AIR TRAFFIC CONTROL SPECIALISTS' PERCEPTIONS OF SIMULATION FOR DEVELOPING JOB-RELATED COMPETENCIES

by

Colin Alwin Harris

EdS, The University of West Florida, 2018

MS, Troy University, 2010

BS, Excelsior College, 2008

A dissertation submitted to the Department of Instructional Design and Technology

in partial fulfillment of the requirements for the degree of

Doctor of Education

THE UNIVERSITY OF WEST FLORIDA

COLLEGE OF EDUCATION AND PROFESSIONAL STUDIES

December, 2021

The dissertation of Colin Alwin Harris, titled Air Traffic Control Specialists' Perceptions of Simulation for Developing Job-Related Competencies, is approved:

Minkyoung Kim, PhD, Committee Member

Byron Havard, PhD, Committee Member

Mark Malisa, PhD, Committee Chair

Accepted for Department of Instructional Design and Technology:

Nancy B. Hastings, PhD, Chair

Accepted for College of Education and Professional Studies:

William Crawley, PhD, Dean

Accepted for the University of West Florida:

Kuiyuan Li, PhD, Dean, Graduate School

Dedication

I dedicate this dissertation to my brilliant and outrageously loving and supportive wife, Jaclyn, my exuberant, sweet, and kind-hearted daughter, Damishana, my always encouraging siblings, Gregory, Cloyette, Ray, and Rawley, my ever-loving and faithful mother, Vivyenne, and in the memory of my father, Lennox, and brother, Lennox Jr.

Acknowledgments

I want to express my deepest gratitude to my dissertation committee, Dr. Mark Malisa, Dr. Byron Havard, and Dr. Minkyoung Kim, for their guidance, support, and constructive feedback throughout this doctoral journey. Thank you, Dr. Francis Godwyll, for sharing your time and expertise on the dissertation writing process with me. Your guidance has been valuable in the completion of this manuscript. I would also like to acknowledge Lee Parshook, DeAndre Lewis, and Damishana Harris for providing subject matter expertise on this research endeavor. I want to extend a special thank you to the five anonymous participants for agreeing to participate in this study. I also want to acknowledge the support staff's help in answering my inquiries and for helping me retrieve important reference material. I am grateful to my wife Jaclyn for encouraging me to complete this manuscript.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Abstract

Inexperienced and poorly trained Air Traffic Control Specialists (ATCSs) contribute to aircraft accidents and other serious aviation mishaps, which negatively impact human safety, the environment, government and personal property, and the efficient and smooth operation of the National Airspace System (NAS). The Federal Aviation Administration (FAA) can help remedy this problem by ensuring that ATCSs receive academic and simulator competency-based training. The purpose of this qualitative exploratory case study was to understand how ATCSs at an air traffic facility in the southeastern region of the United States (U.S.) described their experiences with the ATCoach simulation training (ATCoach) in developing job-related competencies. I employed Bloom et al.'s (1956) taxonomy of the cognitive domain and its six classifications (knowledge, comprehension, application, analysis, synthesis, and evaluation) to frame and align the study's research questions and interview questions to determine if five ATCSs perceived simulation as a valuable instructional method. Participants revealed that the ATCoach experiences is a valuable instructional method for enhancing ATC professionals' knowledge and skill levels by preparing them to transfer previous knowledge to practice in day-to-day ATC operations and improve their judgment, critical thinking, and decision-making skills—not their self-confidence. However, the simulator's physical fidelity limitations had an adverse influence on participants' learning experience. The findings, therefore, indicate ATC knowledge does not necessarily occur during the ATCoach but instead during previous classroom learning or experience. Future research should evaluate the entire ATC training program taking a learner from Certified Professional Controllers in Training (CPC-IT) status to Certified Professional Controllers (CPC).

Chapter 1: Introduction

The Federal Aviation Administration (FAA), a subsidiary entity under the umbrella of the United States (U.S.) Department of Transportation (DOT), is the authority responsible for the safety of civil aviation and the traveling public (FAA, 2017a). According to the FAA (2017b), on a single day, an average of 2,246,000 passengers fly throughout the United States National Airspace System (NAS). Aviation safety is the highest priority of the FAA as it manages the United States NAS. The U.S. Congress, DOT, National Weather Service (NWS), National Aeronautics and Space Administration (NASA), and United States National Transportation Safety Board (USNTSB), as well as other federal agencies and stakeholders, influence the day-to-day management and safety mechanism of the NAS (Ray, 1999). Still, air traffic control (ATC) safety largely falls on the shoulders of the FAA's Air Traffic Control Specialist (ATCS). The ATCS job category is highly technical, specialized, and safety-centric. As a result, the FAA has established professional training programs to ensure that ATCSs have the knowledge, performance skills, judgment, critical thinking skills, and self-confidence necessary to apply air traffic procedures safely and efficiently (Buck & Pierce, 2018). A significant portion of the FAA's air traffic control (ATC) training is delivered via simulation instruction. Over the years, the FAA has adopted scenario-based simulation to provide training to new Developmental ATCSs (DEVs) and Certified Professional Controllers in Training (CPC-IT). To maintain proficiency (often as a means of recertification) in their craft, experienced ATCSs participate on a recurring or remedial basis in some form of ATC simulation training activity. The scope of instruction is guided by the type and configuration of the ATC facility, the facility level, and the surrounding airspace and airport terrain. The simulation training is also oriented towards the level of expertise and the previous experience of each ATCS.

The problem is that in the United States, there is an alarming number of reported incidents where ATCSs' mistakes contributed to planes flying dangerously close to each other, narrowly evading catastrophic disasters (Mohammed Amin, 2015; USNTSB, 2016b). In 2018, 269 pilots reported being involved in a near midair collision (Bureau of Transportation Statistics [BTS], 2019b). For example, on July 7, 2015, two planes collided in the sky over Moncks Corner, South Carolina, killing the Cessna pilot and passengers (USNTSB, 2016a). On August 16, 2015, another fatal midair collision occurred over San Diego, California, killing five people (USNTSB, 2016a). The reports prepared by the USNTSB (2016a, 2016b) indicated that ATC judgment errors were the primary contributing factor. The USNTSB (2016b) found that many ATCSs are under-trained and inexperienced. Inexperienced and poorly trained ATCSs contribute to aircraft accidents, near-collisions (near misses), and other serious aviation mishaps. Consequently, the USNTSB (2016b) offered safety recommendations to the FAA, indicating that ATCSs should receive academic and simulator competency-based training to develop their skills, situational awareness, and judgment so that they may adequately assist pilots.

The purpose of this qualitative exploratory case study was to understand how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach simulation training (ATCoach) in developing job-related competencies. I explored ATCSs' perceptions of scenario-based simulation and the extent to which they perceived simulation as a valuable instructional method for enhancing ATC knowledge, performance skills, judgment, critical thinking skills, and self-confidence at an ATC facility in the southeastern region of the United States.

The findings of this study were organized around the overarching research question and the six subordinate questions. This study is significant because the findings contribute to scholarly research and literature, improve future practice and research, and improve policy and decision-making. The study's findings contribute to scholarly research and literature by (a) contributing to the existing body of knowledge relating to aviation simulation education, (b) adding to the body of knowledge on the value and effectiveness of simulation technology in the development of ATCSs' job-related competencies needed to operate safely in the terminal ATC environment, and (c) providing valuable information about Bloom's taxonomy by adding suggestive evidence concerning the link between learners' participation in experience-based education and their learning outcomes.

The study's findings will improve future practice and research by (a) highlighting the role of simulation technology in the development of air traffic competencies that could improve the level of training and the number of experienced ATCS while improving air traffic safety, (b) providing future investigators with critical data to improve their data collection efforts by employing the combination of life-like scenario-based simulation training with open-ended interviews, and (c) presenting a well-designed evidence-based study that leaders in the field of air traffic could generalize the findings to the larger air traffic population (Blaikie, 2009; Creswell, 2015).

The study's findings contribute to policy and decision-making by (a) providing decision makers in the education sector with critical data that they could use on a global scale to evaluate policies, (b) informing policies on the qualifications necessary for new ATC hires that utilize simulation to evaluate newly hired ATCSs at the FAA Academy, and (c) providing FAA official with critical data of the shortcomings and strengths of simulation training, thereby helping them think about ways to organize instruction to give decision makers time to focus on areas most essential to achieve positive educational outcomes.

This chapter presents an introduction to the research study. First, an explanation is provided on this research project's background and context, including the research problem and the study's purpose. I briefly introduce Bloom's taxonomy as the study's conceptual framework (Bloom et al., 1956), focusing on the cognitive domain and explaining why I chose a qualitative exploratory case study methodology for this research. I then present the research questions and the assumptions of the study. I explain the delimitations and limitations that frame this study. I then offer the significance of this study to research, practice, teaching, and policy in the field of ATC. I offer key definitions relevant throughout the study before ending the chapter with the organization of the study followed by the chapter summary.

Background and Contextualization of the Issue

This study investigated how well the use of the ATCoach radar simulator provides trainee ATCSs with the experience to develop the ATC job-related competencies (knowledge, performance skills, judgment, critical thinking skills, and self-confidence) needed to operate safely in the real air traffic environment. Instructional simulation is a critical component of the education community within the United States, with a dominant presence in disciplines like medicine and aviation that require learners to acquire practical skills and theoretical knowledge (Lateef, 2010). It can be argued that simulation training will never supersede real-time live training (Federal Aviation Advisory Committee [FAAC], 2018). However, the ability to selectively mimic numerous flight conditions in a single sitting is a key advantage of simulation training. Other reasons have been presented about why simulators are essential. For example, Jentsch et al. (2011) noted that simulators are beneficial because they are realistic, safe, economical, and flexible, and offer learner convenience. Instructional simulation is essential because there has been a proven positive correlation between instructional simulation and the enhancement of performance in several disciplines. If the FAA's Air Traffic Organization (ATO) is to improve aviation safety with well-trained and experienced ATCSs, training practitioners need to develop their ATC job-related competencies. One way to enhance these competencies is by ensuring that ATC trainees undergo evidence-based simulation training (USNTSB, 2016b).

The FAA currently utilizes scenario-based simulation to train ATCSs to perform the duties necessary to direct and manage traffic in the real air traffic environment. Still, inadequate empirical evidence exists relating to the value of using simulation technology to provide ATCSs with the experience to develop the competencies necessary to conduct safe air traffic operations (Mercer, 2015). The main reasons for the lack of substantive effort to identify the true value of simulation training in ATC education are (a) it is difficult to evaluate the impact of simulation training (Hays, 2006) and (b) assessing training in an organizational environment receives little attention (Jentsch et al., 2011; Noe, 1986). This research study adds to previous findings on simulation in the aviation industry by exploring ATCSs' perceptions of the value of simulators in helping them to acquire the skills necessary to navigate in the real-world setting.

A substantial amount of research has shown a positive correlation between simulation technology and the enhancement of these five job-related competencies (e.g., Bauer, 2005; Cox, 2010; Lindenfeld, 2016; McDermott, 2005; Van Eck et al., 2015; Zhang, 2016). From an ATC safety perspective, the FAA should strive to provide ATCSs with academic and simulator competency-based training that would develop their skills, situational awareness, and judgment so that they may adequately assist pilots with navigating through the NAS (Alinier, 2013; Buck & Pierce, 2018; USNTSB, 2016b). As will be discussed further, many ATCSs have received inadequate or inaccurate simulation training, increasing the likelihood of midair collisions and aviation-related fatalities (USNTSB, 2016b). Understanding the experiences of ATCSs who participate in simulation training can inform aviation education to improve public safety and the well-being of the NAS.

As discussed fully in Chapter 2, the use of simulation technology for training and development has been a practice prominent in the aviation industry for almost a century (Dekker et al., 2016; Mavin & Murray, 2010). Since Edwin Link created them in 1929 (Jones et al., 2015; Lee, 2017; Link, 1929), instructional simulators have significantly evolved. Also, instructional simulators' evolution has advanced the scope of education and training related to aviation science and technology. For decades, several industries have used simulation technology to administer quality training to their stakeholders (Hays, 2006). The United States military has utilized virtual reality (VR) simulators to enhance pilot training (Ennis, 2009). Similarly, many major airlines rely heavily on simulators to improve their pilots' basic flying skills (Ghosh, 2015). Educational institutions such as Embry Riddle Aeronautical University (ERAU) and Arizona State University have many robust flight simulation and training devices available to their learning communities (ERAU, 2018; Zhang, 2016). According to Allerton (2010) and Lee (2017), simulation has significantly increased the safety of the flying public by increasing the rate by which aircraft pilots generally complete their professional development training.

In the FAA, the ATO utilizes instructional simulators in a different context. The ATO's focus is on enhancing the capabilities of the ATCS instead of the pilot. However, the fundamental purpose of simulators remains unchanged. This means that simulators are used to forecast performance in a training setting before operating on a live system (Ghosh, 2015). The benefits of using simulation technology for aviation training are that simulators are "realistic, safe, cost-effective, and flexible" (Jentsch et al., 2011, p. 197). Though there are obvious benefits to instructional simulators, the research carried out thus far on the aviation industry has significantly underrepresented a critical component of the aviation community—the ATC function (Lee, 2017). In many instances, researchers did not perform any formal assessment of air traffic training or curriculum (Lee, 2017). For example, there is no adequate analysis of the value or effectiveness of ATC simulation on ATC readiness (Dow, 2015; Mercer, 2015). Also, the effect of the level of simulation training on the acquisition of air traffic job-related skills, knowledge, performance skills, judgment, critical thinking skills, and self-confidence is unclear (Salden et al., 2006). The reviewed literature also failed to address the use of simulation training in an ATC terminal radar approach environment (Dow, 2015; Koskela & Palukka, 2011; Mollard et al., 2000; Thomas et al., 2001; Updegrove & Jafer, 2017). Several current studies can be found on the topic of aviation training and risk management (Jensen, 2017), facilitation (Dismukes & Smith, 2017), and the learning environment (Lee, 2017). However, there is a lack of simulation assessment, which may be due to added restrictions for researchers accessing government facilities, personnel, and resources (Merriam & Tisdell, 2016; United States Government Accountability Office, 2019). Nonetheless, there were many studies on the implementation and success of instructional simulation in aviation training programs (e.g., Bauer, 2005; Cox, 2010; McDermott, 2005). Bauer (2005), Cox (2010), and McDermott (2005) identified a positive correlation between simulation technology and skills enhancement. Bauer (2005) found that one can attribute learning to the physical characteristics of the pilot simulation. McDermott (2005) sought to find evidence that showed the effects of flight simulation on the proficiency of pilots. McDermott (2005) found that pilots' mental and physical reactions are realistically duplicated when exposed to aviation instructional simulation.

Despite its advantages and popularity in the aviation field, prior evaluation of the usefulness of computer-generated, scenario-based simulation on ATC job-related competencies is not completely defined or understood (Cox, 2010; Gheorghiu, 2013). A review of the current scholarly literature revealed that much remains to be learned about the appropriate use of simulation technology in ATC education. Also lacking in previous investigations was the comparison of the various air traffic simulators and simulation technology currently in service. A study by Updegrove and Jafer (2017) investigated the ATC simulation training programs at the Mike Monroney Aeronautical Center in Oklahoma City (FAA Academy) to identify how simulation technology can be improved. However, the simulation programs at the FAA Academy are intended to develop basic ATC skills such as "air traffic academics, part-task training, and skills-building" (Updegrove & Jafer, 2017, p. 2). In this study, the simulator under investigation was used for ATC radar certification in the terminal environment.

In addition, researchers working in this field do not universally agree on a positive correlation between simulation training and learning, thus leaving it necessary to prove the educational value of simulators. Jentsch et al. (2011) found that simulation technology has long superseded aviation training. Jentsch et al. concluded that there is over dependency and misuse of high-fidelity simulations to enhance complex skills used in the aviation industry. Jentsch et al. (2011) inferred that simulation is only a tool that helps in the enhancement of skills and therefore does not guarantee learning outcomes. Ennis (2009) professed that simulation is not used to teach but rather closely replicate or simulate the experience. Because this current study was conducted on the FAA's use of computer-generated, scenario-based simulation in ATC training, this research addressed these assumptions and contributed to the gap in the research relating to aviation instructional simulation.

How training is designed and presented can affect a recipient's experience (Northup, 2018) and, therefore, may influence the outcome of simulation-related training. According to

Caro (1971), instructional design is a more substantial contributing factor to training success than simulation attributes. I aimed to understand ATCSs' perceptions of the ATCoach and if they believed it was a valuable method of providing the experience to develop their ATC job-related competencies needed to perform safe operations in the real air traffic environment.

Problem Statement

The real air traffic environment can be unpredictable regarding controlling aircraft. The NAS is often impaired by unusual or emergencies such as temperamental weather conditions, unforeseen aircraft mechanical failure, air-to-ground radio communication failure between ATCS and pilot, and loss of visual ATC display capabilities (Fultz, 2015). These types of situations can render devastating circumstances for the general public. A single disruption to the NAS can result in thousands of flight cancellations (Hanson, 2015; Tokadli et al., 2016). Additionally, aircraft accidents and incidents can render catastrophic human, environmental, ecological, and economic implications such as groundwater and soil contamination from dumping fuel during an aircraft emergency; damages to private property and businesses; loss of life from aircraft accidents; and social panic caused by aircraft accidents resulting in economic impact (Dabney & Brent, 1993; Fultz, 2015; Learmount, 2019).

Controlling planes in the real air traffic environment requires an adaptive workforce of highly trained ATC professionals. The FAA should equip ATCSs with the tools necessary to exercise critical thinking, situational awareness, and judgment when addressing the consequences related to air traffic emergencies. Research has also found that an alarming number of errors and mistakes are made by ATCSs each year, prompting official review (Mohammed Amin, 2015). Previous investigators concluded that some ATCSs lack the critical ATC job-related competencies of exercising the best judgment when managing aircraft (USNTSB, 2016b).

Furthermore, some ATCSs have an incomplete understanding of specific air traffic procedures (USNTSB, 2016b). This deficiency in readiness is an attribute of inadequate or inaccurate academic and simulator competency-based training (USNTSB, 2016b).

It is essential to fully understand the value of air traffic instructional simulation because simulators play a pivotal role in training ATCSs in the FAA. The ATCSs receive some form of simulator competency-based training to develop their job-related competencies so that they may adequately assist pilots (USNTSB, 2016b). Allowing poorly trained and inexperienced ATCSs to control aircraft poses a safety risk to the NAS. The value of using a scenario-based simulator to provide ATCSs with the experience to develop the ATC job-related competencies necessary to operate safely in the real air traffic environment is uncertain (Salden et al., 2006; Updegrove & Jafer, 2017). There are some previous studies on the value of simulation in ATC training (Updegrove & Jafer, 2017). However, no studies have included the training of ATCSs in a terminal radar approach setting.

The FAA is responsible for the flying public's safety as they travel through the NAS to their destinations (United States Congress, 2006). The American public trusts that the FAA's ATCSs will competently manage their flights by providing accurate directions to aircraft pilots. Still, there is an alarming number of reported incidents where ATCSs' mistakes contributed to planes flying dangerously close to each other, narrowly evading catastrophic disasters (Mohammed Amin, 2015; USNTSB, 2016b). In 2018, 269 pilots reported being involved in a near midair collision (Bureau of Transportation Statistics [BTS], 2019b). There were also occasions when ATC errors resulted in fatalities. For example, on July 7, 2015, two planes (Cessna 150M, N3601V, and Lockheed Martin F-16CM US Air Force Jet) collided in the sky over Moncks Corner, South Carolina, killing the Cessna pilot and passengers (USNTSB, 2016a).

The final investigation report prepared by the USNTSB (2016b) indicated that ATC judgment errors were the primary contributing factor. The following month, on August 16, 2015, another fatal midair collision occurred (Cessna 172M, N1285U and North American Rockwell NA265-60SC Sabreliner, N442RM) over San Diego, California, killing five people (USNTSB, 2016a). The USNTSB (2016b) found that ATC incorrectly instructed both pilots, putting the airplanes on a collision course. In the past 5 years, the NAS has grown in complexity and scale. For instance, the United States BTS (2019a) reported that in 2018, 778 million domestic passengers traveled through the NAS. This number is a 4.9% increase in a single year—from 2017 to 2018. The increase in complexity, scale, number of planes, and number of passengers also increases the likelihood of midair collisions and fatality rates (BTS, 2019a). Also, there is a narrow margin for error when controlling traffic throughout the NAS (Radisic et al., 2020). A simple mistake can put the lives of the flying public in jeopardy (Withers, 1986). For instance, if two Airbus A380s were to collide in midair, it could render devastating consequences for passengers, putting approximately 1000 passengers' lives at risk. Consequently, ATCSs must be trained to manage air traffic under conditions of similar size and complexity. However, the safety risks of training in a live setting are too high to mitigate. For example, a training mishap during live operations could result in aircraft collisions and ultimately result in passenger fatalities.

The relevance and significance of this study lie in the fact that the FAA must provide the highest level of training to its ATC personnel. Studies by Treiber (1994) and Maldonado (2009) indicated the significance of this study. Both pieces of research revealed that ATCSs have one of the most stressful jobs in the nation. In addition to the stressors of the job, many of ATCSs are also inadequately trained and inexperienced (USNTSB, 2016b). The stressful nature of ATC, inexperience, and inadequate training are all factors that can increase the likelihood of human error (Maldonado, 2009; Treiber, 1994; USNTSB, 2016b). Compromising passenger safety and loss of human life are against the primary function of the FAA, which is maintaining the safety of the flying public. Therefore, it is the responsibility of ATCSs to mitigate aircraft accidents and other aviation mishaps (United States Congress, 2006). The USNTSB has attributed inadequate or inaccurate air traffic instruction, inexperience, and inattention as some common reasons for aircraft incidents. A central report published by the USNTSB (2016b) offered safety recommendations to the FAA, indicating that ATCSs should receive academic and simulator competency-based training to develop their skills, situational awareness, and judgment so that they may adequately assist pilots. Allowing inexperienced and poorly trained ATCS to direct aircraft can ultimately lead to compromised passenger safety. Facing such an overwhelming need for competent and qualified ATCSs, the FAA has relied on simulation technology to facilitate ATC students in developing their ATC job-related competencies. Providing ATC trainees with the theoretical knowledge necessary to comprehend ATC operations can be adopted as the standard to inspire competence. In conjunction with having solid theoretical knowledge, ATC trainees must be able to apply practical ATC concepts effectively.

Competent ATCSs can translate theoretical knowledge into practical, usable action. They can effectively manage routine air traffic while also recognizing aircraft emergencies and making accurate decisions based on the situation surrounding the incident. Inexperienced and poorly trained ATCSs can contribute to aircraft accidents and other aviation mishaps by providing inaccurate information or by not understanding the implications of specific emergencies. The USNTSB (2016b) found that some ATCSs have an incomplete understanding of specific aircraft emergencies due to a lack of participation in evidence-based simulation training before controlling live air traffic. For example, the ATCSs at the Hugheston ATC facility in West

Virginia told the USNTSB (2016b) that they could not remember the particulars about the emergency handling training. The ATCSs at the New Smyrna Beach ATC facility in Florida indicated to the USNTSB that they “did not recall receiving the evidence-based simulation training on emergencies as required by FAA Order JO 3120.4” (USNTSB, 2016b, p. 6). Similarly, the ATCSs at the Palm Coast ATC facility in Florida did not prescribe to all the required provisions outlined in the “FAA Order 7110.65, paragraphs 10-1-1 and 10-1-2” outlining proper emergency handlining procedures (USNTSB, 2016b, p. 6). Finally, the ATCSs at the Parkton ATC facility in North Carolina indicated they received inadequate information on handling emergencies effectively. They also noted that their training did not include “emergencies, unusual situations, or aircraft systems” (USNTSB, 2016b, p. 6). The Parkton ATCSs also acknowledged not fully understanding certain aircraft malfunctions and the implications (USNTSB, 2016b). The objective of using simulation technology is to help ATC students develop their ATC job-related competencies (Alinier, 2013). However, the reviewed literature has shown that the impact of simulation training on accomplishing this objective is unclear.

In investigating ATCSs’ perceptions of the ATCoach, I focused on how participants perceive the simulator helps in transferring the acquired knowledge, performance skills, judgment, critical thinking skills, and self-confidence to the real air traffic environment. The specific problem under investigation was determining how well the ATCoach equips CPC-IT with the ATC job-related competencies needed to perform air traffic operations (Dow, 2015; Gheorghiu, 2013). Simulation training has been suggested as an alternative approach to alleviate the safety problems of allowing students to practice ATC procedures in environments where human lives are at risk or physical equipment is unavailable (Hamel & Jategaonkar, 2017;

Lateef, 2010; Lawson et al., 2018; Wilson & Rockstraw, 2012; Wolf, 2010). In this study, I used Bloom's taxonomy as the conceptual framework to explore the extent to which simulation is perceived by ATCSs as a valuable instructional method for developing their ATC job-related competencies needed to perform safe operations in the real air traffic environment.

Purpose Statement

The purpose of this qualitative exploratory case study was to understand how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies.

Overview of Conceptual Framework and Methodology

This section provides a brief overview of Bloom's taxonomy of the cognitive domain used in this study to underpin the evaluation of ATC simulation training's value. This section also provides an overview of the qualitative method used in this exploratory case study.

Overview of Conceptual Framework

Benjamin Bloom is an author, scholar, researcher, and education psychologist known in the education community for his contributions to the area of learning and development, specifically, the creation of Bloom's taxonomy. In the 1950s, Bloom chaired a committee of educational practitioners from around the United States who collaborated to create the original version of Bloom's taxonomy (Bloom et al., 1956). Bloom's work was motivated by the desire to create a means of sharing educational practices. Bloom et al. (1956) embraced the idea that the committee could create a system of classifying learning goals and objectives. The committee crafted the model with high school level learners in mind with the intention of defining and distinguishing cognition in learners to facilitate critical thinking and comprehension (Forehand, 2005). Bloom et al. (1956) wanted to create a system to help educational practitioners design curriculum and evaluate learners.

In 1956, the committee proposed and published the first of three critical publications to codify how learners act, think, and feel relating to educational instruction. The three works are known today as learning domains in Bloom's taxonomy, including cognitive, affective, and psychomotor. Each of the three domains has a classification within itself (Bloom et al., 1956; Krathwohl, 2002). The cognitive domain, the first handbook, has been used as a framework for designing, structuring, and sequencing courses, entire degree programs, lectures, seminars, learning objects, and curriculum (Darlington & Bowyer, 2017). The cognitive domain is the knowledge-based domain that consists of six categories (or levels) of learning that focuses on learners' intellectual abilities: comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956). Krathwohl (2002) detailed the rationale for creating the original taxonomy. He stated that the taxonomy was created to "serve as a common language about learning goals to facilitate communication across persons, subject matter, and grade levels" (p. 212). Bloom believed that learning should occur incrementally and hierarchically (from easy to difficult) through the six categories of learning. These six knowledge categories were crafted to help organize the learning objectives, activities, and assessments to be applicable in different educational settings (Krathwohl, 2002). The six levels of classification under the original cognitive domain of Bloom et al. (1956) are discussed further in this section when highlighting the specific domain used as the conceptual framework of this study.

Since its creation, the model has undergone several minor modifications by Bloom and his colleagues (e.g., Anderson & Krathwohl, 2001; Krathwohl, 2002; Krathwohl et al., 1964). In 1964, Bloom et al.'s committee made the first set of modifications to the taxonomy. In 1964, the committee published the modified taxonomy called *Handbook II: Affective*. This second publication focused on the educational objectives for the affective domain. The affective domain is the attitudinal-based domain that consists of five categories of learning: receiving, responding, valuing, organization, and characterization (Krathwohl, 2002). These five categories focus on how a learner develops "attitudes, emotions, interests, motivation, self-efficacy, and values" (Schroeder & Cahoy, 2010, p. 129).

Like the cognitive domain, the categories outlined in the affective domain are also presented in a hierarchical manner in terms of lowest feelings to the most complex (Krathwohl, 2002). The receiving category is positioned at the lowest level of the affective domain. The level focuses on the reality that learners possess different attributes, ideas, and ideologies that should be considered and tolerated (Krathwohl et al., 1964). The responding level of the affective domain suggests that one should be predisposed to responding to the different attributes, ideas, and ideologies of others (Krathwohl et al., 1964). The third category, valuing level, of the affective domain states that an individual should be inclined to value the different attributes, ideas, and ideologies of others (Krathwohl et al., 1964). The organization category is positioned at the fourth level of the affective domain. This level focuses on the idea that individuals have their own values, philosophical assumptions, and worldviews that affect how they organize their thought processes (Krathwohl et al., 1964). Lastly, characterization is the fifth and highest level of the affective domain. This level builds upon the organization category that focuses on the idea that learners will act consistently in accordance with their values, their philosophical assumptions, and worldviews (Krathwohl et al., 1964).

In 2001, 45 years after it was initially published, a revision of Bloom's taxonomy was introduced. This revision credited authors Simpson (1966) and Harrow (1972) for providing the building blocks for what is known today as the psychomotor domain (Anderson & Krathwohl, 2001). The psychomotor domain addresses learners' physical abilities, such as basic motor skills, coordination, physical movement, speech development, and reading (Earle, 1981). The categories outlined in this domain are basic fundamental movement, reflex movements, perceptual, skilled, physical activities, and body language (Harrow, 1972). Simpson (1966) established the psychomotor domain consists of seven categories of behavior presented hierarchically from simple to complex. The seven categories include (a) perception, (b) set, (c) guided response, (d) mechanism, (e) complex overt response, (d) adaptation, and (f) origination.

The perception category is positioned at the lowest level of the psychomotor domain. Simpson (1966) stated that perception is a process where an individual "realized objects, qualities or relations by way of the sense organs" (p. 25). The perception category is divided into three subcategories: sensory stimulation, cue selection, and translation (Simpson, 1966). The set level of the psychomotor domain is described by Simpson (1966) as the stage before an individual engages in a particular act. This is a process of mental, physical, and emotional preparedness (Simpson, 1966). The guided response level of the psychomotor domain represents the first process an individual undergoes in developing complex skills (Simpson, 1966). The mechanism category is positioned at the fourth level of the psychomotor domain. This level focuses on the idea that complex skills are learned through repetition, and then it becomes habitual (Simpson, 1966). The complex overt response is the fifth level of the psychomotor domain, where learners develop a high skill level and can perform complex tasks with certainty and persistence (Simpson, 1966). Adaptation is the next level of the psychomotor domain. According to Simpson (1966), learners at the adaptation level are developed and, therefore, can modify certain required actions. Originate is the next level of the psychomotor domain that states learners develop new solutions to solving complex problems (Simpson, 1966).

In addition to incorporating psychomotor learning into Bloom's taxonomy, Anderson and Krathwohl (2001) revised the six categories of Bloom's taxonomy of cognitive domain by classifying the nouns with verbs to reflect how they are used in objectives (Krathwohl, 2002). The remember category is positioned at the lowest level of the revised version of Bloom's taxonomy of the cognitive domain and correlates with the knowledge level of the original taxonomy. Anderson and Krathwohl (2001) replaced the noun "knowledge" with the verb "remember" on the basis that learners are "expected to recall and recognize knowledge" (p. 213). Similarly, the comprehension level of the original taxonomy was revised and classified as the verb "understand" because, according to Anderson and Krathwohl (2001), learners are expected to understand knowledge and how to use information. Anderson and Krathwohl (2001) amended the application level of the original cognitive domain by replacing the noun with the verb "apply." This third level states that learners take the knowledge learned and apply it to new situations and carry out new procedures (Anderson & Krathwohl, 2001). The analyze category is positioned at the fourth level of the revised cognitive domain. Anderson and Krathwohl (2001) replaced the noun "analysis" with the verb "analyze" on the idea that learners are expected to skillfully examine, break down, and incorporate information learned into other situations.

Evaluate is the fifth level of the revised cognitive domain. Anderson and Krathwohl (2001) changed the position of the synthesis level of the original taxonomy with the evaluation level. For instance, the synthesis level (fifth level) on the original taxonomy was moved to the sixth level of the revised version and renamed "create." Consequently, the evaluation level of the original taxonomy was moved to the fifth level of the revised taxonomy (Anderson &

Krathwohl, 2001). The evaluation level of the revised version of the cognitive domain, according to Anderson and Krathwohl (2001), states that learners at this level make “judgments based on criteria and standards” (p. 215). Create is the highest level of the revised cognitive domain. At the create level, according to Anderson and Krathwohl (2001), learners “put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure” (p. 68).

This research used the taxonomy developed by Bloom et al. (1956) to frame the evaluation of the value of ATC simulation training. This study focused on the cognitive domain and its six levels: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956). Specifically, the original version of the cognitive domain of Bloom’s taxonomy was used to explore the extent to which simulation is perceived by ATCSs as a valuable instructional method for developing their ATC job-related competencies needed to perform safe operations in the real air traffic environment. These six categories of the original cognitive domain have helped in analyzing the learning objectives, activities, and assessments to be applicable in different educational settings (Bloom et al., 1956; Krathwohl, 2002).

At the knowledge level of the cognitive domain, students learn to remember through memorization and recollection of relevant facts, concepts, and answers, with limited understanding. This step represents the foundation that can affect the entire learning process. For example, once the learners memorize the facts related to their intended profession as ATCSs, they transition to the second level of learning: comprehension. With a better understanding of relevant facts, concepts, and information relating to air traffic, learners are better prepared to apply their knowledge and understanding in their learning or their day-to-day operations.

The third level provides opportunities for learners to apply what they know. For example, students can apply air traffic knowledge in a meaningful way by using ATC procedures to communicate with other parties to coordinate air traffic activities safely. On the fourth level, students learn to analyze by examining and breaking down information into elements, determining the interconnection and relationship between the components (Bloom et al., 1956). For example, learners may study standard operating and traffic management procedures, examine FAA safety standards, and look up communication protocols (FAA, 2020b).

After the knowledge, comprehension, application, and analysis stages, learners are ready for the synthesis level (Bloom et al., 1956). Students at the synthesis level should truly understand ATC and differentiate and compare it to other things. Additionally, learners may formulate plans to come up with strategies for accomplishing complex tasks. Evaluation is the sixth and highest level, where learners analyze, critique, and compare facts, concepts, and answers regarding ATC.

The primary justification for using Bloom’s taxonomy as the conceptual framework for this study is that the model is widely accepted in the education arena as a credible and reliable model for underpinning training-related research (Jang et al., 2019; Judy, 2018; Knoesel, 2017). While the taxonomy is not accepted by all as a reliable model for expressing measurable student learning outcomes (Case, 2013; Stanny, 2016), the evidence in support of its use in the educational setting is convincing. The cognitive domain of Bloom’s taxonomy, in particular, has been used as a framework for designing, structuring, and sequencing courses, entire degree programs, lectures, seminars, learning objects, and curriculum (Darlington & Bowyer, 2017).

This study applied the original Bloom et al.’s (1956) taxonomy of the cognitive domain to guide the formation of the research questions, research instrument, and data collection about ATCSs’ perception of the ATCoach. I used the classifications of Bloom’s cognitive domain to assist me in composing the six subordinate research questions (SRQ). In developing the six

SRQs, I composed each question using one of the classifications (i.e., knowledge, comprehension, application, analysis, synthesis, and evaluation) to determine if ATCSs perceived simulation as a valuable instructional method. The outline I used was the lowest level, the knowledge level of Bloom's taxonomy, to assess if knowledge of basic information took place during the ATCoach. The second level, the comprehension level of Bloom's taxonomy, was used to assess if comprehension of basic information occurred during the ATCoach training. I used the third level, the application level of Bloom's taxonomy, to determine if the application of information and performance skills occurred during the ATCoach. I used the fourth level, the analysis level of Bloom's taxonomy, to determine if the ATCoach provided learners opportunities to use judgment and critical thinking to solve complex problems. I used the fifth level, the synthesis level of Bloom's taxonomy, to determine if the ATCoach provided opportunities for learners to use judgment to solve complex problems and how ATCSs synthesize what they learn from their experiences with the ATCoach. I used the sixth level, the evaluation level of Bloom's taxonomy, to determine how ATCSs perceived the ATCoach impacted their judgment, critical thinking skills, and self-confidence to manage complex air traffic scenarios without instructor intervention to meet the minimum requirement for radar certification.

The justification for using the original version of Bloom's taxonomy instead of the revised version is threefold. First, the terminologies of the original taxonomy better align with the job-related ATC competencies. Second, I believed that the ATC training was more aligned with the original taxonomy because create is not an inherent ATC training or operational product. For example, both the original and revised versions of Bloom's taxonomy consist of six levels and are presented incrementally and hierarchically from easy to complex (Bloom et al., 1956). Create is the highest or most challenging level of the revised version of the taxonomy. Create, according to Anderson and Krathwohl (2001), means to "put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure" (p. 68). On the other hand, evaluate is the highest or most difficult level of the original version of the taxonomy. To evaluate means to analyze, critique, and compare facts, concepts, and answers on particular matters (Bloom et al., 1956). The evaluation of ATCS aligns with ATC training for certification. Third, I selected this model because it was ideally structured to support the study's interest, exploring the participants' perceptions relating to the value of the simulator on the ATC job-related competencies based on six categories outlined in Bloom's taxonomy.

Overview of Methodology

In this study, I sought to understand ATCSs' perceptions of the ATCoach and if they believed it was a valuable method of providing the experience to develop their ATC job-related competencies needed to perform safe operations in the real air traffic environment. Based on this study's purpose, a qualitative methodology was the most appropriate approach for assessing the phenomenon under investigation. Qualitative research allows a researcher to be part of the research, observe participants' interactions, and interact with the participants to create human knowledge (Creswell & Creswell, 2018). Qualitative research design provides nonnumeric data that focuses on exploring and understanding the meaning of a phenomenon, person, or group in a natural setting (Creswell & Creswell, 2018). This interaction in the "natural" setting is an inherent qualitative feature, and it is a feature absent in quantitative designs. The qualitative research method allowed me to explore the experiences of ATCSs at an ATC facility in the Southeastern United States.

Qualitative research approaches focus on the lived experiences of participants by honoring the respective meanings, structures, and essence of their lives (Merriam & Tisdell, 2016; Patton, 2014). By design, qualitative investigations allow researchers to reserve the chronological flow and show the causal relationship between events and consequences (Amaratunga et al., 2002). I used the qualitative exploratory case study approach outlined by Yin (2018) to explore ATCSs' perception with scenario-based simulation and the relationship between simulation training and the readiness of ATCS.

