated an eta square of .000, illustrating the effect size was small. The results of this study found that security personnel who completed the training program using the screening tutoring software scored higher in their posttraining detection scores compared to security personnel who did not use the screening tutoring software.

Based on Green and Swets (1966) signal detection theory which provides a framework for understanding an individual's ability to analyze information and make a decision amidst ambiguous stimuli, the findings of this study support other related studies. Research studies conducted by Hättenschwiler et al. (2015), Hofer et al. (2006), Koller and Schwaninger (2006), Schwaninger (2003), and Schwaninger and Hofer (2004) about detection theory to assess the detection performance of airport security screeners found that detection performance increased for those participants that utilized the online tutoring software.

In addition to supporting the field of studies surrounding detection competency, the findings of this study also support studies completed for educational practices and improvement-for-training practices. The findings of this study align with studies in educational practices by Noe et al. (2014) and Salas, Tannenbaum et al. (2012) which found the use of technology to practice job-related skills result in positive changes in employee performance. The findings of this study also confirm trainee's change in competency found in studies by Boril et al. (2016), Subramaniam et al. (2014), and Taylor (2017) that investigated the use of training tools to simulate workplace performance in a safe training environment.

Limitations of the Study

Several limitations were inherent to this study, including internal and external validity and lack of control over confounding variables. A lack of control over the amount of time participants who were required to complete the simulated X-Ray screening tutoring software intervention, spent in this self-directed activity, limited internal validity. The presence of additional screening exercises availed to trainees during the orientation program influenced internal validity; in addition to the simulation screening tutoring software which was not accounted for. Heale and Twycross (2015) presented these factors as limitations to internal validity and accepted as limitations to the study.

External validity was limited due to a lack of random sampling, the moderate number of participants in the study, and the relative time-period used to conduct the study. Hiring practices by the different cruise companies of the corporation were not controlled for. Newly hired trainees enter orientation with various levels of security experience. The ANCOVA procedures used accounted for pretest differences (Heale & Twycross, 2015). Confounding variables were not controlled for and may have included previous work experience performing screening tasks on X-ray machines.

Recommendations

The validation of the use of the online screening tutoring software to support security personnel's screening competency before they join the ship is important to explore further. The findings of this study provide valuable information for developing and measuring threat detection competency of security personnel. In their continuous quest to maintain security and safety of passengers on board their vessels, the maritime industry and cruise companies may gain insight from this study. In addition, individuals and organizations responsible for developing the learning experience for security personnel may benefit from this study. The essential investment in training programs to maintain and increase employees' knowledge and skills (Anderson, 2014; Noe et al., 2014; Senge, 2013) will benefit by further experimental, correlational, and mixed-methods studies.

A limitation of this study was the inability to control for variables and conduct a true experimental research design using random assignment of participants into control and intervention groups. I recommend conducting experimental studies to measure differences between organizational groups in the cruise industry that currently use simulation software to train their employees in detection competency. Experimental studies would yield the most scientifically valid evidence (MacMillan & Schumacher, 2010).

Another limitation of this study was the lack of consideration for years of experience in screening as a covariate. Considering years of experience may make a difference in competency outcomes, as was the case in two previous studies by Hättenschwiler et al. (2015) and Schwaninger and Hofer (2004). Experience is an important factor in regard to competency (Kirkpatrick & Kirkpatrick, 2005). Furthermore, other demographic characteristics might influence competency training outcomes, and so it is recommended to account for pertinent variables in further research.

Studying the impact of a combination of threat detection training and assessment techniques to reach security personnel threat detection performance outcomes would best be done using mixed-methods research (Sterchi et al., 2019). Using a variety of training techniques was recommended to maximize learning by Salas, Tannenbaum, et al. (2012) and Noe et al. (2014). Both quantitative and qualitative data might best inform the best combinations of different types of training. Qualitative data would perhaps provide the narrative to explain differences in types of quantitative competency outcomes not accounted for by years of experiences and demographic characteristics.

This study was also limited in terms of time. I recommend conducting a longitudinal study to track detection performance from orientation through the first two years of employment. A longitudinal study may allow researchers better understand any changes in detection performance of security personnel and help convince executive leaders in the travel industry that performing screening tasks with simulation software in a risk-averse environment provides learners with proven tools that promote the transferability of learning threat detection skills to the workplace (Hughes, Zajac, Woods, et al., 2020). The findings from this study may provide business stakeholders with the data needed to make decisions about training budgets, enhanced performance standards, and continuous development for security personnel.