This study used a qualitative exploratory case study methodology outlined by Yin (2018) in conjunction with the six levels of the original Bloom et al. (1956) to explore ATCSs' perceptions of scenario-based simulation and the extent to which ATCSs perceive simulation as a valuable instructional method for enhancing ATC knowledge, performance skills, judgment, critical thinking skills, and self-confidence to operate in the real air traffic. Yin (2018) described exploratory research as a means of exploring the overarching research question and rigorously investigate phenomena that have not been adequately researched. Yin (2018) also identified case study as a form of research design used to explore a phenomenon in its real-world context that utilizes one or multiple data sources to discover meaning and gain insight into a specified group, situation, or experience. The exploratory case study design is used in research where the phenomenon under investigation "has no clear, single set of outcomes" (Yin, 2018, p. 18). Therefore, this qualitative study used an exploratory case study design to collect data from a purposive sample of ATCSs working at an ATC facility in the southeastern region of the United States. To answer the research question and subordinate questions rigorously and substantially, I decided to adopt a type of case study design called exploratory case study (Yin, 2018). The exploratory case study methodology was chosen because it allows for the comparative evaluation of the program, group, or individuals under investigation (Creswell & Creswell, 2018). The exploratory case study methodology is also appropriate for this study because it allowed me to conduct this research on real-life phenomena and problems (Yin, 2018). For example, the exploratory case study methodology allowed me to explore the extent to which ATCSs perceive simulation as a valuable instructional method for enhancing their ATC competencies.

In case study research, the investigator can collect the data through multiple methods to answer the research questions that have stemmed from the identified problem. These data collection methods can include interviews, observations, and examination of documents and research (Merriam & Tisdell, 2016; Yin, 2018). In this study, I collected data using the interview data collection method. I crafted and employed an interview protocol guide (IPG) to determine if participants perceived simulation as a valuable instructional method for enhancing specific ATC knowledge and skills. The 23-question IPG was presented to all participants to answer the overarching research question. The 23 questions were divided into six categories to align with the research questions and the six levels of the original cognitive domain of Bloom's taxonomy. I asked the participants questions on the IPG in a synchronous manner over Zoom (2020) video conferencing platform. The video and audio of each interview process were recorded using the recording feature of the Zoom software. I used the responses of each participant for data analysis by extracting the audio from the recorded interview data, then uploading it to an audio-to-text transcription software platform called Otter.ai (2021). After editing for accuracy, I uploaded the transcript to an online data coding platform called Atlas.ti (2021) for coding and thematic analysis. The coding and thematic analysis processes were performed by identifying and visually color-coding and grouping like phrases and sentences (Attride-Stirling, 2001). The data analysis approach was to organize participants' perceptions and accounts from interview responses into manageable themes to understand and explain the findings better. This approach was accomplished by following the data logging, data coding, and thematic analysis steps recommended by Attride-Stirling (2001). Once all the data was coded and grouped by themes, I compared and contrasted participants' responses to each other and then to the literature. The data were analyzed and presented to answer each of the research questions by applying the six levels of the cognitive domain of Bloom's taxonomy: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956).

Research Questions

The following overarching research question was a reflection of the purpose of this study: How do ATCSs at an air traffic facility in the southeastern region of the United States describe their experiences with the ATCoach in developing job-related competencies? The classifications of Bloom's taxonomy of the cognitive domain guided the following SRQ:

SRQ 1: What knowledge do ATCSs at a Southeastern United States air traffic facility learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 2: How do ATCSs at a Southeastern United States air traffic facility comprehend what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 3: How do ATCSs at a Southeastern United States air traffic facility apply what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 4: How do ATCSs at a Southeastern United States air traffic facility analyze what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 5: How do ATCSs at a Southeastern United States air traffic facility synthesize what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 6: How do ATCSs at a Southeastern United States air traffic facility evaluate what they learn from their experiences with the ATCoach in developing job-related competencies?

Assumptions of the Study

This section presents some assumptions considered to be true and applicable for this qualitative exploratory case study. According to Gay (1976), assumptions are unverified facts or conditions deemed to be accurate by a researcher. In this study, I identified the following assumptions. First, I assumed that all ATCSs would be forthcoming and truthful in their verbal and nonverbal responses to all interview questions (Roberts, 2010). The rationale for making this assumption was that the participants were purposely selected because their experiences with the ATCoach are worth discussing. I believed that the participants had a vested interest in their training and were likely to be forthcoming and offer honest perspectives that were important to the meaningful findings of this study (Roberts, 2010). Honest and truthful responses increased the accuracy and credibility of the research findings. Informing the participants their responses would be kept confidential made them comfortable and forthcoming in their responses (Creswell & Creswell, 2018; Merriam & Tisdell, 2016). Participants might have been reluctant to respond honestly if they had feared retaliation.

Second, there was one assumption relating to the conceptual framework. I assumed that focusing on the cognitive domain of Bloom’s taxonomy would allow me to get a better understanding of the multiple competencies deemed necessary for ATCSs to be prepared for the challenges they face on the job. I made this assumption because the taxonomy has been proven to be a viable method for framing simulation-related research. For example, Judy (2018) employed Bloom's taxonomy of the cognitive domain to underpin a study to determine the correlation between time spent on simulation training compared to live aircraft training and the impact on advanced and intermediate levels of job-related competencies.

Third, I assumed that participants would be able to convey their learning experiences. The participants in this study were comprised of CPC-IT with years of previous experience directing traffic for the FAA. The questions on the IPG were crafted, in part, to predict participants' responses relating to ATC and their experiences with the ATCoach. The ATCSs' experiences or lack thereof play a significant role in the data quality when responding to questions about ATC or the ATCoach (Cheng & Grant, 2016). As Dennis (2014) explained, "qualitative research findings are intimately derived from interpersonal contact with participants, their experiences will be directly reflected in those findings" (p. 397). Because of their previous years of experience directing traffic and completing the ATCoach training, I assumed that the participants possessed the knowledge to adequately convey, on a substantive level, their learning experiences.

Lastly, I assumed participants were all exposed to the same or similar training scenarios (via simulations) and training guidelines. I made this assumption because all the participants had previous experience directing traffic at another FAA facility. The participants also followed the same training guideline prescribed in FAA Order JO 3120.4 (FAA, 2018d). The participants also completed the ATCoach training in the same laboratory setting and with the same instructors and Remote Pilot Operators (RPOs). Additionally, all participants followed the same curriculum to complete their training.

Delimitations and Limitations of the Study

The delimitations and limitations of this study are presented to provide clarity and precision about the constraints and scope of the population and the constructs of the study (Locke et al., 2014). Delimiting a study means providing the boundaries a researcher imposed on the study (Roberts, 2010). The limitations refer to factors out of a researcher's control that may potentially affect the outcome of the investigation in a significant way (Roberts, 2010).

Delimitations

I carefully considered five delimitations for this study. Delimitations are a critical consideration for a case study methodology since all the elements that make up the case must be clear for the findings of the case to be rigorous (Merriam & Tisdell, 2016). First, I delimited the scope of the research by narrowing the investigation to a single phase of training, a single geographic location, one ATC facility type, and the type of simulation training to investigate. My initial intent was to evaluate the training value of two different computer-based instructional training scenario configurations: the simulator and the curriculum used by the FAA for training ATCSs at Airport Traffic Control Tower (ATCT) and Terminal Radar Approach Control (TRACON) facilities in the Southeastern United States. A comprehensive review of the literature on ATC training simulation's effectiveness (Bauer, 2005; Caro, 1971; Ennis, 2009; Jentsch et al., 2011; McDermott, 2005) revealed insufficient information concerning air traffic simulation training. In the studies reviewed, an emphasis was placed on the initial qualification training (IQT) phase and assessing the efficacy of simulation for ATCT certification. Consequently, I narrowed the study's scope by excluding the ATCT simulator and focusing only on the training simulation used at the selected air traffic facility: specifically, for certifying ATCSs for TRACON operations. These delimitations allowed me to conduct a valid and manageable study.

Second, I delimited the types of ATC participants in this study. The study was confined only to federal employees working under the FAA's ATO umbrella. I excluded all ATCSs who worked for private contractors at the time of the study. My justification for delimiting this study to only federal employees was twofold. One, the ATCSs who work as private contractors are employed by private companies rather than by the FAA (2020a), and therefore they generally direct traffic at small ATCTs. Since I narrowed the study's scope by excluding the ATCT simulator to focus only on TRACON training simulation, all contract towers were automatically excluded. Two, contract towers generally support general aviation, whereas FAA-managed facilities manage general and civil aviation. Because of the operational difference and experiences between contract ATCSs and FAA ATCSs, I opted to narrow the scope of the study to allow for consistency in the participant and the data collection process. These delimitations allowed me to conduct a manageable study by stopping me from overreaching or overextending (Merriam & Tisdell, 2016).

Third, the study was delimited by the data collection sites selected for inclusion. A single ATC facility located in the southeastern region of the United States was the only data collection site, thereby excluding all other ATC facilities and ATCSs associated with those sites. My initial intent was to conduct this research at three ATCT and TRACON facilities in the Southeastern United States. Since all three ATC locations were similar in function and capabilities, I opted to eliminate two of the sites. Consequently, I narrowed the study's scope by focusing only on one air traffic facility, making data collection more manageable, reducing the cost of traveling to the different sites, and improving the ease of communicating the findings (Merriam & Tisdell, 2016). Though these locations are similar in function and capabilities, this delimitation means that the findings of this study may not be representative of ATCSs population training at other facilities throughout the nation.

Fourth, the study was delimited by the population I selected. The target population for this study was confined to professional federal ATCSs categorized as CPC-IT at the time of simulation training (within a year of data collection), thereby omitting all ATCSs in nontraining status. It was necessary to narrow the study's scope by focusing on ATCSs that had recently experienced the ATCoach training. These delimitations allowed me to select participants who possessed recent knowledge of the ATCoach to convey their learning experiences accurately and provide data during the data collection process (Creswell & Creswell, 2018; Merriam & Tisdell, 2016; Roberts, 2010).

Fifth, I delimited the study to examine the six levels of the cognitive domain outlined in Bloom's taxonomy. Bloom's taxonomy is a valid approach to understanding learning better and how to improve learning. The taxonomy was used as a framework to help understand if ATCSs believed the ATCoach is a valuable approach for developing ATC job-related competencies.

Limitations

I identified several factors that have limited the study. Qualitative research is inherently limited because it draws on a limited sample to examine a broader social phenomenon (Creswell, 2013). Creswell (2013) recommended selecting a sample size of five to twenty-five participants for qualitative studies. I selected five participants for this study. This small sample limited the research in the following ways. The human experiences of the participants could render inaccurate articulation or false perceptions of the topic (Yin, 2018). I addressed this limitation by identifying and documenting participants' experiences and how those experiences may have influenced participants' responses to the IPG. I also reported these human experiences with the study's findings. Inconsistencies in participants' perceptions can present difficulties in generalizing findings to the larger air traffic control population (Blaikie, 2009; Creswell, 2015; Foeckler, 2019). I addressed this limitation by ensuring that both the investigation process and the analysis of data were precise and reflect the true essence of participants' lived experiences (Given, 2008). I preemptively created probing and follow-up questions on the IPG to alleviate misunderstood responses. I also used member checking to ensure that what transpired and how the interviewee said it occurred was accurately interpreted. As Merriam and Tisdell (2016) described, member checking establishes credibility by asking some interviewees to verify the accuracy of their experiences and the research findings.

This study might have been limited by preexisting perceptions of ATCSs towards simulation training, ATC training in general, their opinions and attitudes towards the training staff, or how well or poorly they performed altogether. I addressed this limitation by developing tactfully worded questions on the IPG so participants could accurately represent their lived experiences and minimize biases in the responses (Creswell, 2015). I also identified some limitations in terms of time, place, and some physical restrictions associated with using a qualitative case study design (Creswell, 2015). Even as an "insider researcher," gaining access to the laboratory where the ATCoach radar simulator resides can be challenging for collecting qualitative data. I addressed this limitation by first coordinating with the Air Traffic Control Manager (ATCM) in person to get permission to conduct the research and access the training areas. Upon receiving preliminary approval, I sent the ATCM two written requests via electronic mail to get permission to conduct the research and to access the research site.

The ATCSs at the research site worked a wide variety of work schedules, making it challenging to collect data. These challenges can extend the necessary time to interview participants and collect other types of qualitative data (Bernard, 2012). I addressed this limitation by conducting the interviews over Zoom (2020) video conferencing. The primary reason for using the video conferencing method was to adhere to the safety requirements imposed due to the emergence of the COVID-19 virus. Nevertheless, I benefited from the flexibility of collecting data from my home while the participants did the same. This remote video interviewing technique is a benefit not available in traditional face-to-face interviewing (Guest, 2013). The longitudinal effects of a case study can also result in the high cost of doing the research (Yin, 2018). I addressed this limitation by interviewing over a 5-week period. I also utilized a single source of evidence because it was more cost-effective than collecting data from multiple sources (Yin, 2018).

Another limitation of this case study was that technical findings specific to ATC might be challenging to analyze (Denzin & Lincoln, 2018). I addressed this limitation by first turning to the FAA Order JO 7110.65. Whenever the literature proved unsuccessful, I then turned to the subject matter experts (SMEs). I solicited the assistance of two current ATCSs and a former ATCS currently working as an ATC support specialist to serve as SMEs. According to Frey (2018), SMEs play a pivotal role in validating research content. In this study, the SMEs assisted by defining and describing uncommon ATC jargon, deciphering ATC terminologies, and affirming or debunking my assertions or understandings (Frey, 2018). The use of SMEs was particularly advantageous in identifying themes because the participants sometimes rendered responses to the questions on the IPG in their unique ways, making it difficult for me to interpret the data.

Significance of the Study

This study explored ATCSs' perceptions of the ATCoach by exploring their ATC job-related competencies needed to perform safe operations in the real air traffic environment. This section outlines this research's relevance and how the findings contribute to scholarly research and literature, advance the practice, and improve policy and decision-making.

Contributions to Scholarly Research and Literature

The findings of this study contribute to scholarly research and literature on air traffic education and simulation training in the following three ways. First, the study's findings could potentially contribute to the existing body of knowledge relating to aviation simulation education, although there are many studies on instructional simulators (i.e., Alinier, 2013; Beaubien & Baker, 2017; Chhaya et al., 2018; Coyne et al., 2017; Dekker et al., 2016; Dow, 2015; Georgiou et al., 2017; Gheorghiu, 2013; Hamel & Jategaonkar, 2017; Judy, 2018; Knoesel, 2017; Kupfer et al., 2013; Lawson et al., 2018; Macchiarella & Mirot, 2018; McDermott, 2017; Rice, 2016; Sawyer & Anderson, 2018; de Smale et al., 2016; Vagner & Pappová, 2014; Van Eck et al., 2015; Zazula et al., 2013; Zhang, 2016), the research thus far on the aviation industry has significantly underrepresented the ATC component of the aviation community (Lee, 2017). This study adds critical insight into the usefulness of air traffic training simulation, programs, and practices. For example, the research adds to previous findings on the value of simulation in the aviation industry by identifying themes representing how ATCS's perceive simulation-related curricula.

Second, this study investigated how well the ATC simulator provides ATCSs with the experience to develop the job-related competencies needed to operate safely in the terminal ATC environment. Previous research on air traffic simulation was limited to using basic simulation to determine ATC readiness for individuals considering a career in air traffic (Updegrove & Jafer, 2017); comparing different types of ATC simulators (Vagner & Pappová, 2014); investigating the performance and workload between simulators employed to train tower ATCSs (Weikert et al., 2001); and transfer of training in an EnRoute air traffic environment (Dow, 2015). After a comprehensive review of existing literature on the FAA's incorporation of computer-generated, scenario-based simulation into ATC training (e.g., Bauer, 2005; Cox, 2010; Lindenfeld, 2016; McDermott, 2005; Van Eck et al., 2015; Zhang, 2016), I was unable to identify a single study on the value or effectiveness of ATC simulation technology in the development of ATCSs' job-related competencies in a TRACON setting.

Third, this study provides valuable information about Bloom's taxonomy. The six levels of the cognitive domain in Bloom et al.'s (1956) taxonomy served as a foundation for assessing the level at which ATC job-related competencies were enhanced. I found two relevant studies that used Bloom's taxonomy to underpin studies on the aviation industry (i.e., Judy, 2018; Rupasinghe et al., 2010). I could identify only a single study (Mercer, 2015) that used Bloom's taxonomy in ATC research. Also, I was unable to identify a study using Bloom's taxonomy specifically for assessing the value of ATC simulation. This study provides valuable information about Bloom's taxonomy by adding suggestive evidence concerning the link between learners' participation in experience-based education and their learning outcomes.

Improving Future Practice and Research

The findings of this study will advance practice and training in the FAA, which will make ATCSs better able to carry out the mandates put forth by the organization. The FAA deals with several aviation challenges (e.g., regulating civil aviation, airspace and air traffic management, commercial space transportation, unmanned aircraft, research, engineering, and development), all with different safety goals and objectives (FAA, 2018c). The FAA's operational domain is filled with potentially catastrophic human, environmental, and ecological risks (Dabney & Brent, 1993; Fultz, 2015; Learmount, 2019), which requires an adaptive workforce of highly trained professionals. To ensure that ATC training meets the safety demands, ATCSs need on-the-job training that includes academic and simulator competency-based training that will develop their skills, situational awareness, and judgment. However, some ATCSs lack critical ATC job-related competencies or have an incomplete understanding of specific air traffic procedures (USNTSB, 2016b). I identified areas that could contribute to current practices.

First, this study assessed the deficiencies in training practices. Therefore, the study was significant because the findings could improve training for future ATCSs. By highlighting the value of ATC educational simulation, this study provides FAA leaders with important training-related information. For example, if this study accurately determines the extent to which ATCSs' job-specific knowledge, performance skills, judgment, critical thinking skills, and self-confidence are improved, then programs using training simulators would be better positioned to show the correlation between simulation technology and improved performance. Ultimately, the findings would bring attention to the role of simulation technology in the development of air traffic competencies that could improve the level of training and the number of experienced ATCS while improving air traffic safety.

Second, this study provides critical data to improve research practice. Future investigators conducting simulation-related research can improve their data collection efforts by employing the combination of life-like scenario-based simulation training with open-ended interviews. Conducting simulation-related research with semistructured interviews was an approach that could improve the soundness or precision of a study's findings (Bernard, 2012).

Third, this study contributes to education and training practices in the FAA and other sectors relating to the value of simulation in education. The findings of this study could improve air traffic training practices specific to instructional simulation. Generating strong evidence on the value of ATC simulation training could help education practitioners in the FAA and other interested parties (universities, government, and the medical community) to employ the standard and process in this study in simulation training programs in other contexts (Jentsch et al., 2011; Lee, 2017). In addition, instructional simulation is a critical component of ATC training; therefore, by presenting a well-designed evidence-based study, leaders in the field of air traffic could generalize the findings to the larger air traffic population (Blaikie, 2009; Creswell, 2015). The study's findings can provide critical information about the development process from the perspective of the students who were successful in acquiring, maintaining, and applying learned tasks, procedures, and decision-making processes.

Contributions to Policy and Decision-Making

Determining if a simulation is a valuable training approach is of interest to policy shapers such as legislators and regulatory bodies. In this case, answering the research question informs the FAA about the support training practitioners need to deliver the most vital components of air traffic training. The vital component that this study investigated relates to scenario-based simulation and the extent to which the study participants perceived simulation as a valuable instructional method for enhancing ATC job-related competencies. The findings of this study could be used to shape policy and influence decision-making in the following ways. First, if this research found simulation to be an inadequate method of developing ATCSs, the FAA could consider the findings to either revamp their current simulation program or explore a new training platform. Ultimately, this study's findings could be used globally to evaluate policies in the education sector. Second, if the simulation under investigation was proven to be an ineffective instructional tool for developing ATC job-related competencies, the findings can inform policies on the qualifications necessary for new ATC hires that utilize simulation to evaluate newly hired ATCSs at the FAA Academy.

Third, the FAA could benefit from this study's rigorous analysis of the shortcomings and strengths of simulation training, thereby helping instructors think about ways to organize instruction to give decision makers time to focus on areas most essential to achieve positive educational outcomes. For instance, this research could better inform organizations of the intricacies, benefits, risks, and role instructional simulation plays in the preparation of employees. The findings could also inform training practitioners of the value of the simulation training and if students are receiving the appropriate training. Also, the findings of this study could be used to influence decisions regarding the allocation of training funds. For example, decision makers could apportion resources to inadequate training areas.

Definitions of Terms

This section provides operationally defined terms that are uncommon in regular day-to-day correspondence. Also included are words that can be misunderstood, misinterpreted, or require clarification according to their application in this current study. The following terms are defined according to how they are used in this study.

Airspace

The term refers to a section in the sky (in azimuth and altitude) that is managed by individual ATCSs to control and move aircraft (Ayhan & Samet, 2016).

Air Traffic Control

The term refers to the safe, orderly, and efficient movement of aircraft through the NAS (Broach & Dollar, 2002).

Air Traffic Control Specialist

The term refers to a person whose job is to safely control and move aircraft through the NAS. ATCSs generally work in three environments: TRACON, ATCT, and Air Route Traffic Control Centers (ARTCC; United States Office of Personnel Management, 2018).

Altitude

The term refers to a geographic measurement that represents the height of an aircraft measured from sea level (Moir et al., 2013).

ATC Facility

The term refers to a space that houses air traffic personnel and equipment to provide air traffic services. These facilities are TRACON, ATCT, ARTCC, and Flight Service Stations (FAA, 2010).

ATCoach Laboratory

The term refers to a room where the simulator equipment resides. During the data collection process, participants refer to the ATCoach laboratory in the following ways: Radar Lab, Lab, SIMS, downstairs, and down there.

Azimuth

The term refers to a 360-degree geometric representation of horizontal angles represented in angular distance between two points (Walker, 2012). For example, azimuth can be used to determine the location of an aircraft in reference to the north or in relationship to another aircraft.

Certification

The term refers to the FAA authorization status ATCSs must obtain before being allowed to control traffic (FAA, 2018d). After successfully completing a theoretical and practical examination, the status is given to ATCSs, confirming proficiency in ATC operations and compliance with FAA policies, orders, practices, and procedures have been achieved (FAA, 2018d; Nadler, 1996).

Certified Professional Controller

The term refers to an ATCS who has completed all required training and has been certified by an authorized FAA representative (Robello, 2017).

Certified Professional Controllers in Training

The term refers to an ATCS previously certified at a different ATC facility but requires site-specific training on the new equipment, procedures, surrounding airspace, or airport terrain (Robello, 2017).

Developmental ATCS

The term refers to a status given to ATCSs from the time they graduate from the Mike Monroney Aeronautical Center until they are certified at their first duty location or when Certified Professional Controller status is attained (Robello, 2017).

Functional Fidelity

The term refers to “The degree to which a simulated task environment behaves in a way similar to the real task environment in reaction to the tasks executed by the learner” (Van Merrienboer & Kirschner, 2013).

Instructional Simulator

The term refers to a simulation device explicitly used for training purposes (Merrill, 2008).

Job-Related Competencies

The term refers to ATC knowledge, performance skills, judgment, critical thinking skills, and self-confidence.

Knowledge

The term in this study pertains to specific information (ATC terminologies, concepts, theories, techniques, and practices) that allow ATCSs to develop the skills and competencies required to perform ATC tasks effectively (Rodriguez-Blanco, 2018). Theoretical ATC knowledge is validated when ATC experience results in understanding and application of that knowledge. Knowledge also incorporates practical air traffic knowledge acquired through day-to-day hands-on experiences, air traffic operational and safety procedures, and decision-making processes (Rodriguez-Blanco, 2018).

National Airspace System

The term refers to a collective body of facilities, equipment, airports, airspace, and other services used to support the navigation of aircraft in the United States (DeGarmo & Nelson, 2004).

Physical Fidelity

The term refers to "The degree to which real-world operational equipment is reproduced in a simulated task environment" (Van Merrienboer & Kirschner, 2013).

Pseudo Pilot

The term refers to a remote training instructor position that allows a user to monitor, control, and update the aircraft in a simulated environment (Vengal, 2011).

Simulator

The term refers to a software or an instrument used in a non-operational environment that realistically mimics a live or real-world scenario (Merrill, 2008).

Skills

The term refers to the ability and aptitude to execute ATC tasks previously learned.

Terminal Radar Approach Control

The term refers to a dark room located in an ATC facility that houses radar automation equipment. ATCSs use the TRACON to direct aircraft to and from the Airport (Cardosi et al., 1996).

Test and Training Simulator

The term refers to a simulation system used by the FAA to provide training to ATCSs working at a TRACON (Schaefer, 1989).

Organization of the Study

Achieving alignment is a vital characteristic of all well-designed research (Booth et al., 2003). The study needed to follow a proper, logical, and sequential flow in which all the core elements of the research follow sequentially and logically from the identified problem. This section provides a roadmap of how this study is structured, specifically, how each chapter, headings, and subheadings align and flow throughout the manuscript. This study’s organization follows the conventional five-chapter design: (a) introduction; (b) literature review; (c) procedures and methods; (d) data analysis and findings; and (e) summary, conclusions, implications, and suggestions for future research (Roberts, 2010).

Chapter 1 contains critical components essential to the alignment and logical flow of the study. In Chapter 1, I presented the background and contextualization of the issue, making a compelling case for why air traffic simulation must be investigated. The problem of this research was an issue of significance whose investigation will make a valuable contribution to academic and practitioner knowledge. Investigating if ATCSs believe air traffic simulation training was a valuable approach for preparing them for their jobs addressed a gap in existing studies. Following the problem statement, the statement of the research purpose was presented, describing the specific gaps in the research, reasons for conducting the study, and the phenomenon under investigation (Merriam & Tisdell, 2016).

The purpose statement was created using similar information and the same language to describe the phenomenon of interest (Bloomberg & Volpe, 2019). The purpose statement declared the intent to examine the same problem described in the problem statement. An overview of the conceptual framework was the next subsection of Chapter 1 that aligned the study. The conceptual framework for this study was Bloom's taxonomy of the cognitive domain. Bloom's taxonomy of the cognitive domain was appropriate for this study because it offered analytical tools for considering the data to address the research problem and the resulting research question and subordinate questions. The conceptual framework subsection included a substantive overview of Bloom's taxonomy, including the model's origin, context, constructs, appropriateness, and application in this study.

An overview of the methodology was the next critical component of Chapter 1. The qualitative exploratory case study design was appropriately aligned to this study because this study sought to understand how ATCSs perceive simulation training on ATC readiness. The research question was best answered by conducting a comprehensive inquiry into the experiences of a small group of ATCSs in relation to their simulator-based training. The case study design provided insight into the ATCSs' experience in their natural work environment (Creswell & Creswell, 2018). The research questions subsection was the next key component in the logical flow in aligning the study. The overarching research question of this study was aligned with understanding the phenomenon under investigation according to the chosen research methodology, an exploratory case study design. This chapter then provided several research assumptions, delimitations, and limitations. Also, I outlined the significance of the study as it related to theory, practice, and policy. The definitions of terms subsection was another critical section of this chapter, defining all the technical terms relating to ATC operation and training. The final section before the chapter summary was the organization of the study. This section helps readers understand what to expect in each subsequent chapter.

The content of Chapter 2, the synthesis and engagement with peer-reviewed literature on ATC simulation, presents the source of the research problem. Specifically, the unanswered questions from the available literature reviewed dictated the direction this current research followed (Bloomberg & Volpe, 2019). The first part of Chapter 2, the Topical Literature Review section, serves as a thorough descriptive review of past and current relevant academic and peer-reviewed literature relating to ATC simulation training. The section summarizes the knowns and unknowns about ATC training and simulation technology and the conceptual framework. This section also serves as a review of past and current relevant literature concerning ATC, the role of ATC in the NAS, ATC training and development, the effectiveness of instructional simulation, air traffic job specification, the historical background of instructional simulation, linking skill enhancement to simulation technology, and ATC training simulations. The second part of Chapter 2, the Conceptual Framework section, examines Bloom's taxonomy of the cognitive domain. First, the section presents the historical origins of the model, highlighting the creators and their rationale for creating the model. The model's context and constructs were the next critical subsections in Chapter 2. A discussion that follows justifies the appropriateness of using Bloom's taxonomy in the cognitive domain as the conceptual framework for evaluating ATCSs experience with simulator training. This chapter then examines the application of Bloom's taxonomy in the study. The final section before the chapter summary shows the model's application in previous scholarly research and scholarly reactions to Bloom's taxonomy.

Chapter 3 provides details about how I carried out the research. The first section details the qualitative case study design used for investigating how well the simulator provides ATCSs with the ATC job-related competencies needed to perform safe operations in the real air traffic environment. The chapter includes the justification for choosing the qualitative methodology and appropriateness of the exploratory case study design. A discussion explains the site selection criteria, the population, the study's participants, and the process used to select participants. A discussion of this study's ethical considerations precedes a description of the data sources and the research protocols/instrumentation. The process used to field test the IPG is explained, and data collection procedures and researcher positionality are discussed. The chapter then presents ways I validated the study's findings. The final section before the chapter summary provides detailed step-by-step data analysis techniques "used to analyze the data and discover the meaning" (Mart, 2011, p. 42) of ATCS experiences with simulation training.

Chapter 4 presents the data analysis procedures I used in this study. The chapter includes the description of participants followed by the presentation and analysis of participants' responses. The detailed presentation and analysis of the findings relate to how the ATCoach contributed to the development of ATC job-related competencies (Roberts, 2010). I arranged the study's findings using the overarching research question and the six subordinate questions. Chapter 4 concludes with a summary of the chapter's content.

Chapter 5 provides a summary of this qualitative exploratory case study. The chapter includes a summary and major findings of the study followed by the conclusions, supported by the study’s findings and facts from existing literature. The chapter consists of the interpretation of the findings subsection, which precludes the implications of the study (literature, practice, policy/decision-making, and unexpected study outcomes). A discussion explains my recommendation for future research on air traffic simulation and its value on ATC development. This chapter then provides several research limitations and reflexivity before closing with the chapter summary.

Chapter Summary

My interest in conducting this study derived from the safety issues and risks associated with ATC activities performed in the interest of safely controlling aircraft and creating conditions for planes to navigate the NAS without accidents and incidents caused by poor or inadequate air traffic control management. Aircraft accidents and incidents can render catastrophic human, environmental, ecological, and economic implications, including losing human lives (Dabney & Brent, 1993; Fultz, 2015; Learmount, 2019). The problem was that many members in the ATO, ATCSs, responsible for giving “aircraft instructions, air traffic clearances, and advice regarding flight conditions” (National Air Traffic Controllers Association [NATCA], 2019, para. 5), are under-trained and inexperienced. Consequently, ATCSs sometimes make ATC judgment errors which contribute to aircraft accidents, near-collisions (near misses), and other serious aviation mishaps (USNTSB, 2016a, 2016b). The solution to the problem is ensuring that ATCSs receive academic and simulator competency-based training to develop their skills, situational awareness, and judgment so that they may adequately assist pilots (USNTSB, 2016b).

This problem generated the study's purpose to understand how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies. The purpose statement declared the intent to examine the same problem described in the problem statement. In this study, job-related competencies refer to ATC knowledge, performance skills, judgment, critical thinking skills, and self-confidence. This study used the original Bloom's taxonomy of the cognitive domain (Bloom et al., 1956) to focus attention on the problem from the perspective of ATCSs. Specifically, I used the classifications of the cognitive domain to hear, in participants' own words, about their experiences with the ATCoach and to what extent they perceive it as a valuable instructional method for enhancing these competencies needed to perform safe operations in the real air traffic environment.

The overarching research question is a reflection of the study’s purpose and was posed to accomplish the purpose. The overarching research question is how do ATCSs at an air traffic facility in the southeastern region of the United States describe their experiences with the ATCoach in developing job-related competencies. I used the classifications of the original cognitive domain to create six SRQs to answer the overarching research question and ultimately accomplish the study’s purpose. Each of the six SRQs is guided by one of the six levels of classification of the original taxonomy Bloom’s taxonomy. The six SRQs were used to gather critical information, through the lens of the original taxonomy Bloom’s taxonomy, about the development process from the perspective of the ATCS who were successful in acquiring, maintaining, and applying learned tasks, procedures, and decision-making processes.

The overarching research question of this study was aligned with understanding the phenomenon under investigation according to the chosen research methodology, a qualitative exploratory case study design. Qualitative research approaches focus on the lived experiences of participants by honoring the respective meanings, structures, and essence of their lives (Merriam & Tisdell, 2016; Patton, 2014). By design, qualitative investigations allow researchers to reserve the chronological flow and show the causal relationship between events and consequences (Amaratunga et al., 2002). I used the qualitative exploratory case study approach outlined by Yin (2018) to explore ATCSs' perception with scenario-based simulation and the relationship between simulation training and the readiness of ATCS. The qualitative exploratory case study design is appropriate to answer the research questions because case study designs are used in studies to explore a phenomenon in its real-world context by utilizing one or multiple data sources to discover meaning and gain insight into a specified group, situation, or experience (Yin, 2018). In this study, I explored the ATC simulation training phenomenon to gain insight into ATCSs' perceptions of their ATCoach experiences using the interview data collection method. Additionally, exploratory case study designs are used in research where the phenomenon under investigation "has no clear, single set of outcomes" (Yin, 2018, p. 18). The exploratory case study methodology was appropriate for this study because it allowed me to explore the overarching research question and conduct this research on real-life phenomena and problems that have not been adequately researched (Yin, 2018).

This study's findings answered the research questions and indicated that the ATCoach equipped ATCSs with a better understanding of site-specific airspace elements, which better prepared them to transfer the knowledge acquired from pre-simulation training to practice in their day-to-day ATC operations. Participants also revealed that ATCSs apply what they learn from their ATCoach experiences by taking what they learned and executing it when participating in simulation training and controlling live air traffic. The study found that ATCSs synthesize what they learn from their experiences with the ATCoach by using their knowledge of complex airspace elements to develop operational planning strategies and formulate alternative plans presuming their initial strategies were ineffective. The findings suggest that ATCSs perceive that their understanding of ATC-related situations from their ATCoach experiences improved their judgment, critical thinking, and decision-making skills in post-simulation evaluation and in ATC practice—not their self-confidence. Like the USNTSB's (2016a) findings, participants revealed that the ATCoach training failed to incorporate the "emergencies" component stipulated by the FAA Order JO 3120.4.

This study's findings support the conclusion that ATCSs acquire theoretical ATC knowledge from previous classroom learning and experiences before partaking in the ATCoach and reinforced in the ATCoach. Conclusions also indicate that the ATCoach is a valuable instructional method for enhancing ATC professionals' knowledge and skill levels to coordinate aircraft movement through the NAS safely. The conclusions also show that the ATCoach is not a valuable method of enhancing ATCSs' self-confidence. This study's findings also support the fourth conclusion that the simulator's fidelity influences the value of simulation training. This study's findings also support the fifth conclusion that the ATCoach is not a substitute for real-world training.

This study's findings support the implications for theory that learning is constructed to allow students to progress through six learning categories incrementally and hierarchically.

Through the lens of the six classifications of Bloom's taxonomy, this study found that ATCSs develop job-related competencies by progressing through the training from lowest (acquiring knowledge) to highest (demonstrating their mastery, proficiency, and fluency) levels of complexity. This study's findings will also contribute to scholarly research and literature on air traffic education and simulation training by adding information on the value or effectiveness of ATC simulation technology in developing ATCSs' job-related competencies in a TRACON environment. This study's findings support implementing instructors/RPOs reoccurring training as a critical approach for enhancing training staff preparation and students' learning experiences. This study's findings also support implications for practice, with evidence showing that simulation fidelity should accurately represent real-life when developing knowledge to facilitate higher-level thinking and complex skills. This study's findings support implications for policy and decision-making, showing that the findings can be used to enhance the evaluation process for measuring ATCSs' performance upon completing simulation training. Ensuring that learners have the technical aptitude to succeed is contingent on measuring and evaluating how well an ATCSs performs.

Chapter 2: Literature Review

The purpose of this qualitative exploratory case study was to understand how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies. This second chapter serves as a thorough descriptive review of past and current relevant academic and peer-reviewed literature relating to ATC simulation training and Bloom's taxonomy of the cognitive domain (Bloom et al., 1956). The literature discussed in the first part of this chapter focuses on simulation, and its definition, origin, instructional application, use in different industries, and simulation in ATC. The literature on ATC is also reviewed because gaining insight into ATC functions and facilities, safety and accidents, education, and competencies are critical to understanding the scope and relevance of academic and simulator competency-based training in ATC education (Maggio et al., 2016). Also, exploring students' perceptions may inform how they learn and may also reveal the impact and usefulness of training components and programs (Lindenfeld, 2016). For this very reason, literature is reviewed on student's perceptions of the advantages and disadvantages of the simulation.

The second part of Chapter 2 focuses on the conceptual framework used to frame this study. I employed the original Bloom et al.'s (1956) taxonomy of the cognitive domain to assess ATCSs' perceptions of the ATCoach's value in providing the experience to develop their ATC job-related competencies needed to perform safe operations in the real air traffic environment. First, I present the historical origins of the model, highlighting the creators and their rationale for creating the model. The model's context and constructs are the next critical subsections in Chapter 2. I then justify the appropriateness of using Bloom's taxonomy in the cognitive domain as the conceptual framework for evaluating ATCSs experience with simulator training. I then summarize the application of Bloom's taxonomy in the study and describe how the six levels of the domain align with this study's topic, purpose, and research questions. I then discuss the existing body of literature relating to Bloom et al.'s (1956) taxonomy and its application in aviation-related and simulation research. The final section before the chapter summary addresses the strengths, weaknesses, and criticisms of Bloom's taxonomy.

Topical Literature Review

This section focuses on relevant peer-reviewed literature relating to ATC simulation training. I reviewed the scholarly works from experts to gain a thorough understanding of (a) ATC simulation and its effectiveness, (b) current research on air traffic simulation, (c) how researchers conducted these studies, and (d) what key issues relate to simulation technology.

Simulation

Simulation is a system, device, situation, or process that imitates a real environment (Banks, 2001; Landriscina, 2013). Simulation is used across industries such as the military, aviation, and healthcare for training, measuring, operational testing and evaluation (OT&E), engineering and design, and testing (Heath & Yoho, 2017; Riotto, 2021; Sawyer & Anderson, 2018; Volkaner et al., 2016). Often, engineers use simulation technology to model engineering design and simulate the movement of heat, air, and moisture through buildings (Ferroukhi et al., 2017). Professionals use simulators in situations where operating in the real environment poses a safety risk, like in a clinical setting where learning on live patients is unjustifiable (Colman et al., 2019), or learning to manage air traffic during live operation under peak conditions may put passengers' lives at risk (Hamel & Jategaonkar, 2017; Lateef, 2010; Lawson et al., 2018; Wilson & Rockstraw, 2012; Wolf, 2010). Also, designers rely on simulation technology to test new design ideas before starting development (Colman et al., 2019). In alignment with Lateef (2010), simulation improves the overall quality of training, assessment, design, testing, safety, and evaluation. Simulators are also realistic, relatively safe, economical, and flexible, and offer learner convenience (Jentsch et al., 2011; Lateef, 2010; Vahdatikhaki et al., 2019). Opposing opinions to simulation suggest that many simulation systems inadequately mimic human behavior, encourage learners to take shortcuts when participating in simulation-based learning, inhibit learner-specific instruction, and make high-fidelity systems too expensive to acquire or maintain (Dahlstrom et al., 2017). Simulation technology is widely used in the aviation industry and is a well-established approach for training pilots and ATCSs (Updegrove & Jafer, 2017). Many industries use simulators to test theoretical and practical knowledge about aviation communication and strategies on vectoring aircraft through the NAS (Antosko et al., 2014).

The Historical Origin of Aviation Simulation. In this historical overview of aviation simulation, I focused on aviation simulators' origin, specifically the simulators whose evolution led to the emergence of today's digital computer-based, scenario-driven systems. This review presents a limited discussion of historical events to show the aviation training simulation's origin and impact. This section provides a chronological account of the important historical development of aviation-related simulation.

Instructional simulation was used during World War I (1914–1919). I found the earliest published account of an aviation-related simulator in an article published in the January 1919 edition of the *Popular Science Monthly* magazine. Crossman (1919) provided a detailed history of the purpose and application of a training simulation system used during World War I by the United States military to train their gunners to shoot accurately in flight. While only a basic mechanical device, the gunner training simulator marks a beginning for discussion in the United States, mainly as the simulator was first used for flight-related training and because it is a precursor to computer-based simulators. A student sat in a basic chassis frame that pivots and sways with slight movements from the occupant during practice (Crossman, 1919). Crossman (1919) reported that students practiced with real machine guns mounted on a ground-based chassis frame, and a hidden and protected crew member manually operated the moving targets. This frame simulator and target mechanism were designed to simulate a real machine gun installed on a real airplane (Crossman, 1919). The simulator taught students the principles of sighting a machine gun at fast-flying enemy airplanes (Crossman, 1919).

The Link Blue Box training simulator is the second pivotal development in simulation technology (1929–1940). The Link Blue Box training simulator was the first widely used simulator for aviation training and is a predecessor of relatively all current commercial flight simulators (Page, 2000; Rosen, 2008). During the 1900s, when the airplane was a growing phenomenon, many aspired to fly planes (Futrell, 1998). According to Futrell (1998), during that time, there was only one way to learn how to pilot an aircraft, which was hands-on training. This preparation method was expensive and dangerous because pilots had to progress through many flying exercises on a real plane (Futrell, 1998). In 1929, a successful U.S. piano manufacturer and pilot, Edwin Albert Link, invented the first commercially available flight simulator and changed the face of aviation simulation and training development (Jeon, 2015; Pisano, 2000). On April 14, 1929, Link filed a patent for his simulator as an apparatus for training student aviators (Jeon, 2015; Link, 1929). Link quickly improved his invention by enhancing its instrument capabilities. On March 12, Link (1930) filed a second patent for the modifications made to the original design, adding instrument-guided features to the previous visual observation model. These modifications allowed pilots to experience all the natural sensations and intricacies of flying a real airplane (Link, 1930). Link's design replicated an entire airplane cockpit, equipped with simulated winds and weather conditions (Link, 1929). Link called his invention the Link Blue Box trainer because, at that time, all the simulators were painted blue.

According to the American Society of Mechanical Engineers (ASME), instructional simulation gained popularity during World War II (1941–1945). The Link trainer caught the attention of the U.S. military during World War II. In the early 1940s, Link sold approximately 10,000 Link Blue Box trainers to the U.S. military services (ASME, 2000; Jeon, 2015). The Army Air Corp realized they needed a way to train their pilots to fly in poor conditions and poor visibility using only instruments (Strachan, 2000). With proper training, instruments allowed pilots to control and maneuver aircraft without visual reference to the earth. The ASME (2000) reported that by the end of World War II, the U.S. military had trained over 500,000 of its pilots on the Link simulators. The pilots were first required to go through the prescribed procedure of training on the simulator before attempting to fly a real plane (ASME, 2000). The use of the Link trainer improved flight safety and decreased the time it took to teach each pilot (Flexman, 1950; Povenmire & Roscoe, 1971). The trainers were also used as an opportunity for experienced pilots to sharpen their instrument flying, radio navigation, and landing skills without leaving the ground (ASME, 2000). The Link trainer was equipped with the same basic flight instruments found in World War II aircraft and was the first successful flight simulator (Jeon, 2015). It became the forerunner of today’s modern computerized simulators used in all current leading civil aviation platforms (ASME, 2000).

The emergence of the electrical simulation occurred after World War II (1940–1959). In 1941, Richard C. Dehmel designed the first full aircraft electrical flight simulator on an analog computing platform (Allen, 1993; Dehmel, 1950; Ennis, 2009). The simulator was a replica of the Boeing 377 Stratocruiser and was manufactured by the Curtiss-Wright Corporation (Dehmel, 1950; Parke, 1953). It took a decade for the Curtiss-Wright Corporation to construct the first batch of simulators for military and civilian use (Ennis, 2009). Pan American World Airways was one of the first airliners to employ the new Curtiss-Wright flight simulator (Ennis, 2009). Pan American World Airways was able to successfully train 125 crew members and 85 military personnel utilizing the Curtiss-Wright flight simulator (Page, 2000). A 1954 aviation-related article published in the September edition of *Popular Mechanics Magazine* reported on the desires of United States-based airliners to acquire the Curtiss-Wright simulator (Popular Mechanics Magazine, 1954). The Curtiss-Wright simulator reduced training cost by 60% and training time by 62% (Page, 2000). In 1954, American Airlines purchased four Curtiss-Wright flight simulators for $3,000,000 (Popular Mechanics Magazine, 1954). In addition to the features present in Link's model, Curtiss-Wright flight simulators were equipped with visuals, sound, and movement. The Curtiss-Wright flight simulators were the pioneer simulators designed for today's commercial aircraft (Ennis, 2009; Page, 2000).

An enormous advancement was made to aviation training simulation by merging computer technology with mechanical design (1950–1970). With the development of digital computer technology, simulation technology can reach the boundaries of the human imagination (Ennis, 2009). The use of digital computer-based simulations made the Universal Digital Operational Flight Trainer (UDOFT) unique from its predecessors. It was considered a starting point for true computer-based aircraft simulators, mainly for its ability to digitally replicate in-flight motion (Aerospace Medical Research Laboratories [AMRL], 1963; Humphrey, 1987; Zazula et al., 2013). The UDOFT was conceived by Moore School of Engineering designs at the University of Pennsylvania in 1960, and it was built in collaboration with the Sylvania Electric Products, Inc., the U.S. Air Force, and the U.S. Navy (AMRL, 1963; Zazula et al., 2013). Andresen and Ewing (1964) pointed out that the UDOFT consisted of a high-speed general-purpose digital computer, input/output conversion equipment, two aircraft cockpit mockups, and instructor consoles. In addition, the UDOFT could make flight-related calculations in real-time (Zazula et al., 2013). Also, the simulator could recreate flight environment for a wide variety of aircraft. Due to its flexibility and use of digital computer techniques, the UDOFT advances in design lowered the cost of computation and contributed to the advancement of digital simulation in flight trainers (Andresen & Ewing, 1964).

High-Fidelity Simulation. Fidelity in simulation refers to how closely and accurately the technology adheres to reality (Beaubien & Baker, 2017). Fidelity is commonly presented in two levels: low or high, depending on its approximation to reality (Munshi et al., 2015). Low-fidelity simulators provide a close imitation regarding action and control but lack many of the characteristics needed to offer users a real-life experience (Munshi et al., 2015). High-fidelity simulators aim to closely replicate reality in look, feel, and touch and include factors, elements, and relationships to immerse users in an experience closest to real-life experiences (Munshi et al., 2015). As defined by Hays and Singer (1989), "Simulation fidelity is the degree of similarity between the training situation and the operational situation which is simulated" (p. 50). In aviation training, high-fidelity simulation mirrors the experience received in aviation environments such as an aircraft cockpit or ATCT (Dow, 2015). As such, high-fidelity aircraft cockpit simulators are so realistic that users can perform take-off procedures, conduct midair maneuvers, and land the aircraft (Dow, 2015). Life-sized full-motion simulators offer a full sense of realism as one would experience during a real flight, including weather conditions and turbulence (Chua et al., 2015).

Similarly, ATCT and TRACON simulators are high-fidelity systems that present learners with the same level of intensity they would expect to experience while managing day-to-day air traffic (Chua et al., 2015; FAA, 2020c). In addition to being a training tool, high-fidelity simulation systems are also used in ATC in several ways: as an instrument of measurement and for research and development (Dow, 2015; Li et al., 2012; Thomas et al., 2001). Simulators are used in ATC to measure ATCSs' performance, efficiency, situational awareness, and task complexity (Thomas et al., 2001; Zhang, 2016).

Scenario-Based Learning in Simulation. Scenarios are used in training to provide students with a platform to experience real-world activities and events in a controlled setting (Lynch, 2005). Scenario-oriented learning experiences generally occur in a controlled setting such as a simulation laboratory, and the scenarios are designed to include critical operations that need the most practice (Aebersold, 2018; Bolczak & Celio, 2005). Scenario-based simulators can incorporate problem-solving tasks and activities specifically designed for users to experience real-world situations and events, practice skills, and make judgments and decisions (Lateef, 2010). Researchers found that learners perceive scenario-centric simulation to be a more desirable training solution than traditional methods (Clark, 2009). Therefore, much emphasis, consideration, and preparation must go into the construction of scenarios for simulations to be successful (Kupfer et al., 2013). Researchers Coyne et al. (2017) found high-fidelity with multiple scenario options and sufficient capabilities to be essential features incorporated when designing the simulation. Many scenario-based simulators are highly adaptable, allowing learners to find solutions for a wide range of problems (Coyne et al., 2017). Because of its realism and ability to be manipulated, scenarios have been known to expedite skills development, especially in circumstances where learning job-specific skills cannot be successfully completed in the natural controlled setting or in a situation where safety will be compromised (Bolczak & Celio, 2005; Clark, 2009; Coyne et al., 2017).

Instructional Simulation. Instructional simulation is particularly useful in situations that do not justify actively training in unsafe environments (Vahdatikhaki et al., 2019). Across industries, simulation allows organizations to provide formal training to the employees (Noe et al., 2014) that they "would otherwise have to obtain through on-the-job training" (Coyne et al., 2017, p. 4). Simulation is the use of technology to recreate and render real-world conditions and events. According to Koskela and Palukka (2011), simulators can be used as strategic teaching tools by preparing students for the complexities in their respective professions. When successful, simulation training provides students with enhanced or enriched learning experiences (Updegrove & Jafer, 2017). Simulators set the stage for students to work in a realistic environment without the risks generally associated with dangerous or safety-centric jobs (Fothergill et al., 2009; Macchiarella & Meigs, 2008; Manning, 2000; Surakitbanharn, 2017). Simulation allows researchers and practitioners to collect critical data used to inform decision-making (Onggo & Hill, 2014). Also, simulation provides a platform where students can actively learn (Noe et al., 2014). In the United States, the utilization of simulation for training purposes differs among industries. Since its inception in the instructional setting, simulation has been utilized by the military, medical, law enforcement, first responders, aviation, transportation, education, and research institutions (Onggo & Hill, 2014).

The military uses instructional simulation to improve military personnel's combat readiness, judgment, and decision-making skills (Child, 1997; Rice, 2016; Riotto, 2021). Simulation is used to increase the military tactical advantage in both air and ground operations. Before partaking in live flight training, military pilots train on real-time air and ground combat simulators (Dutta, 1999), which are used to develop their combat skills and weapon utilization.

The military also uses simulation-based driver training to prepare Army and Marine Corps personnel for deployment in a variety of geographic locations and terrains (Child, 1997).

The medical field is one of the prominent users of instructional simulators as it plays a vital role in the training of medical practitioners (Moran et al., 2018). It is also an ideal mode of evaluating the aptitude of medical students (Havyer et al., 2016). The early training simulations used in the medical field were simple human patient mannequins (Meller, 1997). The Harvey Cardiovascular Patient Simulator, for example, was created in 1968 by Dr. Michael Gordon (Rosen, 2008) to improve the "bedside cardiovascular examination skills of medical students" in residence (Cooper & Taqueti, 2004, p. 14). The Harvey mannequin is documented as being one of the first medical training simulators created (Cooper & Taqueti, 2004). Some of the common uses of simulation in medical education are "internal medicine, emergency medicine, obstetrics-gynecology, pediatrics, surgery, and anesthesiology" (Passiment et al., 2011, p. 2). Between 1987 and 2003, there were 23 types of simulators and at least 20 different types of tasks identified for training medical personnel (Cooper & Taqueti, 2004). A study conducted by Hustad et al.'s (2019) aimed to "explore nursing students' experiences of simulation-based training and how the students perceived the transfer of learning to clinical practice" (p. 1). Hustad et al. (2019) found that participants use what they learned during simulation training in the clinical setting. Hustad et al. (2019) also found that participants believed that the simulation activities improved "their self-confidence, skills and clinical judgment" (p. 7) and communication skills.

Law enforcement and first responders are trained in simulation systems to acquire critical skills. Law enforcement personnel are trained on the appropriate use of force, tactical judgment, driving maneuver, and proper use of firearms (Baggett, 2001; Nepelski, 2019). Like the Army and Marine Corps, law enforcement also uses driving simulators to train police officers on the proper operation of their patrol cars (Ferrarin, 2014; Nepelski, 2019). The fire department and Emergency Medical Services professionals also capitalize on the benefits of simulation. They, too, use driving simulators such as fire trucks and ambulance simulators. In addition, first responders use simulation as a tool for improving situational awareness, cardiopulmonary resuscitation, and defibrillation training (Ferrarin, 2014).

Simulation technology is widely used in the aviation industry. Simulation training is a well-established approach to training pilots and ATCS (Updegrove & Jafer, 2017). Simulators test theoretical and practical knowledge about aviation communication and strategies on vectoring aircraft through the NAS (Antosko et al., 2014). To ensure sufficient qualified employees, the FAA utilizes simulation for education and training (FAA, 2020d). The simulators used by the FAA incorporate real-time traffic scenarios to develop the skills and experience of ATC personnel (Cox, 2010). According to Updegrove and Jafer (2017), simulation is the only available method of instruction that allows highly skilled and detail-oriented professions such as ATCS to gain hands-on air traffic experience. Flight simulators are instruments used in the aviation industry to teach pilots how to fly (Hall, 2011). As stated by Hall (2011), flight simulators improve communication skills and decrease pilot errors by allowing them to train on devices that duplicate actual airplane cockpits. Flight simulation improves aviation safety, reduces costs of training, and reduces the potentially damaging effects on the environment (Gheorghiu, 2013).

ATC Training Simulation. According to Updegrove and Jafer (2017) and Buck and Pierce (2018), the FAA utilizes simulation to teach DEVs and CPC-ITs at all three phases of professional development: initial qualification training (IQT), field qualification training (FQT), and general reoccurring training (GRT). During IQT, the first phase of technical training, the FAA use simulation to train newly hired ATCSs basic ATC skills such as "air traffic academics, part-task training, and skills-building" (Updegrove & Jafer, 2017, p. 2) before they report to their duty locations. DEVs who complete the IQT phase must also complete the FQT at their assigned duty location before obtaining the status of Certified Professional Controllers (CPC), where they must be successful at scenario-centric site-specific simulation training before they are allowed to control live traffic (Buck & Pierce, 2018; U.S. Government Accountability Office, 2019). During FQT, DEVs receive site-specific simulation training on the new equipment, procedures, surrounding airspace, and airport terrain at the new duty location (FAA, 2018d). ATCSs in the GRT phase are considered CPC-IT. CPC-ITs are ATCSs with previous experience who transferred from a lessor or higher level (in complexity) ATC facility (FAA, 2018d). Like the FQT, ATCSs in GRT also receive site-specific simulation training. However, the type of simulation training depends on the air traffic operating domain (FAA, 2020d).

ARTCC, ATCT, and TRACON domains differ significantly in operation and scope. Hence, the simulation technology used to train ATCS in these domains is distinguished from each other in terms of capabilities (Chua et al., 2015; FAA, 2020d; Prevot et al., 2014). Despite their differences, simulation training in each of the three domains integrates similar elements within their simulation training that embodies the essential fast-paced, high-risk scenario environment conducive to training ATCSs (Chhaya et al., 2018). EnRoute ATC training simulation is equipped with the capabilities necessary to adequately train ATCSs for ARTCC operation. For example, the EnRoute Automation Modernization, commonly known as ERAM, simulator emulates contemporary tools, processes, and functionality capabilities for managing EnRoute airborne traffic in a realistic setting (Prevot et al., 2014). Simulation accounts for approximately 60% of the time allocated to the Initial En Route Qualification Training course at the Mike Monroney Aeronautical Center (sometimes referred to as the FAA Academy or simply the Academy) located in Oklahoma City, Oklahoma (Chhaya et al., 2018; Updegrove & Jafer, 2017).

Terminal ATC simulation was built to accommodate the TRACON or ATCT operations. TRACON simulations, such as the Standard Terminal Automation Replacement System (STARS) ATCoach, also closely mimic airborne traffic activities but within defined terminal airspace (FAA, 2020c). During FQT, DEVs or CPC-ITs assigned to facilities with STARS must first complete the ATCoach simulation before performing terminal radar ATC operations (FAA, 2020c). ATCT ATC training simulation differs from the ARTCC and TRACON. These terminal simulators teach ATCSs to manage aircraft during landing, while on the runway and taxiway, and during takeoff (FAA, 2018d, 2020c). According to Chua et al. (2015), some of the ATCT simulation systems used by the FAA are full-sized 3D replicas of real ATCT. For instance, the high-fidelity tower simulation system at the Orlando and FAA Academy simulation facilities has a visual display paneled around the room to emulate the windows in an ATCT (Chua et al., 2015). These simulation systems were designed to run scenarios of any FAA-controlled airport, enabling ATCSs to benefit from the realism of a real ATCT.

Air Traffic Control

In 1958, President Dwight D. Eisenhower signed the Federal Aviation Act. The Federal Aviation Act of 1958 was created by the United States Congress to authorize the formation of the Federal Aviation Agency (United States Congress, 1958), currently known as the FAA, and giving the FAA jurisdiction to manage and control the navigable airspace throughout the United States (FAA, 2019; United States Congress, 1958). This act took the functions, powers, and duties of the Civil Aeronautics Administration and transferred these responsibilities to the newly formed, federally run FAA, expanding the authority to handle aviation safety (Aronne, 1963). The FAA was also given the authority to develop and maintain the facilities and equipment that support air navigation and ATC (Aronne, 1963; FAA, 2019). The primary goal of the U.S. Congress was to create a regulatory body capable of providing a safe and efficient way for civil, military, and general aviation flights to navigate the United States (Aronne, 1963; United States Congress, 1958). The FAA was tasked with regulating the safety of civil aeronautics. In the interest of aviation safety and efficiency, the FAA developed several safety rules and regulations, classification of flight standards, and issuance, suspension, and revocation of certifications (FAA, 2019). The FAA is also involved in conducting inspections and investigations of aircraft-related accidents (Aronne, 1963; FAA, 2009; Sconfienza, 1996; United States Congress, 1958). In compliance with the FAA Act of 1958, the FAA developed a conventional system of ATC and navigation for preserving and improving military, general, and civil air transportation. This system is called the NAS (Aronne, 1963; Sconfienza, 1996).

The NAS is a complex environment crafted by the FAA to ensure the safety and efficiency of air navigation throughout the United States (FAA, 2017b; Underwood et al., 2016). The NAS is the world's busiest, safest, most efficient, and most complex air transportation system (FAA, 1989; Underwood et al., 2016). The NAS has three distinct sections: (a) airports; (b) the appropriate rules, regulations, policies, and procedures for operating in the U.S. airspace; and (c) a network of ATC facilities, systems, and equipment (Gray & Rabb, 1971). Operating in each component of the NAS requires optimal skills, experience, and education. For example, pilots, ATCS, and Aviation Safety Inspectors all need specialized training (Arbula et al., 2016; Hopkin, 2017; Telfer, 2018). While all three sections of the NAS are needed to highlight the importance of effective ATC training, this study is primarily concerned with one part, the ATC system.

ATC Facilities and Functions. The NAS is a complex network of people, regulations, and ATC systems (Underwood et al., 2016). There are approximately 14,000 federal ATCS working at ATCTs, TRACON, EnRoute, and service centers throughout the United States (Archer, 2018; FAA, 2018b; Hite, 2004). According to NATCA (2019), the ATCT is a facility that manages air traffic from the airport, where the facility is located up to a radius of three to 30 miles out. The ATCSs that work in this facility are responsible for giving "pilots taxiing and take-off instructions, air traffic clearance, and advice based on observations and experience" (NATCA, 2019, para. 3). The TRACON is typically housed within a radar room within the FAA facility, and the ATCSs in this area are in charge of utilizing ground radar, automation, and communication equipment to manage aircraft within their airspace before transferring them to the ARTCC (Durso & Manning, 2008; NATCA, 2019). EnRoute centers and other service centers are located in 24 ARTCCs throughout the United States and not located at airports (NATCA, 2019). EnRoute ATCSs are responsible for giving "aircraft instructions, air traffic clearances, and advice regarding flight conditions during the EnRoute portions of flights" (NATCA, 2019, para. 5). These ATCSs are responsible for providing air navigation services to thousands of airplanes at any given moment. ATCSs are also responsible for the assistance in moving hundreds of millions of passengers per year, as the ATCs must communicate with hundreds of thousands of pilots to navigate aircraft to their destinations (FAA, 2015, 2018a).

As ATCT, TRACON, and ARTCC ATCSs focus on planes, management teams at the Air Traffic Control Systems Command Center (ATCSCC) help ATCSs see the big picture (Comitz, 2013; Hite, 2004). The ATCSCC ATCSs do not speak directly to pilots, instead, they coordinate nationally with airline officials, fellow ATCS, military personnel, and other users of NAS resources to keep things moving safely and efficiently (Hite, 2004). The ATCSCC provides pre-flight and in-flight services such as flight plans, weather updates, and NAS status reports (Comitz, 2013; Hite, 2004).

Air Traffic Operating Domain. The terminal ATC environment is made up of ATCTs and TRACON (Hite, 2004). ATCSs working at the ATCT manage aircraft on the ground after they land and before take-off (Hite, 2004). Before passengers are allowed to board a plane, the pilot must file a flight plan and receive a pre-flight briefing from the FAA (FAA, 2016b). The aircraft will not taxi until a ground ATCS in the ATCT, monitoring and controlling the planes on the airport operations area (AOA), approves it (FAA, 2016b). The ground ATCS will direct the aircraft along the taxiways to the runway where a local ATCS, also in the ATCT, assumes control of the plane (FAA, 2016b). The local ATCT will safely guide the aircraft through takeoff and over a set course beyond the airport's boundary (within four nautical miles), where the TRACON ATCSs take control (Hite, 2004).

The TRACON may be located at an airport or another location that manages the arrivals and departures for many surrounding airports. Unlike tower ATCSs, TRACON ATCSs work exclusively from radar scope and do not have the capability of looking at a plane through a tower window. TRACON ATCSs separate aircraft within about 50 nautical miles of an airport's airspace at altitudes of up to 17,000 feet (Vortac et al., 1994). Beyond that, EnRoute ATCSs manage the flights.

EnRoute ATCSs work at one of 21 Air Route Traffic Control Centers (ARTCC) across the NAS (Archer, 2018). Each ARTCC has a defined airspace they are responsible for, with multiple sectors inside each ARTCC's airspace (Archer, 2018). Teams of EnRoute ATCSs keep planes flying in line following fixed ground radar positions. Pilots are fully advised as communications are handed off from one airspace to another (NATCA, 2019). As the plane descends, control of the aircraft is handed over to the TRACON ATCSs, who steer the aircraft into the landing path with other aircraft approaching the airport from different directions. The local ATCS at the tower assumes control of the plane for the landing, and the ground ATCS guides the flight back to the gate (NATCA, 2019). That is just a few of the 14,000 federal ATCS keeping the flying public safe each day.

The Responsibilities of an ATCS. Air traffic management is the responsibility of certified ATCSs assigned to ATC facilities such as ATCTs, TRACONs, or ARTCCs (Hite, 2004; Santiago, 1988). The primary job function of an ATCS is to coordinate the movement of aircraft through the NAS safely (United States Office of Personnel Management, 2018). In an ATC environment, each ATCS must be proficient at maintaining an accurate mental image of air traffic flow and safely maneuver large volumes of traffic (Santiago, 1988). In addition, passengers' safety depends on the careful, swift, decisive, constant instructions of ATCSs (Santiago, 1988). An ATCS, regardless of the function of the ATC facility they work at or the complexity of the airspace, must be able to clearly speak, work in a team, and always be on the alert. Safety is the priority, but ATCSs also work towards minimizing delays (Updegrove & Jafer, 2017). Each ATCS is part of a nationwide system that creates intricate airborne maneuvers responding to weather, mechanical difficulties, and all the unforeseeable circumstances that continuously cause significant problems for pre-arranged flight plans (Comitz, 2013; Hite, 2004; Santiago, 1988).

Air Traffic Control Training

Individuals interested in becoming an ATCS must first take a federal civil service test and are examined in a way that measures their ability to cope with mental stress for extended periods (Updegrove & Jafer, 2017). The immense level of stress endured by ATCSs, the severe nature of ATC work, and the zero margin for error all contribute to the need for robust air traffic training and development programs in the FAA (USNTSB, 2016b; Updegrove & Jafer, 2017). ATCSs are trained in three distinct phases: IQT, FQT, and GRT. The IQT is the first phase of technical training, which is delivered to FAA's ATCSs at the FAA Academy (Updegrove & Jafer, 2017). Newly hired ATCSs must first attend technical training at the Mike Monroney Aeronautical Center before reporting to their duty locations (Updegrove & Jafer, 2017). The reason for this training is to ensure that trainees have the technical aptitude to be a successful ATCS. As such, becoming a permanently hired ATCS in the FAA is contingent on how well an individual performs in the IQT phase. Failing the IQT will result in immediate removal from the agency (Updegrove & Jafer, 2017). In contrast, successful completion of the IQT will generally result in the assignment of the ATCS to their permanent field facilities such as ATCT, ARTCC, or TRACON.

The ATCSs who successfully complete the IQT must also complete the FQT at their assigned duty location before obtaining the status of CPC. According to Updegrove and Jafer (2017), the process can take upwards of 3 years to complete. During the FQT phase, the ATCS participates in site-specific training, which varies depending on the size and complexity of the operation (Updegrove & Jafer, 2017). Also, reassignment to a new duty location will require trainees to learn the operations at their new work location. On an as-required basis, ATCS may also need to participate in the third phase, GRT. ATCS participate in the GRT phase to "maintain and upgrade the knowledge and skills necessary to apply air traffic procedures in a safe and efficient manner" (FAA, 2018d, p. 4).

Linking Skill Enhancement to Simulation Technology

The findings in the most relevant literature reviewed concluded a positive correlation between simulation technology and the enhancement of skills. Bauer (2005) investigated the training effectiveness of three simulation configurations (PC-based, motion training, and no-motion training systems). Bauer discovered a positive correlation between learning and all three simulation configurations. Also evident from the research, knowledge can be attributed to the pilot simulator's physical characteristics (Bauer, 2005). In the study, Bauer placed 45 helicopter pilots in a search and rescue mission scenario on the three simulator environments. Bauer wanted to measure the enhancement of simulated helicopter control throughout the instruction program. The pilots were given pre- and posttraining questionnaires to measure simulation configuration differences. The study's findings showed that training performance improved in all three simulation configurations. Bauer concluded that the physical characteristics of pilot simulators directly correlated with learning outcomes.

McDermott (2005) sought to investigate if pilot proficiency is an attribute of flight simulation. McDermott compared the effectiveness of a computer-based aviation training simulator and an FAA-approved Flight Training Device at maintaining pilots' proficiency. McDermott (2005) found that pilots' mental and physical proficiencies realistically mirrored the behaviors displayed when in the simulators. The research was conducted on 63 randomly selected pilots from an FAA database of 308 pilots residing in the northwest Ohio region. McDermott mailed the pilots a questionnaire to collect information about their flight and instrument experience. The investigation demonstrated that learning occurred during the simulations. The research also found that pilots' mental and physical proficiencies are realistically duplicated when exposed to aviation instructional simulation (McDermott, 2005).

Despite the positive support for simulation in education, a positive correlation between instructional simulation and learning outcomes is not shared universally among researchers. Jentsch et al. (2011) found that simulation technology has long superseded aviation training. Jentsch et al. concluded an over-dependency and misuse of high-fidelity simulations to enhance the aviation industry's complex skills. Jentsch et al. (2011) inferred that simulation is only a tool that helps strengthen skills, and therefore, does not guarantee learning outcomes. Previous research supports this argument, professing that simulation is not used to teach; instead, simulation aims to closely replicate or simulate the experience (Ennis, 2009). Caro (1971) studied the importance of selecting the appropriate flight simulators required to attain measurable educational objectives. Caro (1971) reported that instructional design is a stronger contributing factor to training effectiveness than simulation attributes.

The Effectiveness of Simulation for ATC Training

Lindenfeld (2016) conducted a study to "determine the level of influence simulation had on student perception of" (p. 10) ATC competencies to stay the course and pursue a career as an ATCS. Lindenfeld (2016) also wanted to know the impact of exposing students to ATC simulators before committing to a job in ATC. The study found that students showed significant changes in "perceptions of their level of air traffic control knowledge, air traffic control skill, academic self-efficacy, student motivation, and deep learning" (Lindenfeld, 2016, p. 6) after completing an ATC simulation course. Lindenfeld (2016) surveyed 90 students from four U.S. colleges and universities to determine possible correlations between ATC students' perceptions of the eight above-mentioned dimensions and their "motivation to pursue a career as an ATCS"

(p. 6). The survey's intended purpose was also to determine the difference in student commitment to become ATCSs before and after participating in simulation training. Lastly, Lindenfeld (2016) wanted to know how student perceptions of these dimensions influenced the student's commitment. The survey measured students' perception level on an agree/disagree scale. Though the study provided evidence to support the practicality of utilizing an instructional simulator to help participants gain ATC knowledge, ATC skills, academic self-efficacy, student motivation, and deep learning, Lindenfeld (2016) recognized the research could have been more credible by increasing the number of colleges and universities under study.

Nadler's (1996) research tested and evaluated an instructional simulator used to train ATCSs assigned to Chicago O'Hare's ATCT. Nadler aimed to quantitatively measure and analyze instructional ATC simulators' usefulness at complex high-traffic airports. Nadler (1996) was interested in determining the impact the simulation training has on the time it takes for each ATCS to complete their certification. The study also hoped to discover if any savings would benefit stakeholders such as airlines, pilots, and airport operations. Lastly, Nadler was interested in evaluating the simulator's impact on the direction of emerging technology. Nadler (1996) acknowledged there were some flaws in his research. For example, Nadler conducted the study using a sample size of only 10 DEVs. Also, there were inconsistencies in the training method. Nadler (1996) also indicated that a small concurrent control group limited the research. Nadler used historical training data, evaluation of Supervisory ATCS (SATCS), and objective evaluation of pre-recorded training videos to evaluate the simulator's effectiveness. Nadler (1996) analyzed the data by comparing the facility training record with the time a DEV took to become a CPC. Nadler (1996) strengthened his research by evaluating SATCS on their perception of simulation-based to non-simulation-based training in preparing ATCS. The study revealed that simulation-trained ATCS completed their training in 50.1 days less than a traditionally-trained controller, indicating a 25% difference in day-to-certification (Nadler, 1996).

ATC Simulation for Measuring Performance

High-fidelity simulator and simulation systems are used in ATC in several ways, including as a training tool as an instrument of measurement, and for research and development (Dow, 2015; Li et al., 2012; Thomas et al., 2001). Simulators are used in ATC to measure ATCSs' performance, efficiency, situational awareness, and task complexity (Thomas et al., 2001; Zhang, 2016).

Situational Awareness. Zhang (2016) used ATC simulation as a performance measurement tool to examine ATC students' situational awareness. The concept of situational awareness is commonly used in the aviation industry to describe a person's perception, interpretation, and decision-making (Nuutilainen, 1997). As described by Endsley (2017), situational awareness is "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (p. 36). Simply put, situational awareness is being mindful of what is occurring around you. Researchers have shown that a lack of situational awareness contributes to human errors related to aircraft incidents in the United States (Endsley, 2017; Zhang, 2016).

Zhang (2016) conducted a study to understand if administering Situation Presence Assessment Method (SPAM) questions to ATC students during simulation impacted their workload and performance. Zhang (2016) measured the participants' situational awareness by "the accuracy of their answers and the latency of their responses to the SPAM questions" (p. 3). Zhang concluded that ATC students' task performance during SPAM questioning was significantly lower than when participating without the SPAM administration. However, the impact of situational awareness on students' workload was inconclusive (Zhang, 2016).

Technological Impact. Van Eck et al. (2015) sought to understand if "exposure to visually intensive technologies" (p. 198) such as playing videogames affected ATC students' performance. Van Eck et al. conducted a study to measure the students' ATC simulation task performance. Like videogames, simulators are visually intensive technologies that force operators to "regularly practice and demonstrate visual pattern recognition skills such as … counting on-screen objects, tracking moving objects, speed of pattern recognition" (Van Eck et al., 2015, p. 200). Van Eck et al. (2015) replicated the Green and Bavelier (2006) study by exposing ATC students who were non-gamers to hours of videogame play, then embedding the students in ATC simulation. Van Eck et al. (2015) found that previous videogame experience had no significant bearing on ATC students' task performance. Instead, experience in the ATC training program significantly contributed to the students' task performance.

Psychological Readiness. Antosko et al. (2014) conducted a psychological readiness study to assess how human factors affect concentration and work performance in fully qualified ATCSs. This study used the LETVIS simulator to test the theoretical and practical knowledge of ATCSs in a 24-hour period. Participants' psychological readiness was determined by reaction time, "correct motor function, and the reaction to audio and visual stimuli" while also considering circadian rhythm (Antosko et al., 2014, p. 6). Antosko et al. included an error ratio to determine the reliance of responses, reaction time, and the total number of tasks. For example, Antosko et al. decided that ATCSs decision-making correctness is more significant than the time it takes to make decisions. Consequently, to assess ATCSs' psychological readiness, Antosko et al. prioritized accuracy over reaction rate by incorporating an error ratio. "The error ratio expresses reliance on incorrect responses, reaction time, and the total number of tasks" (Antosko et al., 2014, p. 7). Antosko et al. concluded that at a critical point of loss of concentration and reduced work performance occurred after 8 hours of testing. The finding also showed that a critical point was reached after testing for 12 hours (Antosko et al., 2014).

Students' Perception of ATC Training

Students' perspective is essential because it allows for assessing the quality of education by providing feedback about the value and appropriateness of lessons, courses, or programs and other quality assurance processes from learners' point of view. Perception is characterized as "the subjective, individualized meaning of the stressful event and is determined by the individual's unique way of taking in, processing, and using information from the environment" (McQuillan et al., 2009, p. 423). For instance, learners can judge situations and processes such as the value of simulation on enhancing air traffic knowledge, performance skills, judgment, critical thinking skills, and self-confidence. Learners' perceptions are an integral and commonly used approach to understanding how valuable simulations are at providing learning outcomes. Several studies were conducted on the perception of aviation workers, specifically, the perceptions of ATCSs and learning the impact of simulation-based learning (Coyne et al., 2017; Dow, 2015; Georgiou et al., 2017; Lindenfeld, 2016).

Coyne et al. (2017) studied the use of high-fidelity ATC simulation used in Air Traffic Collegiate Training Initiative (AT-CTI) programs at "Embry-Riddle Aeronautical University, the University of North Dakota, the Florida Institute of Technology, Hampton University, Minnesota State University-Mankato, and Florida International University" (p. 10). Coyne et al. evaluated 86 current and former students' perceptions of ATC instructional simulation usage on the following factors: effects of stress, enhancing ATC knowledge, future expectations, and effectiveness. Coyne et al. identified that students with prior ATC and simulation experiences have different perceptions about simulation. Coyne et al. also found the degree to which instructors supported learners' and learners' stress levels during simulation training as influential factors in the study. According to Coyne et al. (2017), students' perception indicated that ATC simulators are a beneficial mode of delivering air traffic training.

Researcher Dow (2015) studied participants' perceptions to determine how simulations of varying degrees of fidelity in the ATC EnRoute domain should be categorized and employed. The research showed "that simulation fidelity was not well defined for EnRoute ATC" (Dow, 2015, p. 154). Dow (2015) used the participants' perceptions in the research to create five categories that differentiated different simulations by their level of fidelity. Dow recommended these categories for use in various ATC domains.

Georgiou et al. (2017) stressed student perceptions to ascertain ATC simulation's value at preparing ATCS for their jobs. Georgiou et al. (2017) concluded that students found the simulation laboratory helpful in developing their communication skills, coordination, and the ability to work well in a team environment. Additionally, findings revealed that participants' perception of ATC simulation-based training directly correlates to the development of their ability to solve complex problems (Georgiou et al., 2017).

Lindenfeld (2016) evaluated 90 students in an aviation degree program to determine the influence ATC simulation has on students' perception of ATC "knowledge, ATC skill, academic self-efficacy, student motivation, and deep learning" (p. 6) to stay the course and pursue a career as an ATCS. Lindenfeld also used students' feedback to determine the impact of exposing students to the ATC simulator before committing to the ATC career. The study concluded that aviation students lacked the needed ATC skills required to function as an ATCS. Additionally, findings revealed that participants perceived they lacked the skills, awareness, and ability to use job-specific ATC technology and techniques (Lindenfeld, 2016).

Mante (2019) conducted an exploratory, descriptive non-randomized study to explore if newly licensed graduate nurses perceive their simulation experiences impacted their self-confidence. Though Mante (2019) found that simulation technology directly affects participants' overall anxiety level, the researcher found evidence that suggested students perceived "their simulation experiences and determined that there is no sufficient evidence that simulation has an impact on enhancing self-confidence" (p. 14). Still, the study also found that simulation technology is a valuable model for administering training instead of traditional training methods (Mante, 2019).