The investment in technology provides ongoing practice and performance assessments to support learning and promote mastery for workplace performance (Noe et al., 2014). The investment in future studies about emerging simulation software may continue to inform cruise companies and training institutions that develop and deliver security training curricula. With transportation security risks constantly changing and of increasing concern, training transportation security personnel to proactively identify threats and risks is vital to the safety of travelers aboard transportation vessels.

Implications

Understanding how the simulation screening software impacts the screening performance of cruise security personnel in the orientation training program is critical for future discussions surrounding this topic throughout the cruise industry. The findings of this comparative study may have a positive social change impact for passenger cruise ship security personnel who complete the program. It may provide insight for security departments of cruise companies, whose training administrators are responsible for developing the competency of their team members. The findings may also provide insight for training institutions that are developing and offering security training for those employed by cruise companies.

For security personnel, knowing that the use of the screening tutoring system during an orientation program improves detection competency may provide motivation and inspire commitment to use the software and foster greater on training security personnel in the threat detection competency. The security personnel may use the tool for longer periods to practice threat detection. Because the tool provides self-awareness for security personnel, each person may set higher levels of personal performance standards. The ongoing training of this skill during orientation may give security personnel greater confidence to apply the skill at work. Higher detection competency may help security personnel make faster screening decisions when at work onboard cruise ships with the potential to save lives.

At the company level, the findings of this study provide greater visibility into the screening performance of security personnel who used the screening software within the program and personnel who did not. The information may inform the cruise companies in their decision to implement the screening simulation software for all participants who attend the program. This decision may foster other related changes within the company, including program structure adjustments, to ensure threat detection practice with the software is built into the program and allocate appropriate funding. In addition to implementing the software within the orientation program, the company can also decide to implement the software for existing security personnel as an ongoing professional development resource tool. Lastly, the findings of this study may influence hiring and performance standards for security departments across the corporation.

This study also has implications for security training institutions and the cruise industry overall. Training institutions that develop and offer industry certified security training may consider the incorporation of the detection competency assessment software to measure threat detection at the beginning of the program or to support ongoing learning throughout the programs they offer. The improvement of cruise industry security personnel detection competency aligns with studies in other industries conducted to measure security personnel detection training.

This study may lead to deeper discussions among industry experts during conferences and workshops. Those responsible for setting industry standards may be interested in establishing further studies around this topic to promote universal understanding and inspire risk assessment. The study may spark interest and exploration of using simulated threat detection tutoring in other environments such as manning agencies for security personnel to maintain knowledge and competency. Ultimately, this study may lead to new standards for security personnel training to ensure working competency throughout the maritime industry.

Conclusion

As the threat to transportation safety continues to change, security personnel must be equipped with the knowledge and skills to detect threats while screening passenger bags. As with the airline industry, the cruise industry already requires training for security personnel at a certain level of competency. However, the inclusion of a simulated x-ray screening tutoring software and a detection assessment tool (X-Ray CAT) to an orientation training program for some participants provided the opportunity to investigate the impact of the simulation tutoring software on participants' detection competency. The purpose of this study was to determine if there was a statistically significant difference in the posttraining competency between security personnel who used the screening tutoring software and those who did not, controlling for pretraining competency.

After conducting an ANCOVA analysis of the archival data of the 89 participants (Group 1= 55% and Group 2 = 45%) who completed the orientation program, the result of this study shows that there was a statistically significant difference in posttraining competency between the two groups. The results showed that the posttraining detection competency scores of security personnel who used the screening tutoring software during the orientation program scored higher than security personnel who did not use the screening tutoring software.

The study highlights the positive impact of detection tutoring software on the detection competency of newly hired security personnel in the cruise industry. The study confirms studies conducted in other industries. Study results compel assessing and training security personnel within the cruise industry on threat detection using simulation. Improved threat detection can be beneficial for passengers, cruise vessels, and cruise companies. Better threat detection yields higher accuracy of hit rates (identifying actual threats) and lower false alarm rates (incorrect threat identification), and would result in safer travel throughout the cruise industry.

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