Hurst's (2015) study was conducted to explore sophomore and senior baccalaureate nursing students' perceptions of selected aspects of high-fidelity simulation and the impact of their "perceptions on students' satisfaction and self-confidence in learning" (p. 7). Hurst (2015) found evidence that indicated participants perceived simulation training as an effective instructional method for enhancing nursing skills. The researcher concluded that students were generally satisfied with their simulation learning experiences. However, senior students and students with industry experience were less satisfied and less self-confident (Hurst, 2015).

Conceptual Framework

This research incorporated Benjamin Bloom's work to explore the extent to which ATCSs perceive simulation as a valuable instructional method for enhancing ATC competencies, including the six major levels of cognitive learning. I chose Bloom's taxonomy of the cognitive domain (Bloom et al., 1956) to guide the investigation into the perceived value of the scenario-based ATCoach instructional training scenario configurations used for training ATCSs. Bloom's taxonomy is a renowned model used in academia to understand learning better and improve learning. The cognitive domain helped me better understand ATCSs' perceptions of the value of the ATCoach in providing the experience to develop their ATC job-related competencies needed to perform safe operations in the real air traffic environment. Specifically, this study used Bloom's taxonomy to explore the extent to which ATCSs perceive simulation as a valuable instructional method for enhancing ATC knowledge, performance skills, judgment, critical thinking skills, and self-confidence.

The Historical Origins and Purpose of Bloom's Taxonomy

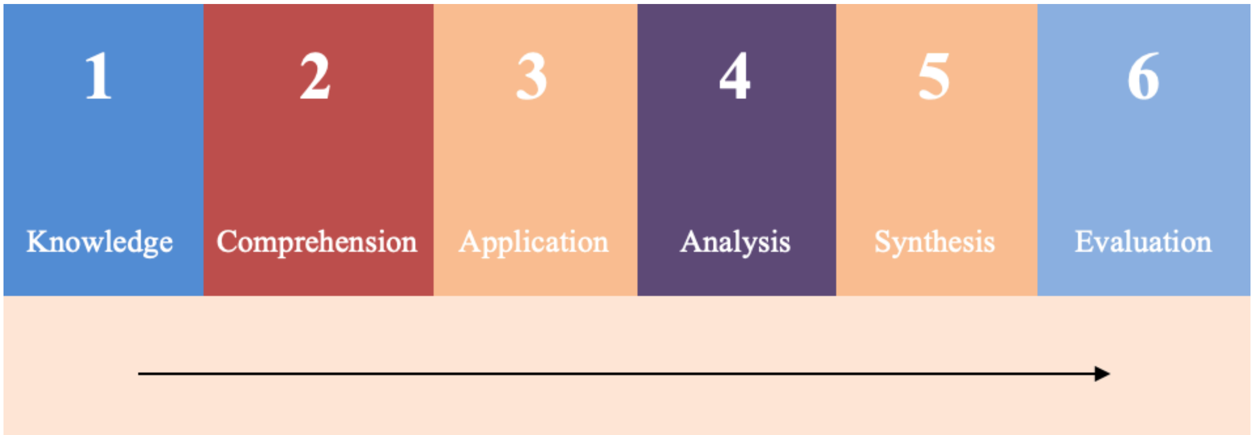
Benjamin Bloom is an author, scholar, researcher, and education psychologist known in the education community for his contributions to learning and development, specifically, the creation of Bloom's taxonomy. In the 1950s, Bloom chaired a committee of educational practitioners from around the United States who collaborated to create the original version of Bloom's taxonomy (Bloom et al., 1956). Bloom et al.'s (1956) committee crafted the original taxonomy model considering high school level learners. Still, the model is applicable and has proven effective in other educational stages (Keating et al., 2018; Orlich et al., 2018). Since its creation, the model has undergone several minor modifications by Bloom and his colleagues (e.g., Anderson & Krathwohl, 2001; Krathwohl, 2002; Krathwohl et al., 1964).

Krathwohl (2002) detailed the rationale for creating the original taxonomy. He stated that the taxonomy was created to "serve as a common language about learning goals to facilitate communication across persons, subject matter, and grade levels" (p. 212). Additionally, Bloom et al. (1956) wanted to create a system to help educational practitioners design curriculum and evaluate learners. In essence, Bloom's work was motivated by the desire to create a means of sharing educational practices. Bloom et al. (1956) embraced the idea that a model could be created through the classification of established learning goals and objectives. The committee also intended to define and distinguish cognition in learners to facilitate critical thinking and comprehension (Forehand, 2005).

In 1956, the committee proposed and published the first of three critical publications to codify how learners act, think, and feel relating to educational instruction. The three works are known today as learning domains in Bloom's taxonomy, including cognitive, affective, and psychomotor. Each of the three domains has a classification within itself (Bloom et al., 1956; Krathwohl, 2002). The first handbook is a well-defined model that consists of six categories (or levels) of learning that focuses on learners' intellectual abilities: comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956). This work highlights the educational objectives of the cognitive domain of learning. These six categories were crafted to help organized the learning objectives, activities, and assessments to be applicable in different educational settings (Krathwohl, 2002). The six categories of Bloom's taxonomy are often represented hierarchically (lowest to highest levels of complexity) as diagrammatically expressed in Figure 1.

Figure 1

Bloom's Educational Objectives for the Cognitive Domain



Note. Adapted from Bloom's Taxonomy of Cognitive Development, by George Mason University, n.d. (http://cehdclass.gmu.edu/ndabbagh/Resources/IDKB/bloomstax.htm). In the public domain.

Description of the Original Cognitive Domain of Bloom's Taxonomy

The cognitive domain has been used as a framework for designing, structuring, and sequencing courses, entire degree programs, lectures, seminars, learning objects, and curriculum (Darlington & Bowyer, 2017). The cognitive domain is the knowledge-based domain that consists of six categories (or levels) of learning. The cognitive domain focuses on a learner's intellectual abilities (Bloom et al., 1956). Bloom believed that learning should occur incrementally and hierarchically (from easy to difficult) through the six categories of learning. These six knowledge categories were crafted to help organized the learning objectives, activities, and assessments to be applicable in different educational settings (Krathwohl, 2002). The six levels of classification under the original cognitive domain of Bloom et al.'s (1956) are discussed further in this section when highlighting the specific domain used as the conceptual framework of this study.

Revisions of Bloom's Taxonomy

Since its creation, the model has undergone several minor modifications by Bloom and his colleagues (e.g., Anderson & Krathwohl, 2001; Krathwohl, 2002; Krathwohl et al., 1964). In 1964, Bloom et al.'s committee made the first set of modifications to the taxonomy. Bloom et al. (1956) published the modified taxonomy, which focused on the educational objectives for the affective domain. The affective domain is the attitudinal-based domain that consists of five categories of learning: receiving, responding, valuing, organization, and characterization (Krathwohl, 2002). These five categories focus on how a learner develops "attitudes, emotions, interests, motivation, self-efficacy, and values" (Schroeder & Cahoy, 2010, p. 129). The affective domain of Bloom's taxonomy is outlined in Table 1.

Table 1

Affective Domain of Bloom's Taxonomy

Category/Level	Description
Characterization	Learners will act consistently in accordance with their values and biases
Organization	Each person has their own values and biases that affect the way they organize their thought process.
Valuing	Being inclined to value the different attributes, ideas, and ideologies of others.
Responding	Being able to respond to the different attributes, ideas, and ideologies of others.
Receiving	Considering the different attributes, ideas, and ideologies of others.

Like the cognitive domain, the categories outlined in the affective domain are also presented hierarchically from the lowest level to the most complex in terms of feelings, emotions, and attitudes (Krathwohl, 2002). The receiving category is positioned at the lowest level of the affective domain. The level focuses on the reality that learners possess different attributes, ideas, and ideologies that should be considered and tolerated (Krathwohl et al., 1964). The responding level of the affective domain suggests that one should be predisposed to responding to the different attributes, ideas, and ideologies of others (Krathwohl et al., 1964). The third category, valuing level, of the affective domain states that an individual should be inclined to value the different attributes, ideas, and ideologies of others (Krathwohl et al., 1964). The organization category is positioned at the fourth level of the affective domain. This level focuses on the idea that individuals have their own values, their philosophical assumptions, and worldviews that affect the way they organize their thought process (Krathwohl et al., 1964). Lastly, characterization is the fifth and highest level of the affective domain. This level built upon the organization category and focused on the idea that learners will act consistently in accordance with their values, their philosophical assumptions, and their worldviews (Krathwohl et al., 1964).

In 2001, 45 years after it was initially published, a revision of Bloom's taxonomy was introduced. This revision credited authors Simpson (1966) and Harrow (1972) for providing the building blocks for what is known today as the psychomotor domain (Anderson & Krathwohl, 2001). The psychomotor domain addresses learners' physical abilities, such as basic motor skills, coordination, physical movement, speech development, and reading (Earle, 1981). The categories outlined in this domain are reflex movements, basic fundamental movement, perceptual, physical activities, skilled, and body language (Harrow, 1972). The psychomotor domain consists of seven categories of behavior presented hierarchically, namely, perception, set, guided response, mechanism, complex overt response, adaptation, and origination (Simpson, 1966). The psychomotor domain of Bloom's taxonomy is outlined below in Table 2.

Table 2

Psychomotor Domain of Bloom's Taxonomy

Category/Level	Description	Subcategory
Origination	Learners "originate new patterns of action in solving a specific problem" (Simpson, 1966, p. 31).	-
Adaptation	Learners are developed can modify certain required actions.	-
Complex overt response	Learners has gained a high skill level and can perform complex tasks.	Resolution of Uncertainty Automatic persistence
Mechanism	Learning complex skills through repetition.	-
Guided response	The early stages in the development of more complex skill.	Imitation Trial and error
Set	The process of preparedness before taking a given action.	Mental Physical Emotional
Perception	The process of realizing "objects, qualities or relations by way of the sense organs" (Simpson, 1966, p. 25).	Sensory Stimulation Cue Selection, Translation

The perception category is positioned at the lowest level of the psychomotor domain. Simpson (1966) stated that perception is a process where an individual "realized objects, qualities or relations by way of the sense organs" (p. 25). The perception category is divided into three subcategories: sensory stimulation, cue selection, and translation (Simpson, 1966). The set level of the psychomotor domain is described by Simpson (1966) as the stage before an individual engages in a particular act. This stage is a process of mental, physical, and emotional preparedness (Simpson, 1966). The guided response level of the psychomotor domain represents the first process an individual undergoes in developing complex skills (Simpson, 1966). The mechanism category is positioned at the fourth level of the psychomotor domain. This level focuses on the idea that complex skills are learned through repetition, and then it becomes habitual (Simpson, 1966). Complex overt response is the fifth level of the psychomotor domain where learners have developed a high skill level and can perform complex tasks with certainty and persistence (Simpson, 1966). Adaptation is the next level of the psychomotor domain. According to Simpson (1966), learners at the adaptation level are developed and therefore can modify certain required actions. Originate is the highest level of the psychomotor domain that states that learners develop new solutions to solving complex problems (Simpson, 1966).

In addition to incorporating psychomotor learning into Bloom's taxonomy, Anderson and Krathwohl (2001) revised the six categories of Bloom's taxonomy of cognitive domain by classifying the nouns with verbs to reflect how they are used in objectives (Krathwohl, 2002). The revised version of the cognitive domain of Bloom's taxonomy is outlined in Table 3.

Table 3

Revised Bloom's Taxonomy of the Cognitive Domain (2001)

Levels	Definition
Creating	Putting "elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure" (Anderson & Krathwohl, 2001, p. 68).
Evaluate	"Making judgments based on criteria and standards" (p. 215)
Analyzing	Breaking down knowledge and recognizing patterns.
Applying	Using knowledge to carry out procedures.
Understanding	Understand knowledge and the use of information.
Remembering	Recognizing and recalling knowledge.

The remember category is positioned at the lowest level of the revised version of Bloom's taxonomy of the cognitive domain and correlates with the knowledge level of the original taxonomy. Anderson and Krathwohl (2001) replaced the noun "knowledge" with the verb "remember" on the basis that learners are "expected to recall and recognize knowledge" (p. 213). Similarly, the comprehension level of the original taxonomy was revised and classified as the verb "remembering" because, according to Anderson and Krathwohl (2001), learners are expected to understand knowledge and how to use information. Anderson and Krathwohl (2001) amended the application level of the original cognitive domain by replacing the noun with the verb "applying." This third level states that learners take the knowledge learned and apply it to new situations and to carry out new procedures (Anderson & Krathwohl, 2001). The analyzing category is positioned at the fourth level of the revised cognitive domain. This analyzing level replaced the noun “analysis,” which focuses on the idea that learners are expected to skillfully examine, break down, and incorporate information learned and including that information into other situations (Anderson & Krathwohl, 2001).

Evaluate is the fifth level of the revised cognitive domain. Anderson and Krathwohl (2001) changed the position of the synthesis level of the original taxonomy with the evaluation. For instance, the synthesis level (fifth level) on the original taxonomy was moved to the sixth level of the revised version and renamed “create.” Consequently, the evaluation level of the original taxonomy was moved to the fifth level of the revised taxonomy (Anderson & Krathwohl, 2001). The evaluation level of the revised version of the cognitive domain, according to Anderson and Krathwohl (2001), states that learners at this level make “judgments based on criteria and standards” (p. 215). Create is the highest level of the revised cognitive domain. At the create level, according to Anderson and Krathwohl (2001), learners “put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure” (p. 68). A comparison of the original and revised version of Bloom’s taxonomy is outlined in Table 4.

Table 4

Comparison of the Original and Revised Taxonomy

Levels	Original Version (1956)	Revised Version (2001)
Highest	Evaluation	Create
↑	Synthesis	Evaluate
	Analysis	Analyze
	Application	Apply
	Comprehension	Understand
Lowest	Knowledge	Remember

Concepts/Domains of Bloom's Taxonomy

Bloom et al.'s (1956) taxonomy is comprised of three domains known collectively as the learning domains of Bloom's taxonomy. The three domains are cognitive, affective, and psychomotor. The cognitive domain, or original taxonomy, is the knowledge-based domain that consists of six categories (or levels) of learning that focuses on learners' intellectual abilities: comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956). The affective domain is the attitudinal-based domain that consists of five categories of learning: receiving, responding, valuing, organization, and characterization (Krathwohl, 2002). These five categories focus on how a learner develops in "attitudes, emotions, interests, motivation, self-efficacy, and values" (Schroeder & Cahoy, 2010, p. 129). The psychomotor domain addresses learners' physical abilities, such as basic motor skills, coordination, physical movement, speech development, and reading (Earle, 1981). The categories outlined in this domain are reflex movements, basic fundamental movement, perceptual, physical activities, skilled, and body language (Harrow, 1972). The psychomotor domain consists of seven categories of behavior presented hierarchically from simple to complex: perception, set, guided response, mechanism, complex overt response, adaptation, and origination (Simpson, 1966). Anderson and Krathwohl (2001) revised the six categories of the original taxonomy of cognitive domain by classifying the nouns with verbs to reflect how they are used in objectives: remember, understand, apply, analyze, evaluate, and create (Krathwohl, 2002).

The Original Taxonomy as the Conceptual Framework

I opted to employ the original version of the cognitive domain of Bloom et al.'s (1956) taxonomy to frame the evaluation of the value of ATC simulation training. The original taxonomy is comprised of six levels of classification (Bloom et al., 1956; Krathwohl, 2002). The levels of classification under the original cognitive domain are comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956). I used the sixth level of classification to examine ATCSs' perceptions of their simulation experience as it relates to their perceived development of ATC job-related competencies: knowledge, performance skills, judgment, critical thinking skills, and self-confidence. These six classifications of the original cognitive domain have helped in analyzing the learning objectives, activities, and assessments to be applicable in different educational settings (Bloom et al., 1956; Krathwohl, 2002). The original version of the cognitive domain of Bloom's taxonomy is outlined in Table 5.

Table 5

Original Bloom's Taxonomy of Educational Objectives, Cognitive Domain (1956)

Category/Level	Description
Evaluation	Analyze, critique, and compare facts, concepts, and answers regarding an area of interest.
Synthesis	Differentiate and compare one thing to another and formulate plans to develop strategies for accomplishing complex tasks.
Analysis	Analyze by examining and breaking down information into elements on the fourth level, determining the interconnection and relationship between the components.
Application	Provides opportunities for learners to apply what they know in a meaningful way.
Comprehension	Understand by decoding information.
Knowledge	Remember through memorization and recollection of relevant facts, concepts, and answers, with limited understanding.

The Six Levels of Classifications of the Original Taxonomy. The cognitive domain is a framework centered on the art of perception, reasoning, understanding, and intellectual skills (Bloom et al., 1956). Bloom believed that all learning should be constructed in a manner that allows students to progress through six categories of learning incrementally and hierarchically. Specifically, learning should be constructed from easy to difficult in the following six major stages: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956).

At the knowledge level of Bloom's taxonomy of the cognitive domain, students learn to remember through memorization and recollection of relevant facts, concepts, and answers, with limited understanding (Bloom et al., 1956). This step's rationale is to set a foundation of knowledge that can affect the entire learning process (Bloom et al., 1956). For example, if a student learns about ATC, they will want to remember the "ATC" career, what it is, its purpose, its function, and who works in that job. Once the learners memorize these facts, they then transition to the second level of learning.

On Level 2, students learn to understand. In this step, learners start to decode information and learn that ATC manages airplanes from takeoff to landing (through three domains) and, if not adequately controlled, can lead to air traffic congestion, mishaps, and accidents (Bloom et al., 1956). With a better understanding of relevant facts, concepts, and information relating to air traffic, learners are better prepared to apply their knowledge and understanding of their learning or in their day-to-day operations (Bloom et al., 1956).

The third level provides opportunities for learners to apply what they know (Bloom et al., 1956). For example, students can apply air traffic knowledge in a meaningful way by using ATC procedures to communicate with other parties to safely coordinate air traffic activities. On the fourth level, students learn to analyze by examining and breaking down information into elements, determining the interconnection and relationship between the components (Bloom et al., 1956). Additionally, learners will identify evidence to support generalization regarding ATC knowledge and understanding (Bloom et al., 1956). For example, learners may study standard operating and traffic management procedures, examine FAA safety standards, and lookup communication protocols, concluding that when aircraft are at the same altitude, maintaining a 3-mile minimum separation it will significantly reduce the likelihood of a midair collision (FAA, 2020b).

After the knowledge, comprehension, application, and analysis stages, learners are ready for the synthesis level. Students at this level should truly understand ATC and differentiate and compare it to other things (Bloom et al., 1956). Learners may formulate plans to develop their own strategies for accomplishing complex tasks (Bloom et al., 1956). In an ATC training setting, learners may manage scenario-based simulation training of varying levels of complexity (aircraft traveling at different speeds and altitudes) without instructor intervention. Evaluation is the sixth and highest level, where learners analyze, critique, and compare facts, concepts, and answers regarding ATC (Bloom et al., 1956).

Appropriateness of Bloom's Taxonomy in the Study

The primary justification for using Bloom's taxonomy as the conceptual framework for this study is that it is widely accepted in the education arena as a credible and reliable model for underpinning training-related research (Jang et al., 2019; Judy, 2018; Knoesel, 2017). Bloom's taxonomy of the cognitive domain offers researchers a pedagogical foundation for building and framing their simulation-based education research studies, including as a theoretical rationale for the importance of fieldwork, laboratory education, and simulation training (Jang et al., 2019;

Judy, 2018; Knoesel, 2017). In its framing, Bloom's taxonomy provides theoretical scaffolds (building upon previous knowledge) for constructing the progression of simulation experiences that are most helpful in developing the competencies of ATCSs (Mulcare & Shwedel, 2017). Lastly, Bloom's taxonomy of the cognitive domain will also fill the identified gap of using the model to frame research relating to ATC. While the taxonomy is not accepted by all as a reliable model for expressing measurable student learning outcomes (Case, 2013; Stanny, 2016), the evidence in support of its use in the educational setting is convincing. The cognitive domain of Bloom's taxonomy has been used as a framework for designing, structuring, and sequencing courses, entire degree programs, lectures, seminars, learning objects, and curriculum (Darlington & Bowyer, 2017).

The justification for using the original version of Bloom's taxonomy instead of the revised version is threefold. First, the terminologies of the original taxonomy better align with the job-related ATC competencies. Second, I believed that the ATC training was more aligned with the original taxonomy because "create" is not an inherent ATC training or operational product. For example, both the original and revised versions of Bloom's taxonomy consist of six levels and are presented incrementally and hierarchically from easy to complex (Bloom et al., 1956). Create is the highest or most challenging level of the revised version of the taxonomy. Create, according to Anderson and Krathwohl (2001), means to "put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure" (p. 68).

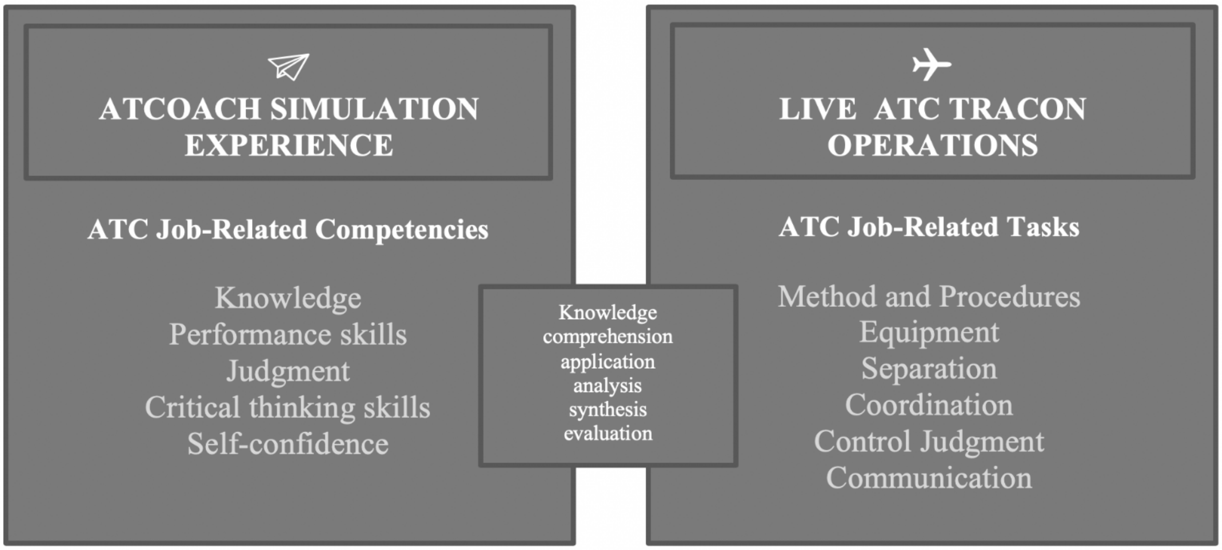
On the other hand, "evaluate" is the highest or most difficult level of the original version of the taxonomy. To evaluate means to analyze, critique, and compare facts, concepts, and answers on particular matters (Bloom et al., 1956). The evaluation of ATCS aligns with ATC training for certification. Third, I selected this model because it was ideally structured to support the study's interest, exploring the participants' perceptions relating to the value of the simulator on the ATC job-related competencies based on six categories outlined in Bloom's taxonomy.

Use of Bloom's Taxonomy in this Study

This research study summarizes the topic Air Traffic Control Specialists' Perceptions of Simulation for Developing Job-Related Competencies. The study's problem sought to investigate how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies. The original Bloom et al.'s (1956) taxonomy of the cognitive domain provided the framework to focus attention on the extent to which simulation is perceived by ATCSs as a valuable instructional method for developing their ATC job-related competencies needed to perform safe operations in the real air traffic environment. This section describes how the original Bloom's taxonomy of the cognitive domain (Bloom et al., 1956) was used in this study to focus attention on the problem from the perspective of ATCSs. Specifically, I used Bloom's taxonomy to hear, in participants' own words, about their experiences with the ATCoach and to what extent they perceived it as a valuable instructional method for enhancing these competencies. Figure 2 shows the six levels of the original Bloom's taxonomy of the cognitive domain (Bloom et al., 1956), six ATC job-related tasks used to evaluate CPC-ITs for certification, and the ATC job-related competencies used in this study to assess the value of the ATCoach.

Figure 2

Application of Bloom's Taxonomy in this Study



Since the purpose of this qualitative exploratory case study was to understand how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies, I drafted the following overarching research question, how do ATCSs at an air traffic facility in the southeastern region of the United States describe their experiences with the ATCoach in developing job-related competencies? I used the six levels (or classifications) of the original cognitive domain to create six SRQs to answer the overarching research question and ultimately accomplish the study's purpose. Each of the six SRQs is guided by one of the six levels of classifications of the original taxonomy Bloom's taxonomy. The six SRQs were used to gather critical information, through the lens of the original taxonomy Bloom's taxonomy, about the development process from the perspective of the ATCS who were successful in acquiring, maintaining, and applying learned tasks, procedures, and decision-making processes.

To get participants' perspectives, I asked several questions about their experiences with the simulator using the six levels of the original cognitive domain to help me better understand participants' learning process. Bloom et al.'s (1956) taxonomy stated that learning should occur from easy to difficult in the following six levels: knowledge, comprehension, application, analysis, synthesis, and evaluation—knowledge being the lowest and evaluation the highest. I used these six levels to craft interview questions intended on ascertaining ATCSs' perceptions of their simulation experience related to their perceived performance skills' development during simulation training.

First, I crafted four interview questions, framed by the knowledge level of Bloom's taxonomy, to assess if knowledge of basic information took place during simulation training and what knowledge was learned from ATCSs' experiences with the ATCoach. Second, I used the comprehension level of Bloom's taxonomy to craft two interview questions to assess if comprehension of basic information occurred during simulation training and how ATCSs comprehend information learned from their ATCoach experiences. Third, I used the application level of Bloom's taxonomy of the cognitive domain to determine if the application of information and skills occurred during simulation training, providing opportunities for ATCSs to apply what they knew to practice directing and managing aircraft. Fourth, I crafted three interview questions, framed by the analysis level of Bloom's taxonomy of the cognitive domain, to determine if the ATCoach provided learners opportunities to use judgment to solve complex problems by matching, classifying, analyzing errors, generalizing, and specifying knowledge to generate new conclusions (Marzano & Kendall, 2008). Fifth, I developed four interview questions, framed by the synthesis level, to determine how ATCSs perceived the simulation training impacted their self-confidence to manage complex air traffic scenarios without instructor intervention to meet the minimum requirement for radar certification. Lastly, the six classifications of the cognitive domain of Bloom's taxonomy were used collectively to determine if the ATCoach simulation system was useful at developing the critical thinking skills of ATCSs such as "comparison, classification, sequencing, cause/effect, patterning, webbing, analogies, deductive and inductive reasoning, forecasting, planning, hypothesizing, and critiquing" (Loveland & Dunn, 2014, p. 15). Table 6 shows Bloom's taxonomy of the cognitive domain depicting the six learning levels and the ATC Job-related competencies they framed.

Table 6

Application of Bloom's Taxonomy of the Cognitive Domain in ATC Training

Levels	Bloom's taxonomy	ATC Competencies
Highest	Evaluation	Judgment, critical thinking, and self-confidence for post-simulation training evaluation.
↑	Synthesis	Judgment and critical thinking
	Analysis	Judgment and critical thinking
	Application	Performance Skills
	Comprehension	Knowledge
Lowest	Knowledge	Knowledge

Application of Bloom's Taxonomy in Other Empirical Studies

This section discusses the existing body of literature relating to Bloom et al.'s (1956) taxonomy and its application in aviation-related and VR simulation research. Bloom's taxonomy is commonly used in education to underpin many assessments that learners undergo, and it describes how mastery is developed in students in many subject areas (Anderson & Krathwohl, 2001). Researchers have also used Bloom's taxonomy to examine the effectiveness of virtual airport simulation training (DeCarlo, 2010). DeCarlo (2010), Parmar (2017), Judy (2018), and Rupasinghe et al. (2010) have all used Bloom's taxonomy of the cognitive domain to underpin their studies. However, the model was used in different contexts and for different purposes.

DeCarlo (2010) conducted a mixed-method study, using Bloom's taxonomy, to examine the effectiveness of a virtual airport simulation training program for developing professional competencies of diverse adult learners at commercial airports in North America. DeCarlo (2010) also used Bloom's taxonomy to analyze nine "professional competencies variables of knowledge, situational awareness, critical thinking, communication, judgment, decision-making, crew resource management, self-efficacy and ethics" (p. 4). The researcher interviewed five SMEs and surveyed 76 airport operations participants from 12 airports in North America. DeCarlo (2010) found that the simulation was an effective mode of delivering initial airport operations training. The participants' responses suggested that the nine above professional competencies variables should be incorporated in the training program. DeCarlo (2010) indicated that the nine professional competencies could be used as a model to underpin future aviation-related research.

Judy (2018) employed Bloom's taxonomy of the cognitive domain to underpin the study to determine the correlation between time spent on simulation training compared to live aircraft training and the impact on advanced and intermediate levels of job-related competencies. Specifically, Judy (2018) sought to investigate which training mode (simulation or live) was the best predictor of "overall pilot effectiveness as measured by the Naval Standard Score" (p. 2). Judy utilized the upper classifications of Bloom's taxonomy—analysis, synthesis, and evaluation to investigate the advanced training phases and the lower levels—knowledge, comprehension, and application for the intermediate training phases. Judy found that the live flight training at the advanced phases was a more effective mode of training pilots than simulation. However, at the intermediate phases, Judy (2018) found that simulation training was more effective and efficient than at the advanced phases.

Parmar (2017) applied Bloom's taxonomy in a similar application, specifically in combination with the Structure of Observed Learning Outcomes taxonomy, to determine the risk and benefits immersion and embodiment VR simulation training have on cognition. Parmar (2017) wanted to know if students experience with the VR simulation training would facilitate "embodied cognition, higher telepresence, social presence, and engagement as compared to the control condition" (p. 43). To satisfy the study's purpose, Parmar (2017) incorporated both qualitative and quantitative pre- and postcognitive questionnaires framed by the categories of Bloom's taxonomy. The study explored the views of 40 sixth- and seventh-grade middle-school students about their "overall experience, system usability and satisfaction" (Parmar, 2017, p. 61). Data analysis showed that quantitative and qualitative data supported a positive correlation between VR training and increased cognition. Most students believed that VR simulation would improve their learning. Additionally, Parmar (2017) found that the learners who participated in immersion and embodiment VR training performed at a higher rate than those who partook in the immersive non-embodied training. The students who took the immersion and embodiment VR training scored significantly higher in Bloom's taxonomy's knowledge and comprehension levels (Parmar, 2017).

Rupasinghe et al. (2010) used Bloom et al.'s (1956) taxonomy in the design and development of an "Aircraft Maintenance Technology (AMT) education program" at Greenville Technical College in South Carolina (para. 5). The researchers utilized the six levels of classification under Bloom et al.'s (1956) original cognitive domain to organize AMT course modules' objectives and outcomes and evaluate the effectiveness of the AMT program's students. According to Rupasinghe et al. (2010), the AMT curriculum used VR technology-based simulators to develop the job-related competencies of future aircraft maintenance technicians required to perform aircraft inspections. Through the lens of the six classifications of Bloom's taxonomy of the cognitive domain, Rupasinghe et al. (2010) refined and monitored "the progress of the student learning after the VR augmentation" (para. 1). Rupasinghe et al. (2010) concluded that by using the cognitive domain of Bloom's taxonomy, they were able to design and implement the AMT program curriculum successfully. Rupasinghe et al.'s (2010) study also suggested that simulation training framed by Bloom's taxonomy facilitated learners' success.

Strengths, Weaknesses, and Criticisms of Bloom's Taxonomy

As Bloom's taxonomy gained notoriety, several scholars have analyzed the model, rendering critical exposition on its strengths, weaknesses, and credibility (i.e., Adams, 2015; Bertucio, 2017; Case, 2013; de Smale et al., 2016; Pikhart & Klimova, 2019; Stanny, 2016; Van Hoeij et al., 2004). Many researchers either levied some form of criticism of the model by either dispelling its credibility, its reliability, or its practicality. In contrast, others highlighted the taxonomy as a potentially useful model for teaching many instructional philosophies that aim to develop critical thinking and higher-order cognitive abilities and skills.

There are several strengths of Bloom's taxonomy, including the taxonomy "serve as a common language about learning goals to facilitate communication across persons, subject matter, and grade levels" (Krathwohl, 2002, p. 212) and the taxonomy "form a universal language among teachers" (p. 485). Specifically, the taxonomy provides a trusted method for educational practitioners to exchange ideas and insights. According to Bertucio (2017), Bloom's taxonomy provided standardization and clarification to educators of all socio-professional situations within academia. Adams (2015) shared Bertucio's positive sentiments in a written summarization of Bloom's taxonomy of the cognitive domain, adding two critical reasons why Bloom's taxonomy is a viable method of training or instructing others: improving instructor preparedness and promoting the use of learning objectives to facilitate higher-order thinking. Adams (2015) argued that learning objectives should be presented in a manner that takes learner reaction to instruction into consideration. Additionally, instructional objectives should include higher levels of cognitive skills that encourage improved learning outcomes. As stated by Pikhart and Klimova (2019), Bloom's taxonomy is very useful in remedying the decline of information transfer and information accuracy prevalent in the epoch of technology. Pikhart and Klimova (2019) also suggested that the taxonomy is a powerful tool because it can be used to develop any type of course and any kind of instruction.

Scholars have highlighted some of the taxonomy's weaknesses. For example, the taxonomy incorrectly asserts that the cognitive process is a rigid, one-dimensional, incremental, and hierarchical (simple to complex) process, neglecting the presumption that the learning is more multi-dimensional, and the six categories intersect (Krathwohl, 2002). According to Krathwohl (2002), the cognitive processes do not rely on the rigid hierarchical structure of the taxonomy but instead depend on the nature and complexities of the issue the learners are engaged in. Another limitation of Bloom's taxonomy is that it does not account for the human-to-human relationships and interactions critical in the cognitive process (Vela, 2020). The cognitive process should extend beyond the knowledge and application aspects of learning (Fink, 2017). Learners need to gain new insight about themselves and others, and learning should incorporate other learning dimensions such as the human dimension, caring about the subject at hand, and learning about the process of learning (Fink, 2017; Vela, 2020). Bloom's taxonomy does not address students' critical role in their cognitive development (Vela, 2020). Another weakness of the taxonomy is that it is not learner centric, meaning, it focuses more on the cognitive levels of learning and less on the learners' independence, capabilities, and social relatedness. For example, in developing the taxonomy, Bloom et al. relied heavily on the perspectives of faculty members rather than interviewing learners to gain insight on their learning experiences (Vela, 2020).

There are also several criticisms levied at Bloom's taxonomy. For example, the taxonomy is an incomplete method for expressing measurable student learning outcomes (Stanny, 2016). Stanny suggested that many of the verbs are misaligned with the six levels or to specific levels in the taxonomy. Stanny drew this conclusion by studying Bloom's taxonomy to ascertain if it is a useful model for examining the learning outcomes and other instructional considerations relating to where in the taxonomy students fall after completing a college-level degree program. Stanny (2016) completed the research by determining if collections of verbs compiled from 30 high-ranking websites met the standards outlined in the categories in Bloom's taxonomy.

Additionally, de Smale et al. (2016) disputed the effectiveness of Bloom's taxonomy for framing simulation-related and game-related research. de Smale et al. (2016) argued that Bloom's taxonomy does not consider learning that takes place from students interacting with each other. de Smale et al. (2016) also added that the model does not consider the higher-order skills, like collaboration, problem-solving, and critical thinking, required for learners to engage in deep learning.

Bertucio (2017) also criticized the impact of Bloom's taxonomy on the education community. Bertucio research has also shown that teaching under hierarchical systems of learning, such as Bloom's taxonomy, comes with a set of consequences that manifest in the classroom (Bertucio, 2017). Bertucio (2017) stated, in a critique of education and curriculum development relating to the Cartesian method and Bloom's taxonomy, that under Bloom's taxonomy, emotions and affections are not considered when developing instruction. Furthermore, emotions and affections in the classrooms are viewed primarily among educational practitioners as futile. Developing instruction that allows learners to synthesize knowledge in a rigid, linear, tiered, and nonholistic manner often leaves students exhausted and uninspired (Bertucio, 2017).

Case's (2013) study offered a contrary view of Bloom's taxonomy. According to published research, Bloom's taxonomy is among some of the most detrimental theories in education (Case, 2013). Case (2013) illustrated why the model was harmful to students' cognitive development and the training and instructional process. Case stated that the taxonomy is harmful because education practitioners often distort the model while ignoring its limitations. Case (2013) also strongly argued against the scaffolding of the six categories, indicating that though accomplishing the lower-levels subsumed tasks before achieving higher levels of complex assignments is helpful, it is otherwise not necessary to promote higher-level thinking.

Chapter Summary

Chapter 2 was presented in two parts. The first part is a thorough descriptive review of past and current relevant academic and peer-reviewed literature relating to ATC simulation training. A search of the literature returned relevant articles on the development of aircraft simulators used for education, training and development, and research. The reviewed articles also highlighted efforts toward evaluating the effectiveness of those for teaching ATC skills. A brief overview of training simulators was also presented in this chapter, highlighting the concepts and applications of simulation technology. Some of the articles reported on the correlation simulation training has on skills enhancement or the proficiency of pilots after partaking in simulation training (Bauer, 2005; McDermott, 2005). Other articles touched on the value of simulation training in the air traffic field (Lindenfeld, 2016; Nadler, 1996).

The reviewed literature showed a need for this study because there is a lack of substantive research on air traffic simulation training. The reviewed literature also revealed that much remains to be learned about the appropriate use of simulation technology in ATC education. For example, though there are several studies conducted on instructional simulators, the research carried out thus far on the aviation industry has significantly underrepresented a critical component of the aviation community—the ATC function (Lee, 2017). Additionally, there is a gap in research carried out thus far on ATC simulation training. Specifically, I could not identify a single study on the value or effectiveness of ATC simulation technology in the development of ATCSs' job-related competencies in a TRACON environment. I found one study (Dow, 2015) that provided insight into how to use ATC simulation to train ATCSs working at the EnRoute domain. In this study, the simulator under investigation is used for ATC radar certification in the terminal domain.

This study adds to the identified gap relating to ATC simulation training because it is the first research to investigate the development of job-related competencies via simulation training for the TRACON application. In addition, this study adds to the identified gap relating to the educational value of simulators because researchers working in this field do not universally agree on a positive correlation between simulation training and learning. This study also adds to the gap in the research relating to aviation instructional simulation because it will add critical data about the ATC component of the aviation community (Lee, 2017).

The second part of Chapter 2 focused on the conceptual framework used to frame this study. I employed the original Bloom et al.'s (1956) taxonomy of the cognitive domain to assess

ATCSs' perceptions of the ATCoach's value in providing the experience to develop their ATC job-related competencies needed to perform safe operations in the real air traffic environment. First, I presented the historical origins of the model, highlighting the creators and their rationale for creating the model. The model's context and concepts were the next critical subsections in the second part of Chapter 2. I then justified the appropriateness of using Bloom's taxonomy in the cognitive domain as the conceptual framework for evaluating ATCSs' experience with simulator training. I then summarized the application of Bloom's taxonomy in the study and described how the six levels of the domain align with this study's topic, purpose, and research questions. I then discussed the existing body of literature relating to Bloom et al.'s (1956) taxonomy and its application in aviation-related and simulation research. The final section before the chapter summary addressed the strengths, weaknesses, and criticisms of Bloom's taxonomy.

Chapter 3: Procedures and Methods

Many ATCSs lack the experience and attentiveness needed to safely manage air traffic through the NAS (USNTSB, 2016b). Adequate and accurate academic and simulator competency-based training will develop ATCSs' skills, situational awareness, and judgment so that they may adequately assist pilots with navigating through the NAS. Additionally, academic and simulation training is a solution to reducing aircraft incidents caused by poorly trained ATCSs (USNTSB, 2016b). Therefore, the purpose of this qualitative exploratory case study was to understand how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies. The following overarching research question is a reflection of the study's purpose and was posed to accomplish the purpose. The overarching research question is how do ATCSs at an air traffic facility in the southeastern region of the United States describe their experiences with the ATCoach in developing job-related competencies. The classifications of Bloom's taxonomy of the cognitive domain guided the following SRQs:

SRQ 1: What knowledge do ATCSs at a Southeastern United States air traffic facility learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 2: How do ATCSs at a Southeastern United States air traffic facility comprehend what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 3: How do ATCSs at a Southeastern United States air traffic facility apply what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 4: How do ATCSs at a Southeastern United States air traffic facility analyze what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 5: How do ATCSs at a Southeastern United States air traffic facility synthesize what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 6: How do ATCSs at a Southeastern United States air traffic facility evaluate what they learn from their experiences with the ATCoach in developing job-related competencies?

The remainder of Chapter 3 presents the procedures and methods used to conduct this qualitative exploratory case study. Specifically, Chapter 3 presents the philosophical assumption beneath the qualitative research design, the strengths and weaknesses of the qualitative exploratory case study design, and the appropriateness and rationale for using this design to answer the overarching research question and achieve the study's purpose. This chapter also includes information about selecting the research site, including a description of the radar training lab. I briefly introduce the population, the participants, and the criteria used for selecting participants. Additionally, this chapter provides information on the ethical issues and permissions I had to comply with when conducting this study. I discuss the data sources, research protocols, and field-testing procedures used in this study. Then, I present the data collection procedures used in the study. Following this, I discuss my positionality by explaining my sociocultural identity in relation to the study’s participants. I then explain my plans for ensuring trustworthiness and rigor in the study. Lastly, I discuss the data analysis techniques before ending with the chapter summary.

Research Design

There are two main types of research methods: quantitative and qualitative designs (Creswell & Creswell, 2018). Researchers select the kind of design depending on the study's purpose (Creswell & Creswell, 2018). As explained by Creswell and Creswell (2018), the aim of the quantitative design is to provide “a numeric description of trends, attitudes, or opinions” (p. 13). Quantitative research focuses on testing theory and measuring specific variables, while qualitative study aims to understand complex social interactions (Creswell, 2015). Additionally, the qualitative approach allows a researcher to be part of the research, observe participants' interactions, and interact with the participants to create human knowledge (Creswell & Creswell, 2018). Quantitative design, contrarily, provides nonnumeric data that focuses on exploring and understanding the meaning of a phenomenon, person, or group in a natural setting (Creswell & Creswell, 2018). This interaction in the “natural” setting is an inherently qualitative feature, and it is a feature absent in quantitative designs.

I sought to understand ATCSs' perceptions of the ATCoach and if they believed it was a valuable method of providing the experience to develop their ATC job-related competencies needed to perform safe operations in the real air traffic environment. Based on this study's purpose, a qualitative case study design was the most appropriate approach for assessing the phenomenon under investigation. The qualitative research method allowed me to explore the experiences of ATCSs at an ATC facility in the Southeastern United States. The qualitative method was founded on social constructivist ideology, a paradigm or worldview where researchers seek understanding of the world in which we exist to discover meaning and gain insight into a specified group, situation, or experience (Creswell & Poth, 2017). Social constructivism enables researchers to experience what the participants experience (Creswell, 2015). From an ontological perspective, social constructivists believe that reality is socially constructed, meaning, people make sense of the world based on their social interactions (Holstein & Gubrium, 2008). Epistemology is a philosophical concept that affects the way researchers unearth knowledge in the natural social context of their research (Kivunja & Kuyini, 2017). The social constructivist believes that the goal of research is to understand the participant's views. Thus, my goal was to understand ATCSs' constructed realities on the value of the ATCoach in developing competencies. Social constructivist research calls for the researcher to adapt the theoretical lens of a social scientist researcher (Rodwell, 1998). Social constructivism relies on an inductive approach. Inductive approach means that instead of proposing the theories and patterns at the beginning of the study, they instead develop and evolve as the investigation progresses (Creswell & Poth, 2017). For example, qualitative research has an open-ended approach that allows researchers to modify the phenomenon under investigation and the research questions in accordance with participants' responses (Creswell, 2015). This flexibility makes qualitative research more inductive than the closed-ended quantitative research approach that collects data before the study begins (Creswell, 2015). This rigidity makes quantitative research more deductive. I grounded the investigation of this study's problem with a social constructivist approach and qualitative methodology.

Social constructivism was the appropriate philosophical underpinning for this study because it allowed me to be a part of the research phenomenon (Creswell, 2013). Since I investigated ATCSs' simulation experience, my current understanding of simulators, ATCS, and ATC shaped the inquiry's scope. Prescribing to the social constructivist ideology, my knowledge or lack of knowledge about simulators and simulation training affected the understanding of simulation education (Kolb, 1984). As reinforced by Kolb and Kolb (2005), participants create new abstract knowledge and thoughts based on previous knowledge and experiences. For instance, I sought to investigate the experiences of ATCSs with simulation training. Consequently, I became a part of the phenomenon and created the construct of the social world in which the study took place (Willig & Stainton-Rogers, 2013).

Qualitative research approaches focus on the lived experiences of participants by honoring the respective meanings, structures, and essence of their lives (Merriam & Tisdell, 2016; Patton, 2014). By design, qualitative investigations allow researchers to identify the chronological flow and show the causal relationship between events and consequences (Amaratunga et al., 2002). I used the qualitative exploratory case study approach outlined by Yin (2018) to explore ATCSs' perception with scenario-based simulation and the relationship between simulation training and the readiness of ATCS.

There are several strengths and weaknesses inherent in qualitative research design. The first strength of qualitative research is that the design is flexible, and researchers can modify the data collection and analysis processes as new ideas, theories, or patterns (Creswell, 2015). The flexible nature of qualitative research allows researchers to modify and adapt the research process depending on the study's findings (Creswell, 2015). According to Creswell (2015), an added benefit of qualitative research is that the design allows for data collection in the natural environment—in the real-world context and naturalistic ways. Another strength of qualitative research is that the design presents detailed accounts of participants' experiences in the researcher's language and the participants' voices (Creswell, 2015). Qualitative research allows for nonnumeric data collection by using open-ended approaches in which researchers ask participants general questions and "the participants shape the response possibilities" (Creswell, 2015, p. 19). Another strength of qualitative research is that the design can help determine possible causes of issues and provide meaningful insights from the participants' perspective (Creswell, 2015). In this study, I used the qualitative research design to gain insight into the ATCoach's perceived value on the development of ATC competencies.

There is a set of practical and theoretical weaknesses researchers need to consider when conducting qualitative research design. One of the most significant qualitative research weaknesses is that the data collection and analysis processes are very time-consuming (Anderson, 2010; Creswell, 2015). For example, qualitative research generates a lot of narrative data that takes much longer to complete than quantitative studies. Analyzing large amounts of data can also be labor-intensive. I addressed this weakness by (a) limiting the number of participants to five to control the amount of data collected, (b) choosing interview as the only data collection method, and (c) interviewing participants over a video conferencing platform to save time.

Another weakness is that operating in the real-world setting can render unreliable data due to several factors that may affect the data (Creswell, 2015). For example, researchers' bias, participants' reluctance to be forthcoming, and misinterpreting questions may affect the interpretation of qualitative data. I addressed this weakness by (a) creating questions on the IPG to counteract the effects of my philosophical assumptions and worldviews, (b) conveying to the participants that I would protect their identity and privacy, (c) developing questions on the IPG that was clear and unambiguous (Creswell, 2015), and (d) creating follow-up questions on the IPG to convey the intended meaning of the questions.

Another drawback is that qualitative data are prone to subjectivity due to the researcher's role in analyzing and interpreting the data. In qualitative research, the researcher determines what is essential or irrelevant in data analysis (Creswell, 2015; Merriam & Tisdell, 2016). Hence, the interpretation of data relies heavily on the researcher's judgment. I can argue that a different researcher may interpret the same data differently and reach different conclusions. I addressed this weakness by (a) accurately annotating participants' responses and meanings through raw, direct quotes; (b) highlighting contrasting points of view for context, clarity, and authenticity; and (c) member checking the interview data to check for accuracy and clarify any inaccurate representation of participants' responses (Merriam & Tisdell, 2016).

A case study is a research method that "investigates a contemporary phenomenon (the 'case') in depth and within its real-world context" (Yin, 2018, p. 15). There are three types of case study in qualitative research: exploratory, explanatory, and descriptive (Yin, 2018). Explanatory case study is used in studies where the investigator needs to "explain how or why some condition came to be" (Yin, 2018, p. 287). Yin (2018) defined exploratory case studies as a research approach used to "identify the research questions or procedures to be used in a subsequent research study" (p. 287). Descriptive case study is used to describe real-world situations and problems (Yin, 2018). I used the exploratory case study design to understand how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies.

Employing the exploratory case study approach, researchers can administer multiple data collection methods such as interviews, questionnaires, journal entries, observation, documents, and artifacts (Creswell & Creswell, 2018). In this study, I collected data using semistructured interviews to explore the experiences of current ATCSs with the ATCoach. The data from interviews and open-ended statements of concern provided insight into the simulator's perceived value on the transfer of ATC competencies. The exploratory case study approach was appropriate for investigating the air traffic training simulation's value because it aims to derive patterns of meaning from how learners interpret their experiences with the ATCoach. I used the exploratory case study design to understand how participants perceived their experience with simulation training and how it impacted their job performance.

The justification for using the exploratory case study is as follows. First, conducting exploratory case studies is ideal for situations when the researcher may not manipulate participants' behavior and when there is a need to ask why or how (Yin, 2018). For instance, this study asked the question, "how do ATCSs at an air traffic facility in the southeastern region of the United States describe their experiences with the ATCoach in developing job-related competencies?" The exploratory case study was appropriate for this study because the findings are not predetermined (Yin, 2018). For example, this study's findings derived from the participant's responses to the "how" and "what" research questions. Additionally, exploratory case studies are appropriate for studying the causal relationship between simulation technology and the development of job-related competencies (Yin, 2018).

Strengths of Qualitative Case Study Design

In this research, I relied on the strengths of the qualitative case study design to explain in detail the aspects of simulation experience and the development of ATC competencies. Qualitative research is a desirable method because it enables a researcher to perform an in-depth analysis of the phenomenon (Creswell & Creswell, 2018). One of the primary reasons for choosing a case study is that it is flexible in terms of the study's plan, procedure, and direction (Anderson, 2010). For example, researchers can make changes to the framework and the study's direction if there is a discovery of new information. The case study design also provides multiple data validation sources to give an accurate account of the participant's view of the world, including triangulation, member checking, rich description, and detailed guidelines and procedures (Creswell & Creswell, 2018). Utilizing multiple methods will help to increase the rigor of the study by increasing the credibility, trustworthiness, and authenticity of the research (Creswell & Creswell, 2018). Using different data sources is essential in a case study analysis as it strengthens dependability and credibility (Creswell, 2015; Creswell & Creswell, 2018). The case study design is beneficial because it allows researchers to get close to the program, group, or individuals under investigation. Lastly, the qualitative case study is particularly advantageous because it enables participants to discuss and raise concerns otherwise overlooked, as it is often the case in more positivistic inquiries (Anderson, 2010).

Weaknesses of Qualitative Case Study Design

The case study design has numerous flaws to consider when conducting qualitative research. First, the research quality depends highly on a researcher's ability to properly articulate the findings in a narrative way (Anderson, 2010). I addressed this weakness by providing raw, direct quotes from the interview transcripts. Second, the small sample size inherent in qualitative research could render inaccurate or false perceptions about the participants' human experiences relating to the research topic (Creswell & Creswell, 2018). I addressed the small sample size weakness by selecting information-rich participants whose experiences added valuable data to help answer the research questions. Information-rich individuals are those who best answer the research questions (Patton, 2014). I believed that information-rich ATCSs possessed specific experiences and specialized knowledge to answer the research questions intelligently and provide the necessary data to address the study's purpose (Merriam & Tisdell, 2016).

Third, a researcher's presence during the data collection process can cause participants to omit critical information, resulting in inaccurate findings or false perceptions (Anderson, 2010). Inconsistencies in participants' perceptions can "make it difficult to generalize the findings"

(Foeckler, 2019, p. 66) to the larger air traffic population (Blaikie, 2009; Creswell, 2015). I addressed this weakness by putting participants at ease and making them feel comfortable divulging information. I promised to ensure the anonymity of all participants. The participants' confidentiality was honored by removing their names and assigning numbers to individuals (Creswell & Creswell, 2018). Additionally, I omitted the specific location of the research site from all discussions about the study.

Fourth, the large amount of qualitative case study research data can make the analysis process very time-consuming (Anderson, 2010). I addressed this weakness by limiting the number of participants to five and choosing a single data collection mode (i.e., interviews). Logically, larger sample sizes will call for more interviews. More interviews will inherently provide more data, making analysis more time-consuming (Anderson, 2010). Interviewing over the Zoom (2020) video conferencing platform was another time-saving approach I used in this study to collect primary data. A 1-hour interview served as the primary data collection method.

Fifth, the longitudinal effects of the case study design can also increase the research cost. I reduced the research cost by (a) narrowing the study's scope by focusing only on one air traffic facility, making data collection more manageable, reducing the cost of traveling to the different sites, and improving the ease of communicating the findings (Merriam & Tisdell, 2016); (b) utilizing a single source of evidence because it is more cost-effective than collecting data from multiple sources (Yin, 2018); and (c) using the Zoom (2020) video conferencing platform to conduct remote interviews, eliminating the cost associated with traveling to participants' locations (Guest, 2013; Merriam & Tisdell, 2016).

Last, researchers are the primary research instrument in qualitative case studies, therefore, the researcher's philosophical assumptions and worldviews are carried into the study, ultimately affecting the way findings are interpreted (Creswell & Creswell, 2018). The first mechanism to counteract the effects of philosophical assumptions and worldviews was developing an IPG that was free of researcher bias. I designed the IPG questions considering the general questions before addressing the more focused questions (Creswell, 2015). I also ensured that the questions aligned with the classifications of the conceptual framework and the research questions. The IPG ensured that all participants were exposed to the same experiences and questions during the interviewing process (Creswell, 2015). I field-tested the IPG once it was created. Field testing is a process where SMEs review the interview questions and provided feedback on the questions' credibility and dependability (Merriam & Tisdell, 2016). I field-tested the IPG by conducting preliminary interviews before implementing the primary interview (Merriam & Tisdell, 2016). After data collection, I emailed the interview transcript to each participant for review to check for accuracy, clarify any inaccurate statements, and edit their accounts (Merriam & Tisdell, 2016). Once the participants verified their accounts, I analyzed the data by abiding by the conceptual framework's classifications and criteria. Additionally, I presented alternative explanations whenever the data supported findings that differ from the expected outcome (Merriam & Tisdell, 2016).

Site Selection

The ATC facility is in the southeastern part of the United States. Also, the ATC facility is among many U.S. locations that use simulation technology to develop the ATC job-related knowledge, performance skills, judgment, critical thinking skills, and self-confidence needed to operate safely in the real air traffic environment (FAA, 2020d). The site selection criteria for this study was based on the following four factors: (a) facility classification and level of operation, (b) site and training simulator lab access, (c) my geographical proximity to the research site, and

(d) the training population. The primary reason for selecting the site was its classification and level of operation. As reported in the 2018 Air Traffic Controller Workforce Plan, there are 315 FAA-operated ATC facilities throughout the NAS (FAA, 2018b). The number of facilities and classifications are as follows: 131 ATCT, 26 TRACON, 132 collocated ATCT with TRACON, 21 ARTCC/En Route, one Air Traffic Control System Command Center, and four collocated TRACON and ARTCC, also known as CERAP (FAA, 2018b). These FAA ATC facilities are classified into different levels (4 through 12) depending on the traffic count, complexity of the airspace and air traffic operations, and sustainability of traffic (FAA, 2018b). The Level 4 designation is reserved for facilities with the lowest traffic volume and complexity, and Level 12 is a designation assigned to facilities with the highest traffic volume and complexity (Vidulich et al., 2017).

I selected a TRACON ATC facility in the U.S. southeastern region to serve as the research site for data collection since the facility holds a Level 10 classification. More specifically, the facility is the fourth highest classification among the 132 ATCTs with TRACON ranked only behind Charlotte ATCT (Level 12), Miami ATCT (Level 12), Honolulu Control Facility (Level 11), and Philadelphia ATCT (Level 11) for volume and complexity (FAA, 2016a). The significance of selecting a Level 10 facility for this research is that the findings may also apply to all other Level 10 and lower facilities using the ATCoach Radar Test and Training simulator. I did not investigate all aspects of air traffic training at the research facility. The study focused only on the TRACON part of the ATC operation.

I am an employee of the FAA and have access to the site. However, I am not an ATCS and do not have unrestricted access to the areas of interest. Consequently, the ATCM granted permission to access the resources (training lab, radar simulator, training records, and trainees) otherwise reserved for ATC personnel. Additionally, the ATCM provided clearance to interview CPCs who previously participated in simulation training at the research facility. The ATCM is the facility's "gatekeeper" and must first give permission before research activities can occur (Merriam & Tisdell, 2016). As an "insider researcher," gaining access to the ATCM was relatively simple because our offices are in the same building, allowing me to simply walk to his office and request permission to access the site for research purposes. It is important to note that "outsider researchers," those not working at the research site, may find it particularly difficult to obtain permission to the location of interest or similar facilities due to the restrictions imposed on government facilities, personnel, and resources (Merriam & Tisdell, 2016; U.S. Government Accountability Office, 2019). Outsider researchers may overcome this barrier by having an advocate within the organization who can speak to the "gatekeepers" on their behalf (Merriam & Tisdell, 2016).

I secured permission to the research site by first coordinating with the ATCM in person to get permission to conduct the research and access the training areas. I informed the ATCM that I was a doctoral student at the University of West Florida (UWF) researching ATC training (Merriam & Tisdell, 2016). I also told the ATCM that I was interested in conducting my research at the site of interest, specifically, the ATCoach Radar Lab. I also informed the ATCM that I would be conducting interviews in my office and the activities would not disrupt normal day-to-day activities (Merriam & Tisdell, 2016). Lastly, I informed the ATCM that I would share the findings with the organization (Merriam & Tisdell, 2016). Upon receiving preliminary approval, I sent the ATCM two written requests via electronic mail to get permission to conduct the research (see Appendix A) and access the research site (see Appendix B). The ATCM signed and returned the permission document to me via electronic mail. To contact the manager at the government facility, outsider researchers can conduct a Google search of the government facility of interest and call the listed phone to request the contact information of the facility manager.

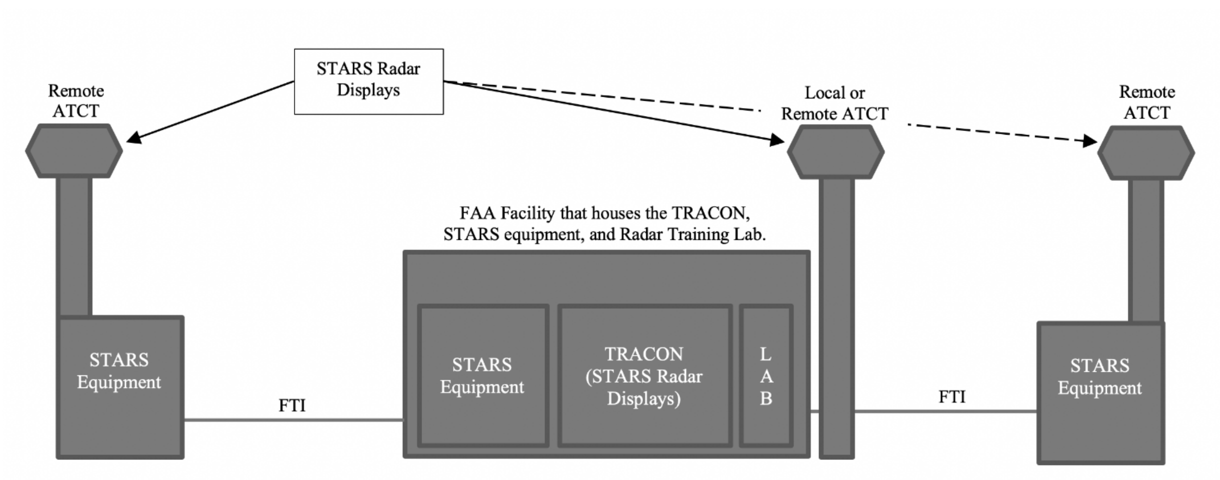
Description of the ATCoach Radar Simulator

The ATCoach simulator was designed for site-specific on-the-job training that is responsive to the specialized needs of ATCSs working at TRACON facilities throughout the FAA. The ATCoach radar simulator provides simulation of air traffic scenarios designed to prepare ATCSs for success in ATC practices. They further extend their readiness to perform critical ATC tasks and to employ knowledge, performance skills, critical thinking skills, judgment, and self-confidence to address ATC issues.

In the late 1990s, in a joint venture, the FAA and the Department of Defense (DOD) procured an ATC automation system called STARS that replaced some of their legacy equipment (FAA, 1997). The FAA and DOD use these systems to provide state-of-the-art ATC capability for managing terminal area airspace throughout the United States (FAA, 2018a). Generally, STARS systems are located at TRACON facilities and ATCTs at surrounding airports. The TRACON facilities house the primary servers (the brain) responsible for data processing and associated equipment for processing and displaying video for the TRACON and local ATCTs. The remote ATCTs house the equipment for processing and displaying video for the remote ATCTs. The equipment at the remote ATCTs is connected to the equipment at the TRACON facility via secure FAA Telecommunications Infrastructure (FTI). Figure 3 is a basic depiction I created of a standard STARS system. As part of the STARS design, a portion of the systems' hardware and software resources are allocated for ATC training and development.

Figure 3

Basic Illustration of STARS System



Physical Characteristics of the Radar Lab. The ATCoach radar lab is located in a designated room at the research site at a TRACON facility in the southeastern region of the United States. Figure 4 is a network diagram I created of the ATCoach radar lab. The lab consists of one Test Training and Simulation Equipment (TTSE/SIM), four General Purpose Workstations (GPW), and four Terminal Control Workstations (TCWs). The TTSE/SIM is used by the instructor to process simulator commands, the GPWs are used by the training staff as pseudo pilot positions, and the TCWs are the workstations used by the trainees. Figure 5 is a photograph I took depicting the ATCoach radar lab.

Figure 4

ATCoach Radar Lab Block Diagram

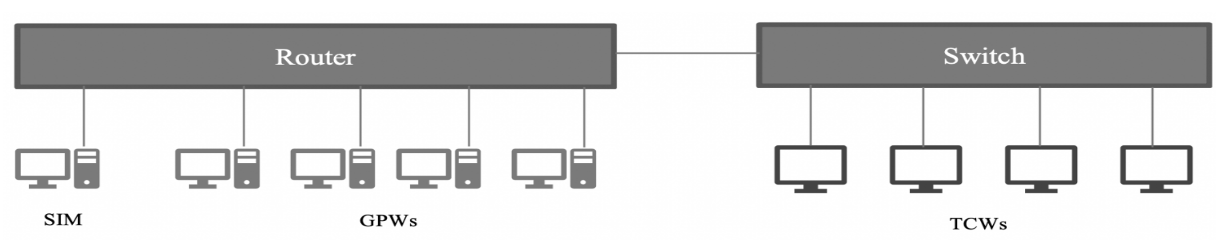


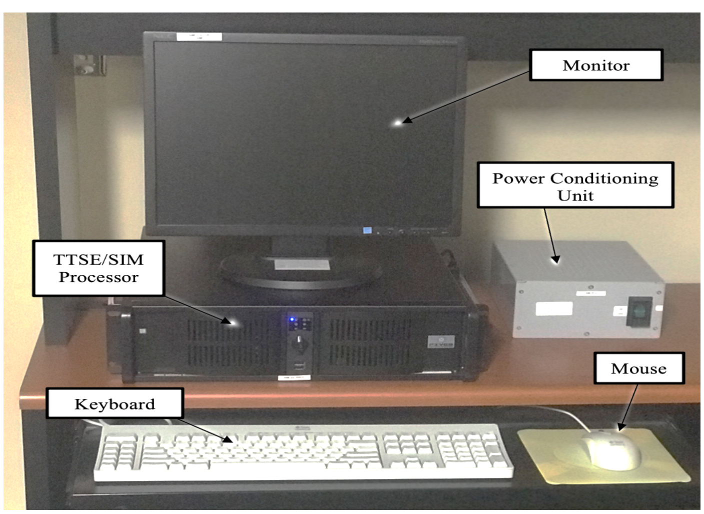
Figure 5

The Radar Lab at the ATC Research Site

The TTSE workstation serves as the software program host, instructor/supervisor interface, and processing control for training functions (FAA, 2020c). The TTSE also houses the ATCoach application software to provide training simulation data to the TCWs and instructor/supervisor control. The TTSE includes a Dell X2000 processor running a UNIX Solaris Operating System (OS), monitor, keyboard, and mouse, and a 120 Volt AC (VAC) power conditioning unit (PCU). Figure 6 is a photograph I took of the TTSE.

Figure 6

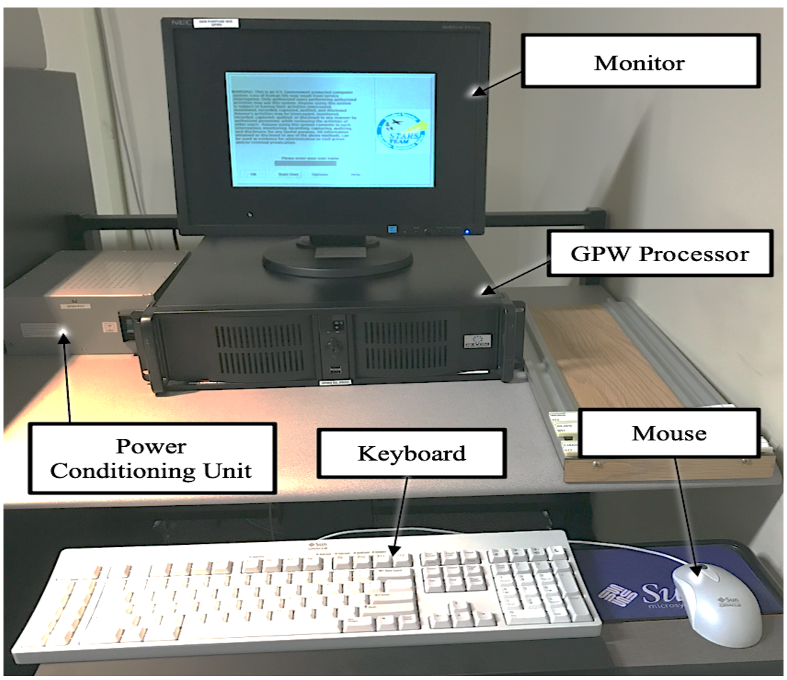
Test Training and Simulation Equipment



The GPW hardware configuration is identical to that of the TTSE/SIM and runs on the same operating system. The GPW is utilized as a pseudo pilot position during simulation training. The TTSE/SIM provides data and control, while the GPW is designated as a pseudo-pilot workstation for assigning air traffic scenarios during training (FAA, 2020c). Figure 7 is a photograph I took of the GPW.

Figure 7

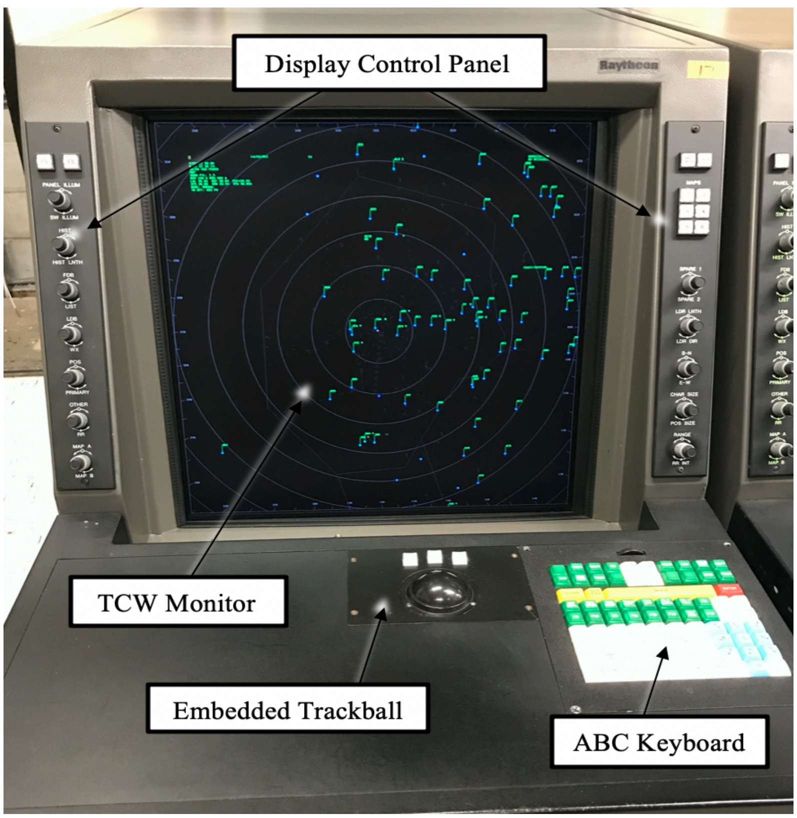
General Purpose Workstation



The TCW workstations used in the ATCoach radar lab are identical to those used in the TRACON room. It provides trainees with data entry, data display, and other functional capabilities to perform simulated ATC operations in the lab environment. Since the lab equipment is part of the STARS system, the TCWs can display live radar data if a situation justifies it. As illustrated in Figure 8, the TCW consists of a radar display screen, two display control panels, an ABC keyboard, and a trackball. The TCW also contains a Data Entry Controller (DEC), a DEC power supply, a video switch, and a TCW monitor. The TCW can accommodate up to three sets of data entry devices (three keyboards and three trackballs). There are also two Dell X2000 processors (hidden behind the front panel) running UNIX Solaris Operating System (OS). Each of the processors contains the X-Sever application software, which allows it to display live and simulated radar video. Figure 8 is a photograph I took of the TCW workstation.

Figure 8

Front View of a TCW Console



Typical Application of the ATCoach Simulator. The ATCoach simulator is a high-fidelity commercially available software application that resides and runs on two types of STARS computer systems—the TTSE/SIM and GPW workstations. From the GPW or SIM, the ATCoach application generates simulated targets and displays them on the TCW workstations, providing the TCWs are placed in training mode. Since the ATCoach technology is integrated within the existing STARS automation system, it generates and displays real-time radar sensor messages and flight data messages on the TCWs as if they originated from actual surveillance radars and aircraft.

The instructor ensures that the simulation training is carried out according to the curriculum design and is in line with the classroom instruction. The instructor determines the volume level and complexity of the scenario by choosing the appropriate weather conditions, flight conditions, and any abnormal situations (FAA, 2018d). The instructor also assesses the performance of the trainee during simulation training and discusses training strategies, methods of recovery, and alternative approaches to improve training outcomes (FAA, 2018d). The instructor set-up panel resides on the GPW and is used to set up parameters for the scenarios. Figure 9 is a photograph I took of the ATCoach Instructor Setup Menu. The instructor can access the ATCoach ATSetup Menu from the ATCoach Instructor Setup Menu. The ATCoach ATSetup Menu allows the instructor to configure simulation exercises and control system connectivity (FAA, 2018d). Figure 10 is a photograph I took of the ATCoach ATSetup Menu.

Figure 9

ATCoach Instructor Setup Display

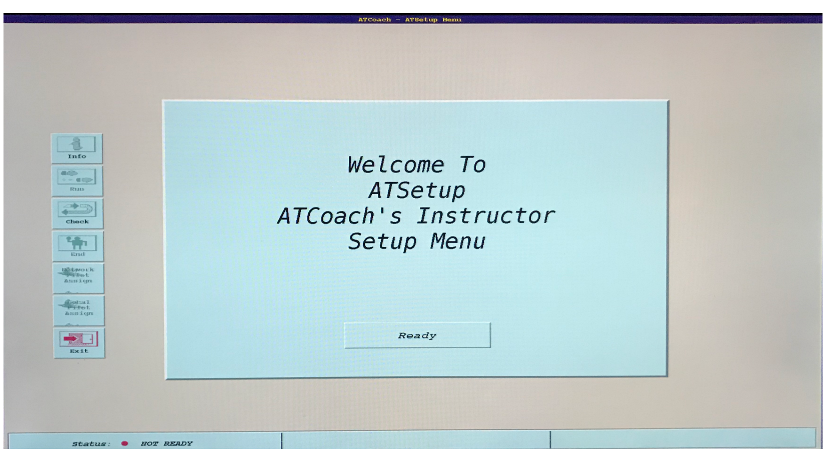
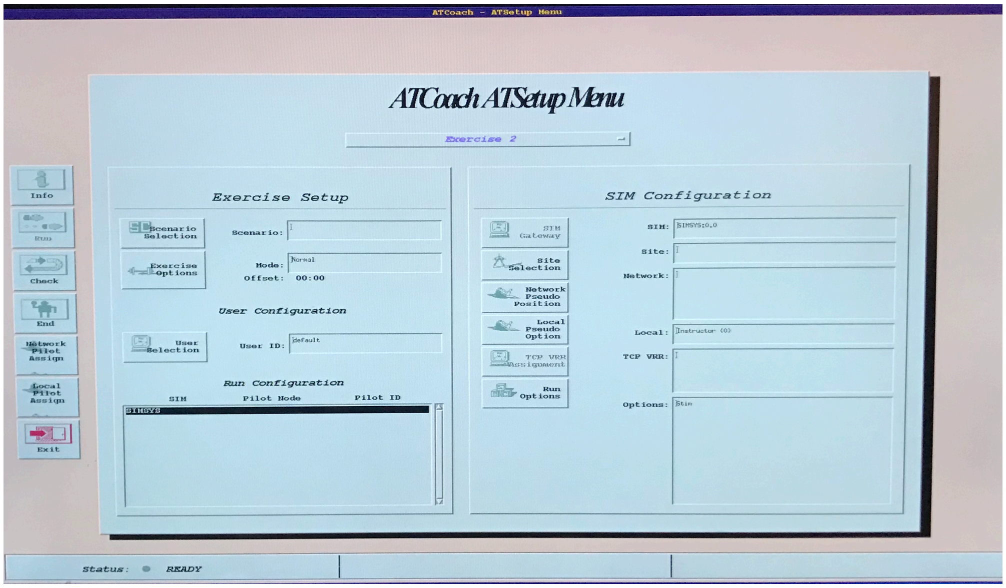


Figure 10

ATCoach ATSetup Menu



The training staff uses the GPW for pseudo pilot purposes. The ATCoach platform on the GPW allows training personnel to simulate aircraft flight behavior while trainees monitor aircraft on the TCWs and provide instruction to the pseudo pilots. The pseudo pilot sits at the GPW and communicates verbally with the ATCSs as a real pilot would during live ATC operations. This communication generally involves the ATCS orally telling the pseudo pilot what to do and the pseudo pilot acknowledging those instructions and physically changing the behavior of the simulated aircraft on the TCW display by entering commands into the ATCoach application on the GPW. Simply put, the pseudo pilots move the aircraft around the screen by following the ATCSs’ direction to maintain or change heading, speed, altitude, and spatial relationships. Ultimately, the pseudo pilot’s role is to replicate realistic ATC conditions. Pseudo pilots generally operate multiple aircraft. The number of aircraft operated by a pseudo pilot depends on the volume and complexity of the scenario and the experience of the pseudo pilot. The ATCoach Pilot Setup Menu is similar to the ATCoach Instructor Setup Menu, as seen in Figures 11 and 12.

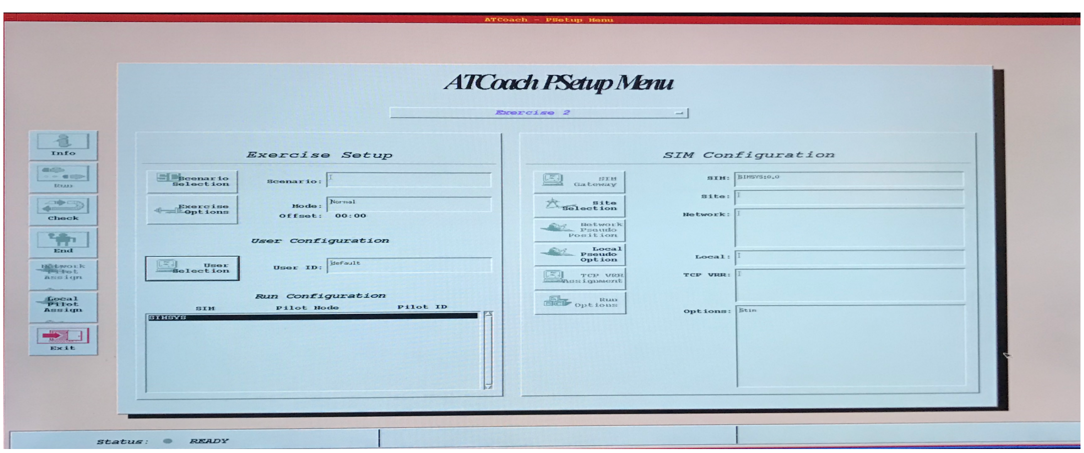
The pseudo pilot can access the ATCoach PSetup Menu from the ATCoach Pilot Setup Menu. The ATCoach PSetup Menu allows the pseudo pilot to select the desired pilot position and exercises and set up the parameters necessary for running the ATCoach scenarios (FAA, 2018d). Figures 11 and 12 are photographs I took of the ATCoach PSetup Menu.

Figure 11

ATCoach Pilot Setup Menu Display

Figure 12

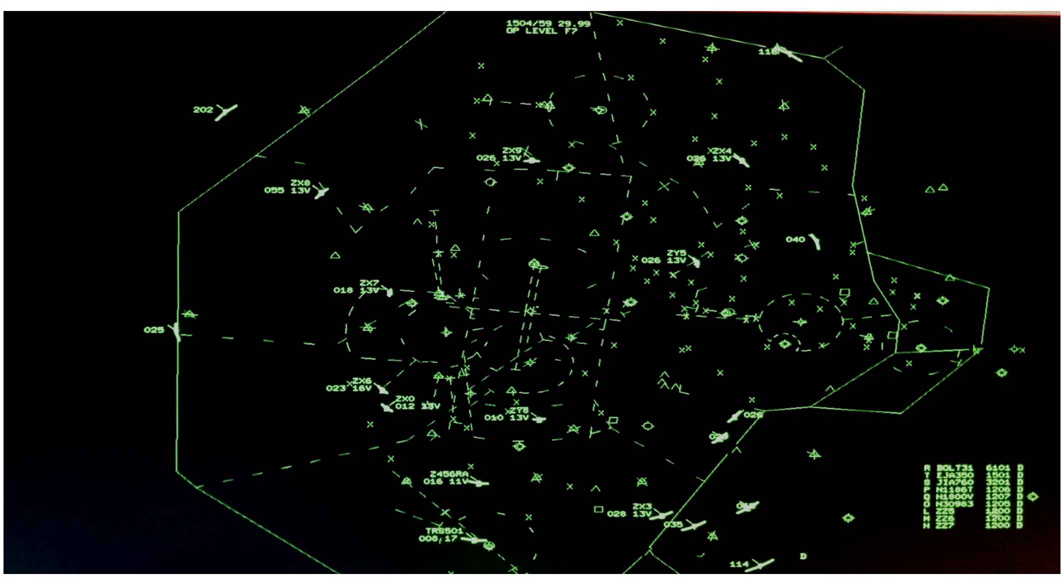
ATCoach PSetup Menu



The TCW enables the trainee (CPC-IT) to monitor ATC operations on the TCW monitor and direct pseudo-pilots to take the appropriate actions. The CPC-IT must perform several complex ATC tasks such as ensuring all the aircraft are adequately separated as they are controlled through the assigned airspace, effective traffic flow is maintained, and aircraft identity is maintained (FAA, 2018d). These tasks are accomplished when the CPC-IT applies good control judgment in the control of aircraft during simulated air traffic scenarios. For instance, knowing when to instruct the pseudo-pilot to increase, decrease, or maintain speed or when to change altitude are complex ATC tasks that require good control judgment. The CPC-IT must prioritize job tasks and verbally instruct pilots on the appropriate actions to take, respond rapidly to, and recover from pilots' failure to adhere to air traffic instructions. Additionally, the CPC-IT must continuously know the identity (call sign), heading, speed, and altitude of all the aircraft in the designated airspace. Figure 13 shows a photograph I took of the Radar Display screen used to run scenario exercises on the TCW workstations.

Figure 13

ATCoach Radar Display Screen



The scenarios are created at different levels of complexity and traffic volume and are specific to the research site. The most difficult scenario at the research site is based on an average of the facility's busiest traffic volume per hour of operation, plus 10%. The easiest scenarios are based on 50% of the facility's average busiest traffic volume per hour of operation (FAA, 2018d). "The hourly operations rate is based on 100 percent traffic volume from an average period of a busy day" (FAA, 2018d, p. D-24). The level of complexity correlates with the number of air traffic situations incorporated into the scenario, such as arrivals, departures, over flights, adverse weather, flight conditions, emergencies, and other abnormal or unusual conditions (FAA, 2018d). Figure 14 is a representation I designed showing how the scenario volume levels are calculated.

Figure 14

Example Calculation of Scenario Volume Levels

P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**
21	30	23	20	21	23	30	30	21	20

(21 + 30 + 23 + 20 + 21 + 23 + 30 + 30 + 21 + 20) / 10 =

23.9

Lowest Volume Level: 24/2 = 12 aircraft
Lowest Volume Level is 50% of the traffic worked during a typical busy period.

Highest Volume Level: 24 + 10% = 26 aircraft
Highest Volume Level: 110% of the traffic worked during a typical busy period.

Population

According to Creswell and Creswell (2018), a population consists of a group of individuals who adhere to specific criteria and have common characteristics that a researcher is studying. A population is a particular group of individuals that a researcher is interested in gathering information. For this qualitative case study, I selected participants from the identified population based on characteristics relevant to the study (Lodico et al., 2010). This study's population was ATCSs working at an FAA ATC facility. The research population consisted of ATCSs from different hiring sources, age ranges, gender, and prior education and training. According to the facility's 2020 Staffing and Training Team Assignment roster (STTAR), the air traffic operation consisted of 80 personnel, including CPCs, CPC-ITs, SATCS with CPC credentials, management, support staff, and training staff. As such, the ATC facility contained ATCSs whose participation helped answer the research question. At the research facility, ATCSs fell into multiple FAA hiring sources: retired or separated military controllers, veterans' recruitment appointment, terminal CPC transfer, Collegiate Training Initiative, EnRoute CPC transfer, AT-SAT Competitive Test, and reinstated ATCS. Depending on the hiring source, the FAA could have hired individual candidates with no prior training, college education specific to ATC, military ATC training, or previous training at another FAA facility. The research facility was staffed with CPCs ages 21 to 56, with 56 being the maximum age an ATCS can control air traffic. The participants' ages ranged from 29 to 43. The research site's population also included male and female employees who were selected to participate in this study. Data were collected from a purposive sample of CPCs who participated in the ATCoach in 2019.

Population demographics and statistics provide critical data that researchers can use to better understand the study's situation and allows them to make accurate and relevant predictions relating to the outcome (Merriam & Tisdell, 2016). Knowing the total size of the population and its internal characteristics such as age, gender, race, ethnicity, and educational background helps determine whether the study participants are represented in the phenomenon under investigation (Merriam & Tisdell, 2016). Table 7 depicts a profile of the ATC population at the research site.

The population profile consists of a professional community of diverse socioeconomic characteristics.

Table 7

Population Profile

Population	Job Category and Gender	Percentage
Population by Certification Status	Supervisory ATCSs/CPC-S	9%
	CPCs	57%
	CPC-ITs	14%
	DEVs	6%
	Management and Support Staff	8%
	Training Staff	6%
Population by Gender	Male	80%
	Female	20%

Participants

Participants are individuals selected by a researcher to be included in the study (Creswell & Creswell, 2018). The purpose of this qualitative exploratory case study was to understand how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies. Therefore, the participants of this study needed to be ATCSs. I sought to understand the value of simulation from the participants' perspectives (Merriam & Tisdell, 2016). Consistent with this goal, the study participants needed to be ATCSs who partook and completed simulation training. This goal was accomplished by gathering responses from five ATCSs who experienced the

ATCoach—about their views and experiences with the simulator and the extent simulation training impacted the ATC competencies they need to operate in a real air traffic environment.

The participants selected for this study were also integral to the data collection process. Since this study investigated the value of simulation training from the ATCSs' perspective, it was critical to identify the participants who could provide accurate accounts of their experience with the ATCoach. The sample consisted of both male and female participants between the ages of 21 and 65 years, representing all genders and age groups. The current study also included ATCSs from different hiring sources, professional backgrounds, and work experience selected to maximize diversity among responses (Rubin & Babbie, 2007). At the research facility, ATCSs fall into multiple FAA hiring sources: retired or separated military controllers, veterans' recruitment appointment (VRA), terminal CPC transfer, Collegiate Training Initiative (CTI), EnRoute CPC transfer, AT-SAT Competitive Test, and reinstated ATCS (SME 2). All five participants worked previously at another ATC facility and obtained CPC status before transferring to the research site. Therefore, their hiring source would be considered CPC transfer.

The research site also included CPC with an ATC background consisting of specified professional activity related to the ATCT, TRACON, and ARTCC operations (SME 2). One of the participants, ATCS 1, have approximately 16 years of professional experience as an ATCS, consisting of 6 years (2005–2009) of En-Route ATC experience at Oakland ARTCC (ZOA), 2 years of non-ATC operations at FAA headquarter in the District of Columbia, 6 years (2011-2017) of terminal radar approach experience at Potomac TRACON, and 4 years (2017–present) of combined terminal radar approach and tower experience at the research site. Another participant, ATCS 2, have 7 years of professional experience managing air traffic. The participant started working as an ATCS in 2014. This experience included 3 years (2014–2017) terminal local and ground control experience at the ATCT at Mobile Regional Airport (MOB) in Mobile, AL. In 2017, ATCS 2 transferred to the research site and, as of June 2020 (data collection process), the participant was certified in the tower environment only.

The third participant, ATCS 3, have a combined professional ATC career of 13 years. ATCS 3 have 2 years (2008–2010) of terminal tower experience at North Las Vegas ATCT (VGT) and 7 years (2010–2017) of tower experience at Las Vegas TRACON (L30). In addition, ATCS 3 worked for a year (2017–2018) at the Atlanta TRACON (A80) and have 3 years (2018–present) of combined ATCT and TRACON experience at the research site, adding terminal radar approach experience to her professional background. The fourth participant, ATCS 4, have a total of 13 years of ATC experience in the terminal environment consisting of 2 years of tower-only experience at St. Thomas ATCT (STT) in Charlotte Amalie, Virgin Islands, 7 years of combined tower and terminal radar approach experience at the Tallahassee ATCT (TLH), and two years (2019–present) terminal radar approach control only experience at the research site. Lastly, ATCS 5 have 20 years of ATC terminal radar approach control and tower experience managing air traffic. ATCS 5 started in Florence, SC (FLO) and worked there from 2001–2004. The participant then worked at Charleston, WV (CRW) from 2004–2017. In 2017, ATCS 5 transferred to the research site and is now certified in the tower and radar approach environments.

Although the SATCSs, management, and support staff personnel are part of the overall ATC population, I omitted them from the study due to their current role in the organization. The training staff was not part of the target population because that group consisted primarily of retired ATCSs currently working as civilian contractors.

Participants Selection

I included five FAA ATCSs from the research site to participate in this study. All five participants were active employees of the FAA located at the research facility in the Southeastern United States at the time of data collection. I utilized the purposive sampling approach to gather rich information. Purposive sampling is a research technique where the investigator selects participants based on their ability to provide substantive information for the data collection (Merriam & Tisdell, 2016). Purposive sampling is a deliberate effort made by researchers to seek out and select people they determine to have specific experiences and specialized knowledge and who are information-rich (Merriam & Tisdell, 2016). This approach is purposive because I relied on my judgment to determine the appropriate sample by first setting selection criteria essential in choosing the participants (Merriam & Tisdell, 2016). The sample is purposive because I collected data only from CPC learners who have completed the ATCoach. In this study, I used the following specific criteria for including participants in the study. First, I chose ATCSs who had previously participated in the ATCoach at the research facility in the Southeastern United States. Other selection criteria are as follows. The participants were CPC, had prior ATC experience and knowledge, completed the ATCoach, and completed the simulation training in 2019 or after.

I used two different purposive sampling strategies to select the participants. I applied the typical and maximum variation sampling strategies to sample participants from the ATCSs eligible for inclusion in this study. My first step was to sample all ATCSs currently working at the research site that participated in the ATCoach. This method of selection is called typical sampling (Merriam & Tisdell, 2016). Typical sampling is a form of purposive sampling strategy that represents the “average person, situation, or instance of the phenomenon of interest”

(Merriam & Tisdell, 2016, p. 97). The justification for choosing the typical purposive sample method was that the process allowed for the selection of ATCSs, who reflected the general attributes of the ATC population. The typical purposive sampling strategy helped me to ensure that the participants selected represented an average or typical ATCS (Patton, 2014). The first step I took in the participant selection process was creating a list of all the potential recruits. Using the characteristics of an average or typical ATCS who completed the ATCoach, I selected and included into the sample every person who fit that profile (Merriam & Tisdell, 2016). Once I created a list of all the individuals that completed the ATCoach in 2019, the second step was to apply the maximum variation sampling strategy.

In order to learn a great deal about ATCSs' experiences, I also utilized maximum variation sampling, another strategy of purposive sampling used to capture a wide range of ATCSs' perspectives relating to the value of the simulator on the ATC job-related competencies. According to Patton (2014), maximum variation sampling occurs when the researcher purposefully selects "a wide range of cases to get variation on dimensions of interest" (p. 267). Because this study used a small sample size of five participants, I constructed a sample consisting of participants with various experiences for a variation in perspectives (Patton, 2014). The participants selected for this study possessed a wide range of experiences and contributed to advance the study. The rationale for using the maximum variation sampling in this study was that it yielded greater insights and understanding into how ATCSs perceived their experiences with the ATCoach in developing job-related competencies (Patton, 2014). Most of the participants who met this study's selection criteria also possessed competencies essential to collecting rich data. I used maximum variation to ensure that the population's characteristics (gender and work experience) were represented in the study (Merriam & Tisdell, 2016). For example, the participants' industry background before transferring to the research site included experience in the ARTCC, TRACON, and tower environment. Maximum variation sampling of ATCSs was first used in identifying and seeking out individuals who collectively represented the three ATC operational domains (work experiences). I then identified and selected ATCSs of different gender (i.e., male and female) to be represented in the sample.

During the recruitment period, I distributed information to prospective participants about the scope of the study and the nature of the data collection process. Also, I provided contact information and other relevant information about the investigation. All ATCSs 56-years-old and below were eligible to participate. Recruitment (see Appendix C) took place over 2 weeks, allowing for maximum participation. Recruiting of participants occurred through the review of the STTAR and training record of available ATCS at the research facility. Potential participants were notified through email. The correspondence contained my email and contact information for communication, questions, and affirmation of willingness to participate.

I included five FAA ATCSs as the unit of analysis for this study. I included individuals in the study based on the prescribed criteria. Additionally, I deliberately recruited these individuals because they are information-rich. Information-rich individuals are those who best answer the research questions (Patton, 2014). I considered that ATC experience or lack thereof might significantly influence participants' ability to speak intelligently on their ATCoach experience. I also selected the five participants because I believed that conducting a study with a small number of participants would be manageable. I prescribed to Bernard's (2012) assertion that ATCSs work a wide variety of schedules, making it challenging to collect data. Consequently, I decided that a small sample size would make the study more manageable regarding recruiting ATCSs, conducting interviews, analyzing and presenting the findings, and ultimately answering the research questions (Hackshaw, 2008).

As this research was a qualitative exploratory case study involving interviews, no standards or guidelines for sample size assessment exist. Several scholars (i.e., Creswell & Creswell, 2018; Glaser & Strauss, 2017; Marshall & Rossman, 2016; Merriam, 2007; Morse, 1994; Patton, 2014) offer varying recommendations regarding the appropriate sample size to use in qualitative inquiry. I prescribed to Creswell's (2013) recommendation of using a sample size of five to 25 participants. In this study, five participants from the CPC group were interviewed, with five participants representing approximately 10% of the CPC group. Considering potential scheduling and time constraints, a small sample size was practical for this research. Of the CPC group, 27% participated in some form of ATCoach in 2019. I solicited participants from among the ATCSs who participated in the ATCoach training in 2019 hoping that a minimum of five participants were available to be studied.

Data saturation was an essential factor that affected my decision in the number of ATCSs I decided to include in the study. Saturation is the threshold in data collection when the gathering of new data does not render new theoretical insights about the phenomenon under investigation (Patton, 2014). Data saturation occurs when the interviews generate enough information, and the researcher begin hearing similar feedback from the participants (Merriam & Tisdell, 2016). I settled on selecting individuals based on Morgan et al.'s (2002) findings that suggest data saturation generally occurs after interviewing approximately five to six participants. Guest et al.'s (2006) research using 35 participants concluded that they achieved data saturation after the first six interviews. Because of the homogeneous nature of the ATCoach training, I anticipated that most participants would share a similar learning experience. With that determination, coupled with the position of Morgan et al. (2002) and Guest et al. (2006), I predicted that I would achieve data saturation with a sample size of five experienced ATCSs. As such, this study's sample consisted of individuals with industry experience to produce quality information to answer the research questions (Patton, 2014). I found that data saturation in this study occurred after interviewing approximately three participants.

There are several advantages to using the purposive selection method. The longitudinal effects of a case study can also result in the high cost of doing the research (Yin, 2018). Purposive sampling effectively reduces the time and costs associated with data collection (Yin, 2018). According to Lavrakas (2008), purposive sampling is considered one of the most effective approaches used in qualitative research for keeping the cost and time low. Another benefit of using purposive sampling, according to Merriam and Tisdell (2016), is that it provides multiple sampling options (i.e., typical, maximum variation, convenience, unique, snowball, and chain). Additionally, purposive sampling is an excellent approach to improving data generalizability. It eliminates the researcher's need to randomly select participants and instead create a sample based on established criteria such as "special experience and competence" (Merriam & Tisdell, 2016, p. 96).

Purposive sampling also has some disadvantages. The major drawback of purposive sampling is that it is subjective and relies heavily on the researcher's judgment in setting participants' selection criteria (Merriam & Tisdell, 2016). The issue of assumptions and worldviews is important because it can influence the interpretation of the findings, underlining the research approach and the objectivity of the study (Creswell & Creswell, 2018). The researcher's philosophical assumptions and worldviews can lead the questions. Leading research questions with philosophical beliefs and worldviews can influence the data collection making the results lean in the direction most desirable to the investigator and ultimately resulting in misrepresented findings (Saidin & Yaacob, 2017).

I opted to employ purposive sampling because I believe it is the most appropriate selection method for this study. The reason for selecting purposive sampling was because the critical information needed to satisfy this study's purpose was best collected from individuals who possessed a specific set of competencies and special experience (Merriam & Tisdell, 2016). For example, I gathered data from individuals who completed the ATCoach simulation training in 2019. To ensure all participants met this study's selection criteria, selecting individuals before the data collection process was required (Merriam & Tisdell, 2016). This study's participants were not recruited to capture the average opinions of the general ATC population, but because of their ATCoach experience and in-depth understanding of ATC (Merriam & Tisdell, 2016; Patton, 2014). Therefore, purposive sampling was the most appropriate option among the other qualitative sampling methods.

Purposive sampling was also most appropriate for this study because the study has a small sample size. I decided to keep the sample size small to ensure the research cost and time were manageable. I also utilized a single source of evidence because it was more cost-effective than collecting data from multiple sources (Yin, 2018). According to Lavrakas (2008), purposive sampling is considered one of the most effective approaches used in qualitative research for keeping the cost and time low. As stated by Yin (2018), purposive sampling effectively reduces the time and costs associated with data collection.

Ethical Issues/Permissions

This study complied with all national, statewide, and university ethical standards and regulations for researching human subjects (see Appendix D). Compliance was accomplished by following the guidelines of each entity, collecting the appropriate consent, and respecting participants' rights. First, I obtained the appropriate institutional review board (IRB) approval before allowing participants to enroll in this study (Creswell & Creswell, 2018). I submitted an IRB application and associated documents to UWF's IRB showing that the study adhered to all ethical considerations outlined in the Belmont Report. The Belmont Report is a document that outlines the ethical principles that should be adhered to when researching human subjects. The Belmont Report protects all research participants' rights, confidentiality, and welfare (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research [NCPHSBBR], 1979). There are certain ethical issues that researchers should consider when conducting qualitative research. The Belmont Report offered guidelines indicating that researchers should consider three ethical principles (i.e., respect for persons, justice, beneficence) when researching human subjects (NCPHSBBR, 1979).

The respect for persons principle emphasizes that researchers have the ethical responsibility to ensure that the anonymity of participants and subjects with diminished autonomy should be protected (NCPHSBBR, 1979). This study adhered to the ethical conviction of the respect for persons principle by obtaining voluntary, informed consent from participants before enrolling the participants in the study (NCPHSBBR, 1979). After receiving IRB approval (see Appendix E), I initiated the data collection process once the ATCM granted permission. The data collection process started by first obtaining consent from the participants. I presented the first document asking for participants' informed consent. The informed consent forms (see Appendix F) informed all participants of the research purpose, participants' role in the study, and the time they would spend participating. I also notified participants of their right to quit without fear of reprisal. I also advised participants that their confidentiality will be honored by assigning numbers instead of their names (Creswell & Creswell, 2018). Also, I informed all participants of any benefits rendered for participating in the study. A recorded media addendum to informed consent was also presented to participants to audio record the interview (see Appendix F). The participants signed both the informed consent and media consent forms.

The beneficence ethical principle states that researchers should cause no harm to the research subjects (NCPHSBBR, 1979). The focus of beneficence emphasizes that researchers should follow two rules when conducting research: (a) do no harm and (b) protect participants from harm while maximizing the benefits of their research participation (NCPHSBBR, 1979). The fundamental purpose of beneficence is to protect people from the risk of harm and distress and protect them from exploitation. I adhered to the ethical conviction of the beneficence principle by obtaining voluntary, informed consent from all participants to ensure that they were aware of the risks and benefits before agreeing to participate (NCPHSBBR, 1979). I listed the risks and benefits in the informed consent form (see Appendix F) that a participant may experience. This study interviewed participants on their past experiences with simulation training; therefore, the possibility of experiencing physical harm was practically nonexistent. However, I protected all the information that the participants provided so that it may not be used in any way to harm them. There were also no substantial benefits that the participants might gain from the research that I deemed needed protection (NCPHSBBR, 1979).

The justice principle focuses on who should receive research benefits and who should endure its distress, pain, and stress (NCPHSBBR, 1979). It suggests that all participants are treated with fairness and without exploitation (NCPHSBBR, 1979). It also states that persons of equal standing should be treated equally throughout the research process (NCPHSBBR, 1979). This study adhered to the ethical conviction of the justice principle by affording every ATCSs that met the participant selection criteria equal rights to participate in the study (NCPHSBBR, 1979). The informed consent documentation (see Appendix F) clearly conveyed how I protected participants' identity and privacy. I upheld participants' rights to privacy by following procedures for anonymity (Creswell & Creswell, 2018). Specifically, I detached participants' names from the data they provided by assigning numbers instead of their names.

Data Sources

There are multiple data collection sources in qualitative research, including interviews, observations, and existing documents and records (Yin, 2018). The data collection strategy for this study was interviewing. Interviewing is a data collection process that allows qualitative researchers to elicit personal data from the participants (Guest, 2013). This approach enables the interviewer to build a personal rapport with the participant to collect data that may otherwise be difficult to attain. The interviewer is responsible for collecting the data and allowing the interviewee to focus on answering the questions (Guest, 2013). I used interview data as the centerpiece of the study because interviewing is an insightful and compelling approach to qualitative inquiry (Patton, 2014). I followed Brinkmann and Kvale's (2015) criteria for conducting successful interviews: thematizing, designing the interviews, interviewing participants, transcribing, analyzing, verification, and reporting. I found meaning in what the participants revealed during the interview about their lived experiences (Brinkmann & Kvale, 2015). A 1-hour interview served as the primary data collection method.

Interviewing was selected as a source of data collection because of the following advantages. First, the interviewing process allows qualitative researchers to elicit personal data from the participants (Guest, 2013). This approach enables the interviewer to build a personal rapport with the participant to collect data that may otherwise be difficult to attain. Second, the interviewer is responsible for collecting the data and allowing the interviewee to focus on answering the questions. Third, interviewing is a flexible method of collecting data because the study can apply it to people of different backgrounds (Guest, 2013). Last, interaction with participants allows for greater insight into the problem. Like in-person interviews, the Zoom (2020) video conference interview technique used in this study enabled me to read the participants' body language and make assumptions from the interviewee's gestures.

Interviewing also has some disadvantages. First, the interviewer's philosophical assumptions and worldviews can lead the questions. Leading research questions with philosophical beliefs and worldviews can result in misrepresented findings (Saidin & Yaacob, 2017). Second, the interview data can lose credibility if the interviewer inaccurately annotates the responses or if parts of the answers are missed or ignored (Anderson, 2010; Fritz & Vandermause, 2017). Third, interview data can be challenging to analyze and interpret. Last, interviewing is a subjective technique that lacks objectivity regarding data collection (Saidin & Yaacob, 2017). In this study, I drafted questions on the IPG, counteracting my preconceived assumptions (Anderson, 2010; Creswell & Creswell, 2018). I also incorporated relevant phrases, quotes, and sentences to accurately annotate participants' responses (Curry, 2015; Powell, 2003). Prescribing to Creswell and Creswell (2018), I also included detailed descriptions to preserve the study's credibility.

Description of Research Protocols/Instrumentation

In this section, I describe the research tool used for collecting qualitative data. The study collected data by conducting semistructured interviews with five participants. I designed a semistructured IPG (see Appendix G) to guide and focus the conversation and yet give me the freedom to navigate the topic's scope (Gordon & Todd, 2009). The IPG comprised of 23 questions framed by the six SRQs to collect data. These were open-ended questions designed to address the overarching research question. Additionally, I used the classifications of Bloom's taxonomy of the cognitive domain to frame and align the interview questions with the SRQs. I worded the questions to solicit information about the participants' experience with the ATCoach training simulator. Questions for the interview were predetermined and typed in advance.

I crafted Questions 1 and 2 on the IPG to serve as secondary questions. The secondary questions focused on participant hiring source, professional backgrounds, and work experience selected to maximize diversity among responses (Rubin & Babbie, 2007). I created Questions 3 through 6 on the IPG to focus on the lowest level, the knowledge level of Bloom's taxonomy, and ATCSs' experiences with the ATCoach in developing their ATC knowledge. To establish the participants' interpretation of what "ATC knowledge" means, I asked Questions 3 and 4 on the IPG.

I explicitly crafted Questions 5 and 6 on the IPG to determine what knowledge ATCSs learned from their experiences with the ATCoach in developing their job-related competencies. I used Questions 5 and 6 in conjunction with the previous two questions on the IPG to assess if knowledge of basic information took place during simulation training and what knowledge was learned from ATCSs' experiences with the ATCoach. Participants were asked what knowledge (or information) they perceived they learned from their experience with the ATCoach and how their experiences with the ATCoach affected how they recalled ATC information such as air traffic concepts and facts.

I created Questions 7 and 8 on the IPG to focus on the comprehension level of Bloom's taxonomy of the cognitive domain and ATCSs' experiences with the ATCoach in developing the ATC job-related knowledge competency. I used Questions 7 and 8 to assess if comprehension of basic information occurred during simulation training and how ATCSs comprehend information learned from their ATCoach experiences. Question 8 asked participants what aspects of the ATCoach helped in their understanding of the knowledge learned. Question 8 on the IPG asked how the ATCoach impacted ATCSs ability to understand and describe ATC-related facts such as aircraft classification, prescribed phraseology, equipment status information, and equipment capabilities.

I crafted Questions 9, 10, and 11 on the IPG to focus on the application level of Bloom's taxonomy and ATCSs' experiences with the ATCoach in developing the ATC job-related performance competency. I used Questions 9, 10, and 11 on the IPG to explore ATCSs' perceptions of their simulation experience related to their perceived performance skills development during simulation training. This research used the application level of Bloom's taxonomy of the cognitive domain to determine if the application of information and skills occurred during simulation training: providing opportunities for ATCSs to apply what they know to practice directing and managing aircraft. I explicitly crafted Question 9 on the IPG to determine how ATCSs perceived the ATCoach simulator's fidelity. I asked participants how they felt the activities or scenarios used in the ATCoach related to real-world situations and problems. This question was asked to test my philosophical assumption that the ATCoach simulator precisely reproduced the live ATC environment. Question 10 asked participants how the knowledge, techniques, and rules learned from the ATCoach impacted how they performed ATC duties such as handoffs, pointouts, or coordination. The question was designed to ascertain whether the ATCoach developed certain ATC skills or enhanced ATCSs' understanding of specific ATC knowledge, facts, techniques, or rules. During data collection, the responses of ATCS 3 and ATCS 5 did not address the question surrounding specific ATC tasks. Instead, the answers reinforced previous statements made by participants regarding the impact the ATCoach has on acquiring ATC knowledge. Consequently, the following probing question (Question 10A) on the IPG was asked: In what ways have you applied the knowledge, facts, techniques, and rules learned on the ATCoach simulation to solve real ATC problems? Then question 11 asked ATCSs how their daily performance changed after experiencing the ATCoach.

I crafted Questions 12, 13, and 14 on the IPG to focus on the analysis level of Bloom's taxonomy and ATCSs' experiences with the ATCoach in developing the judgment and critical thinking ATC job-related competencies. I used Questions 12, 13, and 14 on the IPG to determine if the ATCoach provided learners opportunities to use judgment to solve complex problems. Question 12 asked participants how their experience with the ATCoach affected their ability to interpret complex ATC maps such as sector maps, geographic maps, minimum vectoring altitudes (MVA/obstruction maps, or approach plates. Question 13 on the IPG asked participants what they had learned about managing air traffic from their ATCoach simulation experience, allowing them to make good decisions and good control judgment when providing ATC services. Question 14 asked participants how their experience with the ATCoach impacted the way they scanned an entire control environment, gathered clues, and used those clues to draw conclusions.

I created Questions 15, 16, 17, and 18 on the IPG to focus on the synthesis level of Bloom et al.'s (1956) taxonomy and ATCSs' experiences with the ATCoach in developing the judgment and critical thinking ATC job-related competencies. Question 15 asked participants how they have used the different information learned from their experience with the ATCoach to develop their own unique ways of completing ATC duties. Question 16 asked participants to describe "positive control." To build upon the previous question relating to "positive control," a follow-up question asked participants how the integration of information and skills learned from their experience with the ATCoach affected their ability to apply positive control judgment. Question 17 asked participants to describe a time when they had to actively and skillfully examine, break down, and incorporate information learned from their experience with the ATCoach to develop alternate ways of solving an ATC problem. Question 18 asked participants to describe an ATC situation such as an equipment failure or emergency that caused them to reflect on their experience with the ATCoach.

I crafted Questions 19, 20, 21, and 22 on the IPG to focus on the evaluation level of Bloom's taxonomy and ATCSs' experiences with the ATCoach in developing judgment, critical thinking skills, and self-confidence. I used the four questions collectively to determine how ATCSs perceived the simulation training impacted their self-confidence to manage complex air traffic scenarios without instructor intervention to meet the minimum requirement for radar certification. Question 19 asked participants to explain how their experiences with the ATCoach affected their ability to make value decisions about ATC-related issues. Then question 20 asked participants how their experiences with the ATCoach affected the way they prioritized ATC duties. Question 21 on the IPG asked participants how their experiences with the ATCoach impacted their judgments about the values of methods, procedures, and other practices used in ATC. I designed Question 21 to ascertain whether the ATCoach developed ATCSs' ability to exercise their best control judgment. Question 22 on the IPG asked participants what impact their experience with the ATCoach had on their self-confidence to operate safely in the live air traffic environment. I developed the question to ascertain whether the ATCoach improved self-confidence among CPC-ITs after training.

Lastly, I crafted Question 23 on the IPG to capture ATCSs' perspectives on aspects of the simulation training they believe deserve additional attention. This question asked participants if they had anything else to share about their experience with the ATCoach before completing the study's data collection phase. I designed the IPG to facilitate a 60-minute interview; however, the time duration of the interview sessions ranged from 61–72 minutes. The average time duration of the interviews was 67 minutes.

Field Testing

Field testing is a process where SMEs reviewed the interview questions and provided feedback on the questions' credibility and dependability (Merriam & Tisdell, 2016). I field-tested the IPG by conducting preliminary interviews before implementing the primary interview. Field testing the interview protocol is an essential step in adding clarity and efficiency to the data collection process. Specifically, field testing ensures that a researcher words the questions to elicit the most useful responses (Merriam & Tisdell, 2016).

I created an IPG consisting of 23 semistructured questions. I designed the questions to explore ATCSs' perception of their experiences with the ATCoach. I submitted the IPG to a three-member expert panel of ATCSs (SME 1, SME 3, and SME 4) to determine if the questions were adequately worded and would make sense to an ATCS. One of the members on the panel, SME 4, suggested that I should move forward with the interview questions as they were originally written because they believed the questions were well-written. However, the other two members offered feedback on Question 10. For example, SME 3 called for removing the word "facts," claiming, "I don't believe we learn facts in the lab." SME 1 offered a similar suggestion to that of SME 3. SME 1 further suggested that the word "rules" be removed from Question 10 on the IPG, stating,

> Application section, Question 10: One doesn't learn rules in the Sim, but rather applies rules and knowledge learned of the local operation (SOP and LOA's). It is a place to

> apply knowledge of ATC rules that are in JO 7110.65 by using various techniques. If a simulation scenario was given to 10 fully qualified controllers where multiple aircraft were in conflict with one another requiring controller action, I would venture to say that you would easily get at least five different solutions.

Consequently, I revised Question 10 on the IPG by incorporating SME 3's suggestions. However, I decided not to incorporate SME 1's feedback. My justification for this action was that removing the word "facts" would not affect how participants answered the question. On the other hand, since my goal was to ascertain what ATCSs learned from their experiences with the ATCoach, omitting the word "rules" may limit participants' responses on what they learned or did not learn during the ATCoach.

I conducted three pilot interviews after revising the IPG. This study selected the pilot interview participants (PIP 1, PIP 2, and PIP 3) from the pool of qualified CPCs that met a specific criteria, CPCs who had participated in the ATCoach in 2019. The field test participants were omitted from the study because the pilot interviews and the final data collection interviews took place at the same research site. Consequently, I excluded all data collected during the field testing phase of the study. I ensured that the field testing process was subjected to the same scrutiny and guidelines set forth for the final interview data collection stage. The field test interviews adhered to the IRB guidelines before allowing individuals to participate in the pilot interviews (Merriam & Tisdell, 2016). The facility ATCM granted permission to select three ATCSs with CPC credentials to use in the field test. I also notified the site's ATCM before starting the pilot interviews.

The first pilot interview generated useful feedback that allowed for revisions to the original interview questions. I incorporated the revised questions into the final version of the IPG to strengthen the research instrument. The first individual, PIP 1, misunderstood the focus of the study to be the physical simulator and not the simulation training because the questions on the IPG did not explicitly say simulation training. Expressed in the individual's own words,

> I think what I'm about to say is probably the most important because there's, you know, I think the questions that you were asking were coming from the other side. With no disrespect, like not being a controller, you were more focused on the equipment itself.

The term "on the other side" in this context refers to the Technical Operations (TechOps) section under the FAA's ATO umbrella. TechOps is the department where I work. PIP 1 believed that the questions were TechOps-centric and did not focus enough on the ATC experience because I am a member of TechOps. I alleviated the individual's concerns and ensured that the IPG questions explicitly stated that the study was interested in learning more about the complete simulation training. Accordingly, I replaced all references of the word “simulator” with “simulation training” before conducting the other two interviews. The other two participants, PIP 2 and PIP 3, did not offer any substantive feedback on the IPG but instead just answered the question posed. I was satisfied with the flow of the pilot interviews and the responses provided and decided that additional revisions to the IPG were unnecessary.

Data Collection Procedures

The collection of quality data is a primary research concern. According to Cheng and Grant (2016), “the accuracy of the results depends on the quality of the” raw data (p. 338). In this study, I collected data by conducting interviews. Data gathering took place in two phases over a 5-week period. Table 8 presents the procedures used for collecting data.

Table 8

Data Collection Procedures and Timeline

Phase	Week	Tasks
Phase 1: Predata Collection	Week 1	• Secured written consent from ATC Manager (see Appendix A). • Met with ATC training staff and support personnel. • Reviewed training roster to determine potential participants. • Made photocopies of relevant training documents.
	Week 2	• Identified ATCS who participated in the ATCoach training in 2019. • Solicited participants from the identified group.
	Week 3	• Conducted field testing of IPG. • Analyzed field test feedback. • Revise interview protocol.
Phase 2: Data Collection	Week 4	• Obtained informed and media consent from all participants (see Appendix F). • Conducted interviews.
	Week 5	• Conducted interviews. • Took digital photographs of the simulator lab.

I collected data at an ATC facility in the Southeastern United States. The first stage of data collection involved securing written consent from the ATC manager and reviewing the facility's STTAR to determine potential participants.

The second stage focused on interviewing ATCSs to get their perception about their experience with the ATCoach. This study conducted interviews of all participants synchronously using the Zoom video conferencing platform (Zoom, 2020). The interview process started with my informing the participants of their rights and the ethical ramifications of the study:

1. I explained and clarified any misunderstandings relating to the informed consent and the media consent processes.
2. I explained the audio recording process to each participant.
3. I ensured that each participant signed and dated the media consent and informed consent documents.
4. I informed participants that I would transcribe the recorded audio for accuracy once the interview process had ended.
5. Before starting the interview, I gave participants a chance to raise concerns and inquiries about the interviewing process or the study.

I took the following action during each interview: I ensured that each interviewee signed and dated the media and informed consent forms before conducting the interview. I recorded the interviews digitally using the built-in recording feature in the Zoom (2020) video-conferencing application.

After each interview, I digitally cataloged the interview's recorded audio data by name, date, and time to keep them organized. The cataloged audio was transferred from the Zoom file directory onto my Western Digital Sentinel DX4000 private NAS server (NAS server) via a secured MacBook Pro computer. I transcribed the audio cataloged interviews using a web-based artificial software platform called Otter.ai (2021). According to Brinkmann and Kvale (2015), transcribing is reproducing oral language, verbatim, to written language, including variation in voice and tone. After the data were transcribed, I emailed the transcripts to the participants to verify their responses by having them read and confirm their answers.

I saved the digital interview transcripts to the NAS server via a MacBook Pro computer and on a secure folder on the UWF's student Google Drive cloud storage. The interview audio catalog, the signed consent forms, and the transcripts will be kept securely for 3 years after the study has concluded. After this study concludes, all interview-related files and documents will be destroyed by deleting the files (Protection of Human Subjects, 2018).

Researcher Positionality

Positionality refers to a researcher's sociocultural identity in relation to the study participants (Allen, 2017). Savin-Baden and Major (2013) stated that positionality is the perceptions and implications associated with an individual's identity, worldview, and stance in relation to the research, how a researcher's sociocultural identity informs that individual's work. According to Lincoln (1995), the study must present a researcher's positionality honestly in the text.

I am a 47-year-old male of African descent with 22 years of theoretical and practical knowledge in electronic theory and characteristics, functions, operations, and capabilities of a variety of NAS equipment. I have spent 6 years in the United States Air Force as a Ground Radar Systems Specialist, 3 years working for the DOD as an Airfield Systems Specialist (Electronics Technician), and 13 years as an Airway Transportation Systems Specialist for the FAA. I am familiar with the training simulator's physical attributes and general functionality at the

Southeastern United States' ATC facility. Further, I am responsible for performing preventive maintenance, corrective maintenance, and modifications on the simulator equipment. In reference to this study, I am not an ATCS, have no ATC training, and am only familiar with the simulator's technical and functional capacity. Despite having previous technical experience with the ATCoach at the research site, I was positioned as an investigator and did not play the role of participant. My positionality allowed for a basic understanding of ATC terminologies and operational procedures. My professional relationships at the research site allowed for easier access to participants, documents, and the ATCoach training simulator.

Throughout this study, I found that my sociocultural background and differences (e.g., gender, race, class, religious beliefs, etc.) had little to no influence on the data collection and analysis process. However, it is not lost on me that the study could have been created and organized in some way around knowledge from my sociocultural roots (Gordon et al., 2019). Nonetheless, I believe that my knowledge, skills, and industry experience influenced the data collection and analysis process more than my sociocultural background. For example, my knowledge of ATC played a significant role in crafting relevant interview questions, and it also allowed me to interpret participant experiences accurately. In addition, I used semistructured interviews to ensure I got accurate, unbiased responses from the participants (Bernard, 2012).

My 22 years of professional experience have significantly influenced my choice to select the study's topic and identify the problem under investigation. Still, the selection of both the study's topic and the problem to investigate involved a process that evolved as I was exposed to more information and the literature and as I gained a renewed understanding of the dissertation writing process and the university's requirements. I knew early in the doctoral program that I wanted to conduct my research on technical-leaning subject matters (i.e., engineering and design, electronics systems, OT&E, etc.) because my professional experience supported such a track. I understood that research is a very time-consuming scientific process and therefore wanted to investigate a topic that would energize me and align with my professional interest (Anderson, 2010; Roberts, 2010). Additionally, I prescribed the idea that investigating a subject that I have a strong interest in would ultimately help me stay the course and complete the manuscript (Roberts, 2010).

As a student enrolled in the Curriculum and Instruction program at The University of West Florida, it was necessary to focus my research on an issue related to curriculum and instruction (UWF, n.d.). I used my desire to research technical matters with the university's requirement to focus on a problem related to my program specialization. I initially decided to conduct my investigation on the FAA's ATO TechOps training and personnel certification. TechOps is a section under the FAA's ATO umbrella that is responsible for ensuring the safety and efficiency of the NAS by "effectively managing air navigation services and infrastructure" (FAA, 2019). Because of my years of experience working in TechOps, I decided to conduct my research on the STARS training course. STARS is a terminal automation system used by ATCSs to manage air traffic. TechOps personnel perform preventive maintenance, corrective maintenance, and modifications on the STARS system (FAA Order No. AJO 3120.4P). I was forced to abandon the STARS training course as a research subject matter because the STARS maintenance course is taught at the Mike Monroney Aeronautical Center in Oklahoma City. Because of my experience working in TechOps, I understood that conducting research in Oklahoma City would be expensive because of travel and other expenses (Anderson, 2010; Creswell & Creswell, 2018). A more plausible solution was to conduct research on the air traffic training on the same system (i.e., STARS), which is offered locally at the research site.

After deciding to focus on ATC training instead of TechOps, I discovered a potential problem in the workplace that needed a solution (Roberts, 2010). In a casual conversation with a SATCS, I inquired about the ATCoach simulation and received a less than favorable response. Specifically, the SATCS believed that the ATCoach was an ineffective mode of training ATCSs. The SATCS's response challenged my preconceived assumptions and worldviews relating to the ATCoach simulation. For context, the FAA and DOD, in a joint venture, allocated a significant amount of time and money to OT&E efforts to improve the system's functionality. I participated in several OT&E efforts, so I was surprised to find out that the simulation training was considered ineffective. The SATCS' perspective on the value of the ATCoach as a training tool encouraged me to reach out to other ATCSs to unofficially solicit the attitudes about the simulation training at the research site. I received mixed responses from the ATCSs, which demonstrates that the value of the ATCoach in training ATCSs is an acceptable topic to research in the field of curriculum and instruction. I also believe that the subject matter has the potential to contribute to the existing body of knowledge relating to aviation simulation education and the value and effectiveness of simulation technology in the development of ATCSs' job-related competencies (Roberts, 2010).

Recognizing and resolving biases caused by my professional relationship with the research site and my insider status with the organization was important to ensure the findings were accurately represented (Saidin & Yaacob, 2017). Insider bias occurs when the researchers' philosophical assumptions and worldviews influence the quality of the study's findings (Saidin & Yaacob, 2017). The research questions, instruments, data collection approaches, and analysis can be influenced by the researchers' philosophical assumptions and worldviews which can ultimately result in misrepresented findings (Saidin & Yaacob, 2017). Recognizing that researcher bias exists and is prominent in qualitative research, I was mindful that steps needed to be taken to mitigate the effects bias and assumptions have on the interviewing procedure (Creswell, 2015; Merriam & Tisdell, 2016).

To counteract the effects of my philosophical assumptions and worldviews on the research findings, I selected interviewing as the research instrument. Interviewing relies heavily on participants' perceptions and less on the researcher's interpretation of their experiences. I then drafted questions on the IPG, counteracting my preconceived assumptions (Anderson, 2010; Creswell & Creswell, 2018). I created semistructured open-ended questions as an approach to improve the soundness and precision of a study's findings (Bernard, 2012). The purpose of employing the semistructured interview was to avoid leading the participants or influencing the direction of the research findings (Saidin & Yaacob, 2017). I also mitigated researcher bias by framing the research questions and IPG's questions with the conceptual framework. I also analyzed the data by abiding by the conceptual framework's constructs and criteria (Merriam & Tisdell, 2016). I also incorporated relevant phrases, quotes, and sentences to accurately annotate participants' responses and minimize bias (Curry, 2015; Powell, 2003).

Ensuring Trustworthiness and Rigor

Quantitative researchers generally rely on the concept of credibility to address whether their research findings or data accurately represents the phenomena under study (Creswell, 2015). However, qualitative data are immeasurable, and therefore, a measurement of credibility cannot be attained (Smith, 1984). Instead, the term "trustworthiness" is used in naturalistic inquiry to describe how believable the study's findings are and to ensure that it represents the reality of the phenomena under study (Creswell & Creswell, 2018). Trustworthiness is the concept of giving an accurate account of the participant's view of the world. Scholars Lincoln and Guba (2006) developed a framework for assessing how much trust (or how much truth value) researchers should place in interpreting qualitative data. Lincoln and Guba (2006) proposed five criteria for ensuring trustworthiness in qualitative data: credibility, dependability, confirmability, transferability, and authenticity.

Credibility refers to the level of confidence one places in the research findings' truthfulness and how those findings match reality (Merriam & Tisdell, 2016). The evidence's credibility is essential because it legitimizes the research findings from the research participants' perspective (Patton, 2014). I established credibility through the "rich, robust, comprehensive and well-developed" account of the phenomena (Koenig, 2011, p. 121). A common strategy used for establishing credibility, according to Stake (2015), is triangulation. Creswell (2015) described triangulation as a data collection strategy for using different methods. For example, researchers use observation, documents, and individual interviews to increase their study's accuracy. Patton (2014) stated that rigorous and systematic data collection and analysis are the criteria for trustworthiness.

Dependability refers to whether research findings "are consistent with the data collected" (Merriam & Tisdell, 2016, p. 251). I ensured dependability through prolonged engagement with the research data. I conducted several thematic content analyses and narrative analyses on interview transcripts to truly discover the meaning and ensure the meaning did not change over time (Bloomberg & Volpe, 2019).

Confirmability refers to the concept of ensuring research data are accurate and the data's meanings are valid based on how a researcher interprets the participants' responses (Lincoln & Guba, 2006). I confirmed the data by ensuring that multiple individuals' responses were corroborated during the data analysis process to ensure genuine results. A single researcher's interpretation of the data or decision of what is essential may have implications relating to their philosophical assumptions and worldviews.

Transferability is a concept that refers to the level at which the study's results can be transferred to other settings, groups, or situations (Merriam & Tisdell, 2016). I established transferability by selecting a TRACON ATC facility that holds a Level 10 classification to serve as the research site. The significance of selecting a Level 10 facility for this research is that the findings may also apply to all other Level 10 and lower facilities using the ATCoach Radar Test and Training simulator.

The fifth and final criteria of Lincoln and Guba's (2006) framework for assessing trustworthiness is authenticity. In naturalistic inquiries, authenticity speaks to researchers' desires to ensure that both the investigation process and the analysis of data are precise and reflect the true essence of participants' lived experiences (Given, 2008). Authenticity refers to how well a researcher conveys the message, feelings, tones, emotions, and affections evident in participants' responses (Lincoln & Guba, 2006). Onwuegbuzie et al. (2004) identified four factors that must be taken into consideration when determining the authenticity and accuracy of research data: (a) knowledge and competence of the author, (b) the time delay between the occurrence or recording of events, (c) philosophical assumptions and worldviews of the author, and (d) consistency of the data" (Onwuegbuzie et al., 2004). I ensured authenticity by providing raw, direct quotes from the interview transcripts.

Researchers can use several qualitative research methods to attain accuracy (e.g., the credibility, dependability, confirmability, transferability, and authenticity of the research findings). To meet the foundational measures of trustworthiness, Creswell and Creswell (2018) provided the following strategies for qualitative inquiry: member checking, rich and thick description, identifying the worldview of a researcher, triangulation, negative or discrepant case analysis, prolonged engagement, persistent observation in the field, peer review or debriefing, and external audits. This study employed four of Creswell and Creswell's (2018) strategies: member checking, rich and thick description, identifying a researcher's worldview, and peer review strategies to ensure credibility, dependability, confirmability, transferability, and authenticity.

I used member checking to confirm the findings from the interview data. As Merriam and Tisdell (2016) described, member checking establishes credibility by asking interviewees to verify the accuracy of their experiences and the research findings. I used member checking to ensure that what transpired and how the interviewee said it occurred was accurately interpreted. Upon completing the interview sessions, I transcribed the audio recordings on the Otter.ai (2021) speech-to-text transcription application and then saved the text into a word document. Since I restricted the study's sample size to five participants, I sent a copy of the transcribed interview back to all five interviewees via electronic mail (email). The rationale is that taking transcripts back to participants for review will allow them to check for accuracy, clarify any inaccurate statements, edit their accounts, or add more to what was already annotated (Merriam & Tisdell, 2016). Once each participating ATCSs checked the transcript for accuracy and completeness, I made all necessary revisions to the transcribed interviews to improve credibility and ensure authenticity. Blaikie (2009), Creswell (2015), and Foeckler (2019) indicated that it is challenging to generalize inaccurate data. Inaccurate data, according to Foeckler (2019), can "make it difficult to generalize the findings" (p. 66) to the larger air traffic population.

Merriam (2007) stated that case studies employed purposive sampling because they provided rich information. Providing rich and thick descriptions is an excellent approach to improving data generalizability (Merriam, 2007). I used rich and thick descriptions to present the critical elements of this research, including the research site, the simulation laboratory, the participants, and the themes that emerged from the interview data. For instance, I used detailed descriptions, transcripts, and photographic evidence of the simulator laboratory to bring the readers into the research setting and connect readers with the research participants. This method of reporting findings provided the readers with a detailed and visual presentation of the participants' experience.

As humans, we tend to harbor certain philosophical assumptions about the world in which we exist and take many philosophical stances and views when attempting to answer a research question about the world (Robson & McCartan, 2016). As stated by Creswell (2013), researchers' philosophical assumptions and worldviews influence their claims about "ontology (the nature of reality), epistemology (what counts as knowledge and how knowledge claims are justified), axiology (the role of values in research), and methodology (the process of research)" (p. 20). It can then be argued that a researcher's philosophical assumptions and worldviews will influence how they interpret their research findings because qualitative researchers are the primary research instrument (Creswell & Creswell, 2018). Additionally, researchers may impose meaning to research data that may impact the findings (Creswell & Creswell, 2018). In addition, this study used the peer-review approach to ensure I accurately interpreted and presented the findings. For this, the findings were submitted to three selected SMEs at the research site to review the findings to ensure the presentation was authentic.

Data Analysis Techniques

According to Curry (2015), "the qualitative data analysis is an iterative process of individual and group level review and interpretation of narrative data" (p. 56). The data analysis is the core of qualitative research that begins when all data are collected and presented (Flick, 2014; Gibbs, 2008). Data analysis' primary purpose is to discern the collected data by consolidating, reducing, and interpreting its meaning (Merriam & Tisdell, 2016). I scrutinized the findings on ATCSs' perceptions of their experiences with simulation training by employing a purely inductive and comparative approach (Glaser & Strauss, 2017). The data analysis approach was to organize participants' perceptions and accounts from interview responses into manageable themes to understand and explain the findings better. This approach was accomplished by following the data logging, data coding, and thematic analysis steps recommended by Attride-Stirling (2001). Prescribing to Attride-Stirling (2001), analytic steps for data analysis are advantageous as they prevent a researcher from imposing preconceived ideas about the finding. This approach allowed me to reflect, refine, and increase the data's usability (Miles et al., 2014).

Data Logging

Upon completing the interview sessions, I transcribed the audio recordings on the Otter.ai (2021) speech-to-text transcription application and then saved the text into a word document. I then followed Merriam's (2007) recommendation to review the interview transcripts as often as necessary to get familiar with the participant's responses and ensure that the word documents' content accurately represented the audio transcripts' content. After familiarizing myself with the interview transcripts' content, I uploaded the word document version of the transcript to an online data coding platform called Atlas.ti (2021). Atlas.ti (2021) is a web-based application for qualitative analysis that codes and links data. According to Marshall and Rossman (2016), the rationale for coding and linking data is identifying patterns and themes and facilitating the emergence of consistent and distinctive categories.

Data Coding

After uploading the interview transcript into the Atlas.ti online platform, I started conducting the data coding process. Data coding is a process used in qualitative data analysis for breaking down, indexing, and mapping data in a manner that forms a common idea, making it more comprehensible to the reader (Creswell, 2015). I prescribed the recommended steps outlined by Creswell (2015) for conducting data coding. First, I selected one of the interview transcripts and performed an intensive line-by-line coding of the data using the participants' words to form the categories. The six SRQs dictated the categories in the data coding process. For example, Atlas.ti has a feature that allows investigators to code and thematically analyze data by identifying and visually color-coding and grouping like phrases and sentences together (Atlas.ti, 2021; Attride-Stirling, 2001). Second, I created a category for each SRQs and gave each category a different color. Third, I highlighted and color-coded all participants' responses based on the SRQs (i.e., answers to Questions 3 through 6 on the IPG were color-coded green to satisfy SRQ 1).

The next logical step was to identify the context of participants' responses and to identify the message they were trying to convey (Creswell, 2015). I continued the process of coding the interview transcript by identifying text segments. According to Creswell (2015), text segments are "sentences or paragraphs all of which relate to a single code" (p. 243). I combed through the interview transcripts for relevant phrases, quotes, and sentences deemed significant to the study, then appropriately defined and named each category to identify the different elements that fall under these categories (Curry, 2015; Powell, 2003). I developed text segments by creating subcategories, adding a new color-code to relevant phrases, quotes, and sentences, and assigning a category name that accurately represented participants' responses (Curry, 2015; Powell, 2003).

The codes of interest in this study addressed ATCSs' perspectives on aspects of the simulation training and the extent to which they perceive the ATCoach as a valuable instructional method for enhancing ATC job-related competencies. By following this coding procedure, I stayed in tune with the analysis process, developed ideas about the categories, and developed conclusions (Powell, 2003).

Thematic Analysis

Finally, I used the identified codes from the collected data to conduct a thematic analysis. The thematic analysis process identifies patterns and meaning in a data set and then groups the data by similarities (Creswell, 2015). I conducted a thematic analysis by consistently exploring similarities and relationships in the data (Creswell, 2015). The approach selected for this study was to compile and refine all the coded data until strong, relevant themes emerged (Strauss & Corbin, 1998). First, I took the coded data and reviewed it continually and gradually for themes (similarities) that emerged repeatedly, and then arranged and condensed the text into manageable responses (Creswell, 2015). Next, I organized the data in terms of what the phrases, quotes, or sentences conveyed. I arranged that data based on what participants said or meant or what interpretations I drew from their answers regarding their experience with the ATCoach (Creswell, 2015). I then provided a narrative presentation of the data by grouping participants' responses and adding the data's relationship to each other (i.e., comparing data for context). For example, if multiple ATCSs talking about finding a particular scenario task helpful at building self-confidence. Once all the data groups were condensed or expanded into manageable categories, I categorized the data and described the findings. Additionally, I took the data from the coded interviews and cross-referenced it with the reviewed literature and the conceptual framework. I also organized and prepared the data for analysis by reading through and looking for relationships between sources (Creswell & Creswell, 2018).

Chapter Summary

This chapter detailed several major issues, including the research design, site selection, population, participants, and participant selection. Chapter 3 also included ethical issues and permissions, data sources, description of research protocols and instrumentation, field testing, and data collection procedures. Finally, I discussed researcher positionality, ensuring trustworthiness and rigor, and data analysis techniques in this chapter.

The research design for this study was a qualitative exploratory case study. Qualitative research approaches focus on the lived experiences of participants by honoring the respective meanings, structures, and essence of their lives (Merriam & Tisdell, 2016; Patton, 2014). By design, qualitative investigations allow researchers to reserve the chronological flow and show the causal relationship between events and consequences (Amaratunga et al., 2002). Case study research is the comprehensive investigation and analysis of a social unit such as a person, group, organization, community, or society (Cooley & Angell, 1930; Goode & Hatt, 1952; Merriam & Tisdell, 2016; Young & Schmid, 1966) aimed at obtaining tremendous insight into a contemporary social phenomenon (Merriam & Tisdell, 2016; Robson, 1993; Yin, 2018). I used the exploratory case study design to understand how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies. I used the qualitative exploratory case study approach outlined by Yin (2018) to explore ATCSs' perception of scenario-based simulation and the relationship between simulation training and the readiness of ATCS.

This study's site was an ATC facility is in the southeastern part of the United States. The ATC facility is among many U.S. locations that use simulation technology to develop the ATC job-related knowledge, performance skills, judgment, critical thinking skills, and self-confidence needed to operate safely in the real air traffic environment (FAA, 2020d). I selected a TRACON ATC facility in the U.S. southeastern region to serve as the research site for data collection since the facility holds a Level 10 classification. More specifically, the facility is the fourth highest classification among the 132 ATCTs with TRACON ranked only behind Charlotte ATCT (Level 12), Miami ATCT (Level 12), Honolulu Control Facility (Level 11), and Philadelphia ATCT (Level 11) for volume and complexity (FAA, 2016a).

This study's population was selected from an ATC facility in the southeastern part of the United States. I selected participants from the identified population based on characteristics relevant to the study (Lodico et al., 2010). This study's population was ATCSs working at an FAA ATC facility. The research population consists of ATCSs from different hiring sources, age ranges, gender, and prior education and training. According to the facility's 2020 Staffing and Training Team Assignment roster (STTAR), the air traffic operation consists of 80 personnel, including CPCs, CPC-ITs, SATCS with CPC credentials, management, support staff, and training staff. As such, the ATC facility contained ATCSs whose participation helped answer the research question. The research facility was staffed with male and female CPCs aged 21 to 56 years, with 56 years being the maximum age an ATCS can control air traffic. The participants' ages ranged from 29 to 43 years.

The participants selected for this study were also integral to the data collection process. Since this study investigated the value of simulation training from the ATCSs' perspective, it was critical to identify the participants who could provide accurate accounts of their experience with the ATCoach. The sample consisted of both male and female participants between the ages of 21 and 65 years, representing all genders and age groups. All five participants worked previously at another ATC facility and obtained CPC status before transferring to the research site. Therefore, their hiring source would be considered CPC transfer. The research site also included CPC with an ATC background consisting of specified professional activity related to the ATCT, TRACON, and ARTCC operations (SME 2).

I utilized the purposive sampling approach to select participants. Purposive sampling is a research technique where the investigator selects participants based on their ability to provide substantive information for the data collection (Merriam & Tisdell, 2016). This approach is purposive because I relied on my judgment to determine the appropriate sample by first setting selection criteria essential in choosing the participants (Merriam & Tisdell, 2016). The sample is purposive because I collected data only from CPC learners who have completed the ATCoach. In this study, I used the following specific criteria for including participants in the study. I chose ATCSs who had previously participated in the ATCoach at the research facility in the Southeastern United States. Additionally, I selected CPCs who had prior ATC experience and knowledge, completed the ATCoach, and completed the simulation training in 2019 or after. I deliberately recruited these individuals because they were information-rich. Information-rich individuals are those who best answer the research questions (Patton, 2014).

I obtained the appropriate IRB approval before allowing participants to enroll in this study (Creswell & Creswell, 2018). I submitted an IRB application and associated documents to UWF's IRB showing that the study adhered to all ethical considerations outlined in the Belmont Report. The Belmont Report offered guidelines indicating that researchers should consider three ethical principles (i.e., respect for persons, justice, beneficence) when researching human subjects (NCPHSBBR, 1979). I secured permission to the research site by first coordinating with the ATCM in person to get permission to conduct the research and access the training areas. This study adhered to the ethical conviction of the respect for a person's principle by obtaining voluntary, informed consent from the participant before enrolling the participants in the study (NCPHSBBR, 1979). I adhered to the ethical conviction of the beneficence principle by obtaining voluntary, informed consent from all participants to ensure that they were aware of the risks and benefits before agreeing to participate (NCPHSBBR, 1979). This study adhered to the ethical conviction of the justice principle by affording every ATCSs that met the participant selection criteria equal rights to participate in the study (NCPHSBBR, 1979).

The data collection strategy for this study was interviewing. Interviewing is a data collection process that allows qualitative researchers to elicit personal data from the participants (Guest, 2013). I used interview data as the centerpiece of the study because interviewing is an insightful and compelling approach to qualitative inquiry (Patton, 2014).

The study collected data by conducting semistructured interviews with five participants. I designed a semistructured IPG (see Appendix G) to guide and focus the conversation and yet give me the freedom to navigate the topic's scope (Gordon & Todd, 2009). The IPG comprised 23 questions framed by the six SRQs to collect data. These were open-ended questions designed to address the overarching research question. Additionally, I used the classifications of Bloom's taxonomy of the cognitive domain to frame and align the interview questions with the SRQs. I worded the questions to solicit information about the participants' experience with the ATCoach training simulator. Questions for the interview were predetermined and typed in advance.

I field-tested the IPG by conducting preliminary interviews before implementing the primary interview. Field testing is a process where SMEs review the interview questions and provides feedback on the questions' credibility and dependability (Merriam & Tisdell, 2016). I submitted the IPG to a three-member expert panel of ATCSs (SME 1, SME 3, and SME 4) to determine if the questions were adequately worded and would make sense to an ATCS. The three-member expert panel suggested that the words "rules" and "facts" be removed from question 10 on the IPG because rules and facts are not learned during the ATCoach. Consequently, I revised Question 10 on the IPG by eliminating the word "facts" because omitting the word would not affect how participants answered the question. However, I decided not to remove the word "rules" because omitting the word may limit participants' responses on what they learned or did not learn during the ATCoach. I conducted three pilot interviews after revising the IPG. The first pilot interview generated helpful feedback that allowed for revisions to the original interview questions. I incorporated the revised questions into the final version of the IPG by changing the term "simulator" to "simulation training" to reduce participants' misunderstanding of the focus of the study.

I collected data by first securing written consent from the ATC manager and informed consent participants. The second stage focused on interviewing ATCSs to get their perception about their experience with the ATCoach. This study conducted interviews of all participants synchronously using the Zoom video conferencing platform (Zoom, 2020). The interview process started with my informing the participants of their rights and the ethical ramification of the study. I took the following action during each interview: I ensured that each interviewee signed and dated the media and informed consent forms before conducting the interview; I recorded the interviews digitally using the built-in recording feature in the Zoom (2020) video-conferencing application; After each interview, I digitally cataloged the interview's recorded audio data by name, date, and time to keep them organized.

My positionality (sociocultural identity) in relation to the study participants is as follows (Allen, 2017). I am a 47-year-old male of African descent with 22 years of theoretical and practical knowledge in electronic theory and characteristics, functions, operations, and capabilities of a variety of NAS equipment. I have spent 6 years in the United States Air Force as a Ground Radar Systems Specialist, 3 years working for the DOD as an Airfield Systems Specialist (Electronics Technician), and 13 years as an Airway Transportation Systems Specialist for the FAA. I am familiar with the training simulator's physical attributes and general functionality at the Southeastern United States' ATC facility. Further, I am responsible for performing preventive maintenance, corrective maintenance, and modifications on the simulator equipment. In reference to this study, I am not an ATCS, have no ATC training, and am only familiar with the simulator's technical and functional capacity. Despite having previous technical experience with the ATCoach at the research site, I was positioned as an investigator and did not play the role of participant.

Trustworthiness is the concept of giving an accurate account of the participant's view of the world. Scholars Lincoln and Guba (2006) developed a framework for assessing how much trust (or how much truth value) researchers should place in interpreting qualitative data. Lincoln and Guba (2006) proposed five criteria for ensuring trustworthiness in qualitative data: credibility, dependability, confirmability, transferability, and authenticity. I established credibility through the "rich, robust, comprehensive and well-developed" account of the phenomena (Koenig, 2011, p. 121). I ensured dependability through prolonged engagement with the research data. I confirmed the data by ensuring that multiple individuals' responses were corroborated during the data analysis process to ensure genuine results. I established transferability by selecting a TRACON ATC facility that holds a Level 10 classification. The significance of selecting a Level 10 facility for this research is that the findings may also apply to all other Level 10 and lower facilities using the ATCoach Radar Test and Training simulator. I ensured authenticity by providing raw, direct quotes from the interview transcripts.

Data analysis was accomplished by following the data logging, data coding, and thematic analysis steps recommended by Attride-Stirling (2001). Upon completing the interview sessions, I transcribed the audio recordings on the Otter.ai (2021) speech-to-text transcription application and then saved the text into a word document. I uploaded the word document version of the transcript to an online data coding platform called Atlas.ti (2021). After uploading the interview transcript into the Atlas.ti online platform, I started conducting the data coding process. Data coding consisted of line-by-line coding, creating categories, color-coding participants' responses based on the SRQs, identifying the context of participants’ responses, and identifying the message participants were trying to convey (Creswell, 2015). The thematic analysis process consisted of exploring similarities and relationships in the data, condensing text into manageable responses, and grouping participants' responses and adding the data’s relationship to each other (Creswell, 2015). I then provided a narrative presentation of the data by grouping participants' responses and comparing the data for context.

This study's problem was that many ATCSs are under-trained and inexperienced. The solution is that ATCSs receive academic and simulator competency-based training to develop their skills, situational awareness, and judgment so that they may adequately assist pilots (USNTSB, 2016b). This study aligned the problem and purpose to understand ATCSs' perception of simulation training to develop job-related competencies. This problem generated the study's purpose to know how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies. I created the purpose statement using similar information and the same language to describe the phenomenon of interest (Bloomberg & Volpe, 2019). I aligned the research questions with the purpose statement as it reflected the study's purpose and accomplished said purpose. Additionally, I aligned the research questions with the problem by designing the purpose statement to address the issue.

This qualitative exploratory case study design was appropriate because it aligned with the problem, purpose, and research questions. I ensured that the problem, purpose, and research questions adhered to the proper structure inherent in qualitative design (Roberts, 2010). Since this is a case study design, I aligned the framework by using a conceptual framework instead of a theoretical framework (Yin, 2018). The participant and site were also aligned with the purpose and research questions (Creswell, 2013; Merriam & Tisdell, 2016). For example, I specifically addressed the participants and research site when crafting the purpose statement and research questions. Additionally, the data collection and analysis processes used were inherently qualitative and aligned with the exploratory case study design. Lastly, the field test was aligned with the research design because I created my own instrument; therefore, I field-tested the IPG (Roberts, 2010).

Chapter 4: Data Analysis and Findings

Chapter 4 is a presentation of this study's data analysis and findings. The purpose of this qualitative exploratory case study was to understand how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies. The following overarching research question reflects the purpose of this study: How do ATCSs at an air traffic facility in the southeastern region of the United States describe their experiences with the ATCoach in developing job-related competencies? The classifications of Bloom's taxonomy of the cognitive domain guided the following SRQs:

SRQ 1: What knowledge do ATCSs at a Southeastern United States air traffic facility learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 2: How do ATCSs at a Southeastern United States air traffic facility comprehend what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 3: How do ATCSs at a Southeastern United States air traffic facility apply what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 4: How do ATCSs at a Southeastern United States air traffic facility analyze what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 5: How do ATCSs at a Southeastern United States air traffic facility synthesize what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 6: How do ATCSs at a Southeastern United States air traffic facility evaluate what they learn from their experiences with the ATCoach in developing job-related competencies?

This chapter's sections are presented in the following order: description of participants, presentation and analysis of findings, and chapter summary. First, the chapter describes the study's participants, including demographic information such as age, gender, race, ethnicity, hiring source, and certification status collected during the interview process. The description of the study's participants is followed by the narrated presentation of the themes and categories that manifested from the one-on-one, semistructured interviews. These themes and categories are logically presented, so the findings are aligned with the six SRQs. Specifically, the Presentation and Analysis of Findings section of Chapter 4 is organized logically according to the SRQs (i.e., the classifications of the cognitive domain of Bloom’s taxonomy). This section is derived from analyzing the data collected from the study participants. Data analysis’ primary purpose is to discern data by consolidating, reducing, and interpreting its meaning (Merriam & Tisdell, 2016). I scrutinized the data from ATCSs’ perceptions of their simulation training experiences by employing a purely inductive and comparative approach (Glaser & Strauss, 2017). I organized participants’ perceptions and accounts from interview responses into manageable themes to better understand and explain the findings. I followed the data logging, coding, and thematic analysis steps that Attride-Stirling (2001) recommended. Prescribing to Attride-Stirling’s (2001) analytic steps for data analysis prevents the researcher from imposing preconceived ideas about the finding. This approach allowed me to reflect, refine, and increase the data’s usability (Miles et al., 2014).

I determined that separating participants' responses according to the research questions was the more efficient method of organizing the transcribed data. I organized all the data relevant to answering each research question together in a group, thus creating subsections for each research question. For example, all relevant responses that answered the SRQ 1 (i.e., answers to Questions 3 through 6 on the IPG) were grouped and presented under the SRQ 1 subsection of this chapter. I presented direct quotes from the interview transcripts as well as tables highlighting participants' responses. After presenting the findings, a synthesis and thorough discussion highlight the findings and their implications through the lens of previous literature and the conceptual framework. Lastly, a summary of the chapter is provided, highlighting the major issues that arise throughout the study.

Description of Participants

This study's participants were all ATCSs employed by the FAA. All five participants worked previously at another ATC facility before transferring to the research site. The specific criteria used to select participants for this study were as follows: the participants were confined only to federal ATCSs currently working under the FAA's ATO umbrella, previously participated in the ATCoach at the research facility in the Southeastern United States, have taken the ATCoach, and their simulation training must have been completed in 2019. The justification for setting the specific criteria was that selecting ATCSs who completed the simulation training within 1 year from the start of the data collection process allowed for a more accurate representation of participants' lived experiences. Additionally, current FAA employees were more familiar with policies, practices, and standard operating procedures and were also more accessible for data collection. Lastly, participants were selected for their knowledge and experience in the live and laboratory setting and for their ability to provide data from both perspectives.

I used the pseudonym ATCS to identify each participant. The first participant is identified as ATCS 1 and the last as ATCS 5. The participants ranged in age from 29 to 43 years, with an average age of 37.4 years. Three of the ATCSs (ATCS 2, ATCS 4, and ATCS 5) were male and two (ATCS 1 and ATCS 3) were female. ATCS 1, ATCS 2, ATCS 3, and ATCS 5 self-identified as White (Caucasian), and ATCS 4 identified as Latino (Spanish). All participants had previous ATC experience with CPC status at their former duty locations before working at this facility. During data collection, two of the participants (ATCS 1 and ATCS 5) were CPC and three (ATCS 2, ATCS 3, and ATCS 4) were still in CPC-IT status.

Presentation and Analysis of Findings

The overarching research question reflects the purpose to explore the extent to which ATCSs perceive simulation as a valuable instructional method for developing their ATC job-related competencies needed to perform safe operations in the real air traffic environment. I used an IPG during the Zoom (2020) video interviews to collect data. The data were analyzed and presented to answer each of the six SRQs by applying the six levels of the cognitive domain of Bloom's taxonomy: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956). The data were organized in sequential order, starting with SRQ 1.

Subordinate Research Question 1

Questions 3 through 6 on the IPG focused on the lowest level, the knowledge level of Bloom's taxonomy, and ATCSs' experiences with the ATCoach in developing their ATC knowledge. To establish the participants' interpretation of what "ATC knowledge" means, I asked Questions 3 and 4 on the IPG. The answers to the two questions suggest that all five participants were relatively consistent when defining ATC knowledge. Some common words and terms emerged from participants' responses to Questions 3 and 4, including the LOAs (letter of agreements), SOPs (standard operating procedures), FAA Order 7110.65, rules, procedures, practices, pilots, aircraft, configuration, routes, intersections, altitudes, experience, facilities, separation, and facility-specific. Table 9 provides a paraphrased summation of each participant's interpretation of ATC knowledge.

Table 9

ATCSs Interpretation of the Term ATC Knowledge

Participant	Participant Response to the Meaning of ATC Knowledge	Interview Date
ATCS 1	Familiarity with the 7110.65, including the rules you have to follow. Familiarity with managing pilots, recognizing and circumventing weather conditions, preempting traffic volume, and types of aircraft. Knowledge is also experience.	June 29, 2020
ATCS 2	The LOAs, SOPs, and the 7110.65. The type of aircraft and their characteristics, type of pilots, adjacent facilities, facility-specific information, airspace configuration, and separation minimum requirements. Knowledge also means experience.	June 23, 2020
ATCS 3	Learning, understanding, and practicing all the SOPs, LOAs, and procedures in place. Understanding how airplanes fly, how speed work, how weather impacts planes, air traffic safety, and airport-specific winds, understand the technology that you're using, and measurements such as speed versus distance.	June 25, 2020
ATCS 4	The amount of understanding you have of the profession itself. The rules and information you have to apply and execute it to get the job done. ATCSs need to know math and be able to predict aircraft trajectory. The separation requirement, agency guidelines, ATCS to pilot communication protocol.	June 24, 2020
ATCS 5	The things you don't have time to look up in a book such as the routes, intersections, altitudes, and the frequencies.	June 27, 2020

Another consensus in participants' descriptions of ATC knowledge was being familiar with the FAA Order 7110.65, standard operating procedures, letters of agreement, and rules. For example, ATCS 3 described ATC knowledge as "learning, understanding, and practicing all of the SOPs, LOAs, and procedures." Three of the other four participants' description of ATC knowledge were generally consistent with ATCS 3. For example, ATCS 2 characterized ATC knowledge in this way: "knowledge would be the book—the LOAs, SOPs, and 7110.65." In describing ATC knowledge, ATCS 1 stated, "number one is your 7110.65, which includes the rules you have to follow." ATCS 4's definition of ATC knowledge also corresponded with the other participants in that it referred to the rules and information ATCSs have to apply and execute to accomplish daily job tasks. This information and rules included the facility standard operating procedures outlining ATCSs' responsibilities for coordinating air traffic safely and letters of agreement specifying the responsibilities of the FAA and other stakeholders. When defining ATC knowledge, ATCS 4 indicated:

> There's a lot of rules that you have to apply, a lot of information that you have to be able to quickly think and make a plan to execute it, and to do the best you can to your ability to get the job done.

ATCS 5's interpretation of ATC knowledge diverged slightly from the consensus. ATCS 5 explained ATC knowledge as "things that we use every day that you just really don't have time to look up and try to pull out a book, such as routes, intersections, altitudes."

The findings from Questions 3 and 4 on the IPG were consistent with Hopkin's (1995) interpretation that ATC knowledge is "knowledge of the rules, regulations, principles, procedures, instructions, and objectives of ATC" (p. 163). In addition, participants' definition of knowledge aligns with Bloom et al.'s (1956) description of the knowledge level as the recollection of methods and processes. Two participants also described knowledge as experience. For instance, when describing knowledge, ATCS 1 stated, “I guess in a way it’s also experience.” Likewise, ATCS 2 added, “knowledge is also experience.” The “knowledge is experience” definition does not align with the scholarly interpretation of the term “knowledge” or the widely accepted definition of knowledge as the “facts, information, and skills acquired through experience or education” (Malheiro et al., 2018, p. 51). However, the two participants were likely attempting to define knowledge as practical air traffic knowledge acquired through day-to-day experiences (Rodriguez-Blanco, 2018).

I explicitly crafted Questions 5 and 6 on the IPG to determine what knowledge ATCSs learned from their experiences with the ATCoach in developing their job-related competencies. Participants were asked what knowledge (or information) they perceived they learned from their experience with the ATCoach and how their experiences with the ATCoach affected how they recalled ATC information such as air traffic concepts and facts. Table 10 provides a paraphrased summation of each participant’s responses to questions 5 and 6 on the IPG.

Table 10

Knowledge Learned from ATCoach

Participant	Participants’ Responses to Questions 5 and 6	Interview Date
ATCS 1	The ATCoach allows you to reference what you learned when you were immersed in the classroom. The simulation training is really good at helping you understand the sector by teaching you how the sector flows and all the hotspots.	June 29, 2020
ATCS 2	The majority of the knowledge was obtained from reading.	June 23, 2020

Table 11

Knowledge Learned from ATCoach (Continued)

Participant	Participants' Responses to Questions 5 and 6	Interview Date
ATCS 3	Learn the site-specific traffic flow. I already had that information and knowledge when I arrived at the duty location. The ATCoach simulates air traffic events that make you use the knowledge that you have. Mathematics and spatial relations.	June 25, 2020
ATCS 4	The ATCoach allows ATCSs to review something or clarify something learned in the classroom by processing and analyzing what could potentially happen in live air traffic.	June 24, 2020
ATCS 5	The ATCoach reinforces what they teach in the classroom, such as the airspace and the flow of traffic to the other sectors.	June 27, 2020

The common theme that emerged from participants' answers to Questions 5 and 6 on the IPG was that ATCSs learned ATC knowledge (i.e., classroom or previous experience) before partaking in the ATCoach and then reinforced during simulation training. In keeping with participants' interpretation of knowledge, ATCSs unanimously inferred that they acquired knowledge from their classroom experiences and less in the ATCoach lab. ATCS 2, for example, stated, I "didn't learn any definitions or how to separate aircraft;" instead, the participant's experience with the ATCoach was more about "remembering what to do with aircraft at certain points in time in the airspace." ATCS 3 initially stated that ATCSs gained knowledge of site-specific airspace and procedures from the ATCoach. However, a follow-up question clarified the participant's response to mean the ATCoach "simulates air traffic events that make you use the knowledge you have," such as "knowledge of airspace and procedures." ATCS 4 and ATCS 5 offered their perspective on the training sequence, which provides insight into where ATCSs acquire ATC knowledge. ATCS 5 succinctly described the training sequence in the following way: "Before the lab, you'll sit in the classroom for a couple of weeks while they go through all the letters of agreement" and "they just throw all this stuff at you that you're supposed to apply in the lab." Consistent with this theme, ATCS 4 shared,

> Before we did a SIMS itself, we had to pass the practice test. We take multiple tests to test our knowledge. We have to know maps. We have the know routes. We have to know altitudes and speeds. There's a lot of things that we have to know prior to going to the lab.

I used Questions 5 and 6 in conjunction with the previous two questions on the IPG to assess if knowledge of basic information took place during simulation training and what knowledge was learned from ATCSs' experiences with the ATCoach. By employing Level 1 of Bloom's taxonomy, the study found that ATCSs developed ATC knowledge by familiarizing themselves with airspace elements. According to Bloom et al. (1956), learners at this level remember through memorization and recollection of relevant facts, concepts, methods, and processes, with limited understanding. The findings suggest that ATCSs experience the lowest level of Bloom's taxonomy of the cognitive domain by acquiring ATC knowledge and memorizing facts related to the ATC profession (knowledge of LOAs, SOPs, FAA Order 7110.65, rules, procedures, or practices). However, the theme also indicates that gaining ATC knowledge does not necessarily occur during the ATCoach but instead during previous classroom learning or experience.

Subordinate Research Question 2

Questions 7 and 8 on the IPG focused on the comprehension level of Bloom's taxonomy of the cognitive domain and ATCSs' experiences with the ATCoach in developing the ATC job-related knowledge competency. Participants were first asked what aspects of the ATCoach helped in their understanding of the knowledge learned. Table 11 presents a summation of each participant's response to Question 7 on the IPG.

Table 12

Aspects ATCoach Helped in the Understanding the Knowledge

Participant	Participants' Responses to Question 7	Interview Date
ATCS 1	The ATCoach is very helpful in terms of LOAs and how to receive and deliver airplanes in the airspace.	June 29, 2020
ATCS 2	It helps in your understanding of the traffic flow, site-specific airspace, and how it all works. "It's just reiterating what you know by actually implementing it."	June 23, 2020
ATCS 3	The ATCoach is good for learning the traffic flow and patterns of the aircraft flying through the airspace. It is also good for getting used to the frequencies and the sectors.	June 25, 2020
ATCS 4	The ATCoach ability to increase the volume of planes and problems gives ATCSs an idea of what to expect and comprehend what to expect in the real world.	June 24, 2020
ATCS 5	The ATCoach is set up where ATCSs learn all those chokepoints. There are several chokepoints all around the airspace that you have to watch out for.	June 27, 2020

In their responses to Question 7 on the IPG, as presented in Table 11, participants cited several factors that helped them better understand the knowledge learned. ATCSs' responses revealed the following themes: understanding of the (a) traffic flow and traffic pattern, (b) airspace, and (c) volume. Several participants indicated that the ATCoach was helpful in their understanding of the site-specific airspace components. ATCS 3, for example, stated that the only thing the ATCoach was suitable for was teaching ATCSs the flow and patterns of aircraft flying through the airspace. ATCS 2 also believed that the ATCoach was a valuable training method to help ATCSs understand the airspace. ATCS 2 stated that the ATCoach helped with understanding the traffic flow, site-specific airspace, and how it works. A third participant, ATCS 1, also mentioned that the simulation training was "very helpful in terms of the LOAs and how to receive and deliver airplanes in the airspace."

ATCS 5 stated that the ATCoach scenarios were set up in a way that enabled ATCSs to learn all the chokepoints. ATCS 5 added, "there are several chokepoints all around the airspace that you just have to watch out for." Chokepoints are natural places where air traffic converges. According to SME 1, an example of chokepoints is "arrivals trying to get down and departures trying to climb all in the same area." Constrained airspace or inclement weather conditions are factors that create chokepoints. ATCS 4 stated that the ATCoach simulator's ability to simulate increased traffic volume (number of planes in the airspace) gave ATCSs "an idea of what to expect and comprehend what to expect in the real world." In their responses to Question 7 on the IPG, participants' answers suggests that the ATCoach plays a significant role in helping ATCSs understand site-specific airspace.

Question 8 on the IPG asked how the ATCoach impacted ATCSs ability to understand and describe ATC-related facts such as aircraft classification, prescribed phraseology, equipment status information, and equipment capabilities. Participants' responses revealed themes that reinforced previous questions about the knowledge learned from the ATCoach. Table 12 provides participants' answers to Question 8 on the IPG.

Table 13

Understand and Describe ATC-Related Facts

Participant	Participants Responses to Question 8	Interview Date
ATCS 1	It helps with practicing phraseology and learning how to apply the LOA and the rules outlined in the FAA Order JO 7110.65. It is not suitable for learning equipment. "Equipment-wise, it doesn't really affect you for the most part."	June 29, 2020
ATCS 2	I didn't learn anything else from it, like different types of aircraft characteristics or different knowledge of ATC. I pretty much knew all that already.	June 23, 2020
ATCS 3	I learned most of this stuff before I came here. And I do not believe that the ATCoach is an excellent tool to use for learning aircraft characteristics and things like that because it's not true to life. So, I don't think that's an advantage.	June 25, 2020
ATCS 4	It's a great tool to use to help understand the maps, phraseology, aircraft characteristics, speeds, and handling the volume.	June 24, 2020

Table 14

Understand and Describe ATC-Related Facts (Continued)

Participant	Participants Responses to Question 8	Interview Date
ATCS 5	Aircraft classification didn't come up much in the simulation training. I don't recall really having any tricky scenarios where the classification mattered beyond just a heavy aircraft. It did a pretty good job of displaying those hotspots.	June 27, 2020

When presented with specific ATC-related facts (aircraft classification, prescribed phraseology, equipment status information, and equipment capabilities) and asked how the ATCoach affected their ability to understand and describe those facts, the reoccurring theme that emerged from participants' responses suggests that previous experience played a significant role in understanding the majority of ATC knowledge. For example, when responding to Question 8, ATCS 2 said, "as a CPC-IT and working radar before, I don't think it really taught me anything about aircraft characteristics. I mean, I knew how most of them operated anyway." Another participant, ATCS 3, echoed ATCS 2's sentiments, stating,

> I learned most of this stuff before I came here, and I do not believe that the ATCoach is actually a good tool to use for learning aircraft characteristics and things like that because it's not true to life. So, I don't think that's an advantage.

When I asked participants to focus on the equipment status information and equipment capabilities relating to Question 8, ATCS 1, responded in the following way: "I would say equipment-wise, it doesn't really affect you for the most part because we don't really use it that much" during the ATCoach. In terms of the phraseology example in Question 8, ATCS 1 added that the ATCoach would not necessarily help experienced ATCSs but may be beneficial in assisting newly hired ATCS with practicing ATC phraseology before managing live air traffic.

ATCS 4 was the only participant whose initial responses deviated from that of the other participants. ATCS 4 stated that the ATCoach simulation was an excellent tool to help you get an understanding of the “maps, phraseology, aircraft characteristics, speeds, and handling the volume.” The response included ATC knowledge such as maps and volume, which is closely associated with previous answers about what aspects of the ATCoach helped ATCSs understand the knowledge. However, participants rejected the notion that the ATCoach helps ATCSs understand phraseology, aircraft characteristics, speeds, and handling. ATCS 4 later indicated that the ATCoach ability to simulate aircraft speed was flawed—stating that the behavior of the aircraft speed in the ATCoach simulator was unconventional and unrealistic.

I used Questions 7 and 8 on the IPG to assess if comprehension of basic information occurred during simulation training and how ATCSs comprehend information learned from their ATCoach experiences. This study’s findings suggest that the ATCoach, through the lens of the comprehension level of Bloom’s taxonomy of the cognitive domain, increased their ATC knowledge of site-specific airspace elements. The findings also show that the ATCoach equipped ATCSs with a better understanding of site-specific airspace elements, which better prepared them to transfer the knowledge acquired from simulation training to practice in their day-to-day ATC operations. For example, the ATCoach reinforced ATC procedures, allowing ATCS to understand the LOAs, traffic volume and flow, site-specific airspace, how to receive and deliver airplanes in the airspace, traffic patterns of the aircraft flying through the airspace, chokepoints around the airspace, frequencies, sectors, and how they all work. These findings correspond to Lindenfeld’s (2016) findings in that an instructional simulator helped participants develop their

ATC competencies. The findings also support Hustad et al.'s (2019) statement that simulation training increases participants' preparedness for the transition to practice. Additionally, this study's findings reinforce the notion that simulation technology enhances job-related competencies (e.g., Bauer, 2005; Cox, 2010; Lindenfeld, 2016; McDermott, 2005; Van Eck et al., 2015; Zhang, 2016).

ATCSs gained a better understanding of site-specific ATC elements during the ATCoach, which improved their overall ATC knowledge. ATCSs gained a greater understanding of what they learn from their experiences with the ATCoach by practicing a particular procedure until it was mastered. Participants expressed an increased understanding of site-specific traffic flow after participating in the ATCoach. Participants also recalled and reproduced ATC-related facts, which are emphasized and strengthened through repetition and applied to improve critical ATC decision-making processes and planning strategies.

Subordinate Research Question 3

Questions 9, 10, and 11 on the IPG focused on the application level of Bloom's taxonomy and ATCSs' experiences with the ATCoach in developing the ATC job-related performance competency. I asked participants how they felt the activities or scenarios used in the ATCoach related to real-world situations and problems. This question was asked to test my philosophical assumption that the ATCoach simulator precisely reproduced the live ATC environment. Table 13 provides the responses from Question 9 on the IPG.

Table 15

Fidelity of ATCoach Activities or Scenarios

Participant	Participants Responses to Question 9	Interview Date
ATCS 1	"For the most part, the aircraft performance is pretty bad, especially working final because they slow down, speed up, climb, and descent spontaneously."	June 29, 2020
ATCS 2	"I would say yes, it was helpful to some degree. It definitely was not worthless. It was beneficial. It was definitely beneficial."	June 23, 2020
ATCS 3	"Aircraft performance and characteristics in the ATCoach simulation is not accurate and true to life."	June 25, 2020
ATCS 4	"Sometimes, when you're working in the live program, it doesn't always go the way that it does in the simulator. There's a difference between reality and fantasy."	June 24, 2020
ATCS 5	"I think the purpose of the ATCoach is to get the person acclimated with what to expect in the real world or what could potentially happen. But at the same time, I think it exists to test your knowledge."	June 27, 2020

I explicitly crafted Question 9 on the IPG to determine how ATCSs perceived the ATCoach simulator's fidelity. Participants were asked how they felt the activities or scenarios used in the ATCoach related to real-world situations and problems. One common theme that materialized indicates that certain aircraft behaviors from the ATCoach-generated scenarios did not realistically mimic those of live aircraft. For example, ATCS 3 stated,

> The aircraft performance and characteristics in the ATCoach simulation are not accurate and true to life. It is not what truly happens. When in the ATCoach, you tell an aircraft to turn, it turns right away; you tell it to slow down, it goes from 300 knots to 170 knots in a matter of one sweep.

ATCS 1 and ATCS 4 responses to Question 9 were also consistent with ATCS 3. According to ATCS 4, the ATCoach simulation could run different scenarios and problems to give ATCSs an idea of what to expect when controlling live traffic. Still, the caveat was explained in ATCS 4's words, "sometimes when you're working in the live program; it doesn't always go the way that it does in the SIM." For example, the aircraft performance in the ATCoach simulator "is pretty bad because aircraft slow down, speed up, climb, and descend on a dime" (ATCS 1).

Question 10 asked participants how the knowledge, techniques, and rules learned from the ATCoach impacted how they perform ATC duties such as handoffs, pointouts, or coordination. The question was designed to ascertain whether the ATCoach developed certain ATC skills or enhanced ATCSs' understanding of specific ATC knowledge, facts, techniques, or rules. The responses from Question 10 on the IPG are provided in Table 14.

Table 16

Knowledge, Techniques, and Rules Learned from the ATCoach

Participant	Participants Responses to Question 10	Interview Date
ATCS 1	ATCSs learn everything in the classroom and then apply it in the simulation lab. In terms of making pointouts and being a coordinator, ATCSs acquire that knowledge before participation in the simulation training.	June 29, 2020
ATCS 2	I knew how to do handoffs and pointouts and stuff like that prior. I would say, if I came into this not working radar before, it would be beneficial.	June 23, 2020
ATCS 3	Sometimes things don't happen as it says in the SOPS or LOAs, which is frustrating as a trainee.	June 25, 2020
ATCS 4	I know they are examples you've just mentioned, like pointouts and stuff. We don't really practice that as much.	June 24, 2020
ATCS 5	As an ATCS, one has to know what those altitudes are, and the Sims reinforce that.	June 27, 2020

The responses from Question 10 on the IPG reinforced participants' claims that ATC knowledge is learned before partaking in the ATCoach, and knowledge is reinforced on the simulator. For example, ATCS 4 responded by stating, "I know they are examples you've just mentioned," referencing ATC duties such as handoffs, pointouts, or coordination. ATCS 4 added, "We don't really practice that as much." As evident in ATCS 4's answer, the response provided valuable insight into ATC knowledge learned before simulation training. The response also helped highlight ATC knowledge and skills not developed using the simulation system by eliminating specific tasks critical to daily air traffic operations. ATCS 1, for example, stated that in terms of learning how to perform ATC knowledge, techniques, and rules, the ATCoach was irrelevant "because you're learning everything in the classroom and you're just applying it" in the lab. "In terms of making pointouts and being a coordinator, I mean, you're learning that stuff ahead of time." ATCS 1's response was in line with ATCS 4's answer. ATCS 1 used driving a car in a new town to create an analogy for ATC knowledge and the ATCoach. For example, ATCS 1 stated that when individuals move to a new town, they will learn the new roads, where the new grocery stores are, or the new doctor. In ATCS 1's own words, "you already know how to drive a car. You're just trying to learn everything else." In comparison, ATCSs, CPC-IT specifically, already possessed general ATC knowledge before partaking in the ATCoach. The ATCoach simulator provided an avenue for ATCSs to learn site-specific ATC knowledge.

ATCS 2, for example, stated, "I knew how to do like handoffs, pointouts, and stuff like that prior." The responses of ATCS 3 and ATCS 5 did not address the question surrounding specific ATC tasks. Instead, the answers reinforced previous statements made by participants regarding the impact the ATCoach had on acquiring ATC knowledge. Consequently, the following probing question (Question 10A) was asked: In what ways have you applied the knowledge, facts, techniques, and rules learned on the ATCoach simulation to solve real ATC problems? Then Question 11 asked ATCSs how their daily performance changed after experiencing the ATCoach. The answers to Questions 10A and 11 are outlined in Table 15.

Table 17

Knowledge, Facts, Techniques, and Rules Learned on the ATCoach

Participant	Participants Responses to Questions 10A and 11	Interview Date
ATCS 1	You can learn different techniques on how to do things and apply these techniques on the floor.	June 29, 2020
ATCS 2	The scratchpad entries, what's happening, are because of things you've done in the lab.	June 23, 2020
ATCS 3	Learned techniques from the ATCoach instructors.	June 25, 2020
ATCS 4	Separate the planes the most efficient, safest way. Phraseology	June 24, 2020
ATCS 5	Start slowing aircraft way far out. Extrapolate your plan early on.	June 27, 2020

Two themes emerged from the responses to Questions 10A and 11 on the IPG. The first theme revealed that specific knowledge and information learned during the ATCoach are directly implemented when controlling live air traffic. The second theme suggests that the ATCoach addresses particular tasks used by ATCSs to succeed at their job. For instance, the participants collectively expressed that they learned how to circumvent inclement weather conditions, practice phraseology, make scratchpad entries, and separate aircraft in the most efficient and safest ways. Participant responses show that their learnings have direct applications in controlling traffic on the simulator and while managing live traffic. This means that ATCSs used what they learn during the ATCoach to manage simulated air traffic during evaluation and live air traffic after training was completed. Additionally, ATCSs at the research site were taught with specific applications in mind, and they applied those learnings to practice.

ATCSs apply what they learn from their ATCoach experiences by taking what they learned and executing it when participating in simulation training and controlling live air traffic. ATCS 1 explained that the ATCoach gives ATCSs a good enough overview of ATC operation to take what was learned in the lab and try to apply it when controlling live traffic. For example, ATCSs can learn different techniques while learning on the ATCoach simulator and apply them while managing live air traffic (ATCS 1). ATCS 3 indicated that the instructors play an integral role in developing ATCSs skills by passing on techniques acquired from years of experience controlling air traffic. ATCS 3 added that the techniques learned are applicable in directing live air traffic. Other participants' statements were in agreeance with ATCS 3. For example, ATCS 2 said, "you have a better understanding of what's happening around you because you've seen it while learning on the ATCoach simulator." ATCS 2 added, "You learn enough in the labs where you're not completely distraught when you go and actually work live radars." ATCS 4, for example, stated that the ATCoach was helpful in that ATCSs practice how to safely and efficiently separate aircraft within the airspace. ATCS 4 added that ATCSs practice phraseology during the ATCoach to be proficient when directing live traffic.

I used Questions 9, 10, and 11 on the IPG to explore ATCSs' perceptions of their simulation experience related to their perceived performance skills development during simulation training. This research used the application level of Bloom's taxonomy of the cognitive domain to determine if the application of information and skills occurred during simulation training: providing opportunities for ATCSs to apply what they know to practice directing and managing aircraft. This study's findings indicate that ATCSs apply their air traffic knowledge in a meaningful way by following the SOPs, LOAs, and FAA Order JO 7110.65, and knowledge of their understanding of traffic volume and flow, site-specific airspace, traffic patterns, chokepoints to (a) coordinate air traffic activities during the simulation, (b) receive and deliver airplanes in the airspace, (c) separate the planes the most efficient and safe way, and (d) and extrapolate planning strategies. The findings indicate that participants perceive simulation as a valuable instructional method for enhancing specific ATC knowledge and skills, which is consistent with that of Bauer (2005), Georgiou et al. (2017), Lindenfeld (2016), and Van Eck et al. (2015). These researchers discovered a positive correlation between simulation training and learning.

Additionally, Coyne et al. (2017) found that students' perception indicated that ATC simulation is a beneficial mode of delivering air traffic training. This study's findings are consistent with Hustad et al. (2019), who found that skills learned from simulation-based training are transferred to the operational setting in clinical practice. In this study, the simulation training increased participants' preparedness for the transition to practice (Hustad et al., 2019), thus, improving how ATCSs accomplish ATC tasks. The findings were also consistent with the argument that simulator training results in better performance (Bauer, 2005). The findings also support Van Eck et al.'s (2015) conclusion that having experience in the ATC training program significantly contributed to the students' task performance.

Subordinate Research Question 4

Questions 12, 13, and 14 on the IPG focused on the analysis level of Bloom's taxonomy and ATCSs' experiences with the ATCoach in developing the judgment and critical thinking ATC job-related competencies. The question asked participants how their experience with the ATCoach affected their ability to interpret complex ATC maps such as sector maps, geographic maps, minimum vectoring altitudes (MVA)/obstruction maps, or approach plates. Table 16 shows participants' responses to Question 12 on the IPG.

Table 18

Sector Maps, Geographic Maps, MVA/Obstruction Maps, Approach Plates

Participant	Participants Responses to Question 12	Interview Date
ATCS 1	Learn the airspace in the classroom and analyze the airspace in the ATCoach.	June 29, 2020
ATCS 2	Airspace, MVAs, vector routes, and all that stuff. Satellite airports, MVAs, satellite sectors.	June 23, 2020
ATCS 3	The approaches, MVAs, and altitude restrictions. The different obstacles that this aircraft will encounter.	June 25, 2020
ATCS 4	The different maps, MVA, altitude, and minimum vectoring altitude.	June 24, 2020
ATCS 5	Every approach at each airport. Visual clutter in the airspace.	June 27, 2020

The theme that emerged from Question 12 on the IPG suggested that participants believe that the ATCoach works well at getting ATCSs familiar with complex site-specific airspace components. When discussing specific ATC-related knowledge, the findings align with the previous peer-reviewed research in several disciplines that found instructional simulation to enhance learners' performance. ATCS 1, for example, indicated that ATCSs learn the airspace in the classroom; then, their understanding of the airspace is reinforced during the ATCoach by examining, in detail, the structure and information to interpret live air traffic operations.

The other participants' responses were also in agreeance with ATCS 1. For instance, ATCS 2 stated,

> I think that the labs probably do the best job getting you familiar with our airspace; MVAs, vector routes, and all that stuff … I think it's perhaps the best at getting you familiar with all that: satellite airports, MVAs, satellite sectors.

Familiarity with the airspace and the associated geographical maps make the daily tasks of ATCSs easier and enhances their performance and decision-making strategies (SME 1). According to ATCS 3, ATCSs analyze the knowledge learned during the ATCoach while controlling aircraft during the approach phase of air traffic, determining MVA and altitude restrictions for specific routes, and dealing with other obstacles aircraft are going to encounter on their way to the airport. The analysis process also occurred during simulation training sessions because participants also performed similar tasks throughout and during post-training evolutions. Participants also expressed that they had to utilize decision-making strategies to direct pilots after employing the same approach in the simulator to examine the airspace and devise planning options. ATCS 3 stated that the knowledge learned from the ATCoach experiences, specifically the knowledge of the airspace components, informs and justifies decisions relating to asking an aircraft to maintain a certain altitude before descending to the airport, momentarily taking a plane off course. Participants' responses suggest that ATCSs examine the airspace and determine the best possible direction to convey to the pilots.

The participants explained that the ATCoach simulator allows ATCSs to access different site-specific maps used to control live air traffic. For example, the MVA shows the minimum vectoring altitude for an aircraft to fly. The maps are "tools that help make your job easier and a lot more efficient" (ATCS 4). As ATCS 4 expressed,

> Getting all that information, I think, is very helpful. I think all those things are definitely a plus or a benefit on the ATCoach because you're able to access and kind of know,

okay, what's the emergency map … If you want to know where the aircraft might be flying over, you pull it up, and you can know.

Lastly, ATCS 5 stated that becoming familiar with the airspace components allowed for a more efficient way of doing the job because one can reduce visual clutter by being selective on which maps to have displayed on the scope.

Question 13 on the IPG asked participants what they have learned about managing air traffic from their ATCoach simulation experience, allowing them to make good decisions and good control judgment when providing ATC services. Table 17 provides participants' answers to Question 13 on the IPG.

Table 19

Making Good Decisions and Control Judgment when Providing ATC Services

Participant	Participants Responses to Question 13	Interview Date
ATCS 1	Maximize airspace for air flow management.	June 29, 2020
ATCS 2	Baseline of how the traffic flows.	June 23, 2020
ATCS 3	Technique and traffic flow.	June 25, 2020
ATCS 4	Handling the volume. Control more planes and put them in line.	June 24, 2020
ATCS 5	The general flow of traffic.	June 27, 2020

The following theme emerged in determining what ATCSs learned about managing air traffic from their ATCoach simulation experience that allowed them to make good decisions and apply "good control judgment" when providing ATC services. Four of the five participants explicitly explained that learning how the traffic flows is vital for ATC procedures and airspace control. ATCS 4, for example, stated, "I think volume is one of the biggest things or getting to grasp that concept of going over different procedures for the airport that we have around the airspace," and "being able to control more planes and put them in line. Especially when you're looking at the final and making sure that all the aircraft are following each other. I think that it has been very helpful with the lab." Learning the flow of traffic was also mentioned by ATCS 3, who stated, "I think you'll learn a lot of that stuff during ATCoach through technique with instructors and also through learning the traffic patterns and flow of the airspace." ATCS 5 also echoed the responses of ATCS 3 and ATCS 4, stating that the simulation training teaches ATCSs "the general flow of how traffic goes" and "how airplanes fly through the airspace." Similarly, ATCS 2 stated, "you just get that baseline of how the traffic flow works here—and it becomes more muscle memory." ATCS 5's response was implicitly explained, which focused on instructor and student interaction during the ATCoach and the development of techniques for maximizing airspace and air flow management by applying alternative paths.

Question 14 on the IPG asked participants how their experience with the ATCoach impacted the way they scan an entire control environment, gather clues, and use those clues to draw conclusions. This study provides the responses to Question 14 on the IPG in Table 18.

Table 20

ATCoach Impact on the Way ATCSs Scan ATC Environment

Participant	Participants Responses to Question 14	Interview Date
ATCS 1	You have to become familiar with the hotspots.	June 29, 2020
ATCS 2	It does a pretty good job of making you scan and understand your particular airspace for whatever sector you're working.	June 23, 2020
ATCS 3	I think it prevents you from really looking at that scan.	June 25, 2020
ATCS 4	The ATCoach lab helps with scanning all over the airspace.	June 24, 2020

Table 21

ATCoach Impact on the Way ATCSs Scan ATC Environment (Continued)

Participant	Participants Responses to Question 14	Interview Date
ATCS 5	The ATCoach train your eyes to look at the edges of your scope so you don't miss stuff.	June 27, 2020

The primary theme that emerged from the question about what ways ATCSs' experience with the ATCoach impacted how they scan an entire control environment and gather clues indicates that participants believe the simulation training positively affects ATCSs ability to examine a dynamic ATC environment. Responses from participants suggest that the ATCoach teaches ATCSs not to be hyper-focused (tunnel-vision) on a specific high-volume section, or hotspot, of the airspace. Four of the five participants believed that the ATCoach helped reinforce continuous visual scanning of the airspace. Participants discussed the following ways in which the ATCoach impacted how they perform ATC duties, such as scanning an entire control environment and gathering clues. ATCS 2, for example, stated that the ATCoach "does a pretty good job of making ATCSs scan and understanding their particular airspace for whatever sector they are working." ATCS 2 also stated that ATCoach instructors intentionally incorporate simulator scenarios when they least expect it to force ATCSs to scan the airspace. ATCS 4 stated that the ATCoach helped with scanning all over the airspace by adding more complexity to the problem, ensuring that ATCSs are always aware of where the aircraft is going to be in a few minutes or a few miles. In ATCS 5's own words, "they'll throw a lot of practice approaches to train your eye to look at the edges of your scope, so you don't miss stuff" and "that worked really well." The ATCoach also provides opportunities for ATCSs to familiarize themselves with all the hotspots within the designated airspace. "These are the spots I have to keep on looking at which you don't know that ahead of time. You'll figure it out one way or the other, but you just get a jump start on it" while working in the lab (ATCS 1).

Finally, ATCS 3, contrastingly, provided an opposing perspective to the question posed. ATCS 3 explicitly stated that the ATCoach was counterproductive in helping ATCSs develop how they scan an entire control environment. Expressed in their own words, in a dismissive tone, ATCS 3 said, "I think it actually works against you, especially when you're in training down there because they try to bombard you with conflict"—*down there* meaning the ATCoach lab. ATCS 3 added,

> You're constantly scanning the entire airspace, but you do not see anything because you're trying to look for the trap that they have put in there, whether it be an overflight, a weird altitude, or your read back error. Trying not to miss somebody turning on to a final approach course or whatever. I actually think it is negative. I think it makes you panic. I think it makes you scared. I think it prevents you from really looking at that scan. I actually think it doesn't help at all. I think that they purposely try to put stuff in there. I think they want to build up your abilities or show that they can train you, but I think it has the opposite effect.

I used Questions 12, 13, and 14 on the IPG to determine if the ATCoach provided learners opportunities to use judgment and critical thinking to solve complex problems. These three questions focused on the analysis level of Bloom's taxonomy of the cognitive domain and ATCSs' experiences with the ATCoach to develop judgment and critical thinking skills. Analysis is a cognitive process that extends beyond comprehension. It is the process of matching, classifying, analyzing errors, generalizing, and specifying knowledge to generate new conclusions (Marzano & Kendall, 2008). The findings of this study suggest that ATCSs analyze what they learn from their experiences with the ATCoach simulation by (a) identifying elements within the structure of the airspace, (b) recognizing patterns in traffic flow, (c) observing traffic volume, (d) predicting clutter, and (e) identifying hotspots. The findings are also consistent with the fourth level, analysis level of Bloom's taxonomy, which argues that students learn to analyze by examining and breaking down information into elements, determining the interconnection and relationship between the components (Bloom et al., 1956).

Additionally, the theme suggested that the ATCoach could develop ATCSs' analytical thinking and understanding of the airspace structure, sector boundaries, and patterns. Understanding these complex airspace elements allows ATCSs to successfully and efficiently plan and devise optimum solutions and best alternatives to solve critical ATC problems such as assuring aircraft separation, alleviating congestions, and controlling aircraft flow. This finding confirms Koskela and Palukka's (2011) assertion that simulators could be used as strategic teaching tools by preparing learners for their respective professions' complexities. This study's findings suggest that ATCSs developed a thorough understanding of the airspace structure, sector boundaries, and patterns, ultimately giving them the tools to solve complex aircraft conflicts and ensure aircraft separation. Utilizing the analysis level of Bloom et al. (1956), the findings suggest that the simulation training provided opportunities for learners to use judgment to solve complex problems.

The findings also suggest that the ATCoach experience facilitated situational awareness, judgment, and decision-making. These findings are consistent with Thomas et al.'s (2001) and Zhang's (2016) assertion that simulators are used in ATC to assess situational awareness. This study is also consistent with DeCarlo's (2010) study that suggested simulation training framed by Bloom's taxonomy leads to higher-order thinking such as situational awareness, critical thinking, judgment, and decision-making. This study's findings also support Hustad et al.'s (2019) findings which suggest that simulation activities improve "knowledge, clinical judgment and communication skills (p. 7). In addition, these findings show that the research site has satisfied the USNTSB's (2016b) safety recommendations to the FAA indicating that ATCSs should receive academic and simulator competency-based training to develop their situational awareness and judgment so that they may adequately assist pilots. Additionally, the study's findings align with the fourth level of Bloom's taxonomy (Bloom et al., 1956), which shows that participants analyzed by examining and breaking down ATC information into elements; determining the interconnection and relationship between the components; and making aircraft predictions relating to time and space.

Subordinate Research Question 5

Questions 15, 16, 17, and 18 on the IPG focused on the synthesis level and ATCSs' experiences with the ATCoach in developing the judgment and critical thinking ATC job-related competencies. This study asked participants how they have used the different information learned from their experience with the ATCoach to develop their own unique ways of completing ATC duties. Table 19 provides the responses to Question 15 on the IPG.

Table 22

Using ATCoach Experience on Unique Ways of Completing ATC Duties

Participant	Participants Responses to Question 15	Interview Date
ATCS 1	Whatever you're going to do different is generally based on your comfort level or past experience.	June 29, 2020
ATCS 2	I would say that the labs show you about maybe 60 to 70% of what you usually see on a day-to-day basis.	June 23, 2020
ATCS 3	You learn techniques from instructors.	June 25, 2020
ATCS 4	The instructors show you how to do a procedure or how to apply it.	June 24, 2020
ATCS 5	The instructors kind of push you to do things one way.	June 27, 2020

A common theme emerged from the question about how ATCSs used the different information learned from their experience with the ATCoach to develop their own unique ways of completing ATC duties. The theme indicates that participants believe the ATCoach, in its design, is consistent and rigid in teaching ATCSs, which is dictated by the SOPs and LOAs. For example, ATCS 1 stated that "if you watch 12 different controllers run a sector, we're all going to run it more or less the same because that's how the traffic is dictated with our SOPs and our LOAs." The shared experiences of ATCSs during simulation training are evident in their common perspectives, as evident in ATCS 5's response. ATCS 5 expressed that the instructors push them to do things in a particular way. In ATCS 4's own words, "the instructors show you how to do a procedure or how to apply it, and then you kind of try to make it your own and make sure that you know whatever it is that you're trying to apply in the real world."

The responses of ATCS 1 and ATCS 5 indicate that the simulation training did not provide the freedom to try out new techniques. Instead, the responses suggested that ATCSs' experience and self-confidence allowed them to develop their unique ways of completing ATC duties and not necessarily the ATCoach simulator. ATCS 3, for example, stated, "there are many techniques that I use here when I'm working traffic that people here don't use because they haven't worked in a larger facility as I have. And honestly, ATCoach didn't help me with that." ATCS 1's response also reinforced ATCS 3's argument that the simulation training was not a contributing factor to ATCSs' ingenuity. For example, ATCS 1 stated, "whatever you're going to do different is generally based on your comfort level or past experience." Lastly, ATCS 2 dismissed the notion that the ATCoach encourages ATCSs to develop their unique ways of completing ATC duties by emphasizing that the training primarily covers the basics. As ATCS 2 puts it, the ATCoach training covers most of the things an ATCSs would typically see on a day-to-day basis. Despite participants' perceptions of the lack of freedom to diverge during simulation training, ATCS 2 expressed feeling more confident working live traffic after participating in the ATCoach.

Question 16 asked participants to describe "positive control." Table 20 presents the participants' descriptions of positive control.

Table 23

ATCSs Define Positive Control

Participant	Participants Responses Explain Positive Control	Interview Date
ATCS 1	Positive control means you should be able to walk away from your scope for a minute and not worry about anything. Positive control means that every rule that an ATCS needs to apply has been applied. Meaning, there should be no separation error, there should be no issues with anything, and you should be comfortable walking away for a certain amount of time because the planes are properly separated in altitude, distance, and trajectory.	June 29, 2020
ATCS 2	Positive control as working aircraft in a manner in which the ATCS has 100% control over your airspace. Positive control is “having an entire situational awareness of what’s happening in your airspace and knowing what you need to do with every single aircraft in your airspace that keeps them separate and getting them to where they need to go without having any doubts about keeping aircraft separated.”	June 23, 2020
ATCS 3	Positive control means doing something to ensure separation will continue. For example, you have an overflight traveling at 10,500 feet thru your airspace and stopping any departures that may travel under his flight path at 9,000 feet until another form of separation can be applied, like lateral separation. Guessing that the departure aircraft won’t be near the overflight and climbing him to 12,000 feet is not positive control.	November 28, 2020
ATCS 4	Positive control is providing the separation between aircraft at any significant time while you’re controlling it. Positive control means making sure that the plane is doing exactly what you expect them to do.	June 24, 2020
ATCS 5	Controlling each aircraft to maintain separation.	June 27, 2020

To build upon the previous question relating to “positive control,” the study asked participants how the integration of information and skills learned from their experience with the ATCoach affected their ability to apply positive control judgment. Table 21 provides the responses to Question 17 on the IPG.

Table 24

ATCoach Effect on ATCSs Ability to Apply Positive Control Judgment

Participant	Participants Responses to Question 16 Follow-Up	Interview Date
ATCS 1	The ATCoach simulation teaches you the flow of your sector through your LOAs and your SOPs, and where those hotspots are.	June 29, 2020
ATCS 2	Scenario gives ATCSs situations in which they need to ensure positive control.	June 23, 2020
ATCS 3	ATCSs learn to apply the rules that they've learned in the classroom.	June 25, 2020
ATCS 4	The ATCoach scenario provides situations that teach individuals how to provide a good sequence to the airport and positive separation.	June 24, 2020
ATCS 5	ATCSs learn positive control while learning the flow and how things work at the research site because the standard flow of traffic already has positive control built into it.	June 27, 2020

Below are the themes that emerged regarding how the integration of information and skills learned from their experience with the ATCoach affected their ability to apply positive control judgment. Several participants discussed that the ATCoach positively influenced their decisions relating to the separation of airplanes. ATCSs perceived that the simulation training impacted their ability to make positive control judgments by familiarizing them, through practice, with how traffic flows within specific airspace sectors. ATCS 4, for example, mentioned that the simulation training produces scenarios that focus on providing proper sequencing of airplanes to the airport, maintaining positive separation, and making sure that the planes are lined up and following each other to obtain adequate spacing and sequencing. This experience proves beneficial when ATCSs are controlling live traffic, and routine ATC practices prove ineffective. According to ATCS 4, in these instances, ATCSs must have a "Plan A, Plan B, Plan C, all the way to Z" in their arsenal because, as ATCS 4 puts it, "you have to always think of what you would do if this aircraft does not know, does not understand, or did not do what was expected." The study also shows that simulation training provided opportunities for ATCSs to use judgment to solve complex problems. For example, ATCSs' experiences with the simulation training developed their knowledge and understanding of the airspace so that when adverse weather conditions emerged, they could analyze the flow of traffic and elements of the airspace and make the appropriate decision to deviate and circumvent bad weather (ATCS 4).

Like ATCS 4, ATCS 2 stated that the ATCoach scenarios included situations in which ATCSs needed to ensure that positive control was accomplished. ATCS 5's statement is also in agreeance with the other participants. ATCS 5 stated that the ATCoach scenarios already have positive control built into them because it mimics the standard flow of live air traffic at the research site. According to ATCS 1, the LOAs and SOPs dictate the standard traffic flow. This study's findings suggest that the ATCoach allows ATCSs to see how the elements of air traffic come together. Participants' experiences in the simulation lab provided them with the tools to truly understand the airspace sectors and the traffic flow. Understanding the airspace sectors and the traffic flow allows ATCSs to make critical decisions, such as vectoring overflights up, out, and around to solve ATC conflicts (ATCS 5). This study also discovered that simulation training gave participants the experience of identifying and familiarizing themselves with critical areas of the airspace. For example, in ATCS 1's own words, "you are going to see where those hotspots are, so you know; hey, these are the hotspots, so this is where the conflicts are, so I need to make sure I have positive separation at these points." ATCS 1 added that the ATCoach "helps you identify those points where you may need to be extra careful and make sure you have that positive separation, and you're not just hoping it's going to work out."

ATCS 2 and ATCS 4 expressed issues with the ATCoach simulator relating to fidelity, error in the scenarios, and some functionality problems. For example, simulation training issues will inhibit some individuals from properly implementing some of the scenarios' situations (ATCS 2). ATCS 4 pointed to the language barrier between pilots and ATCSs and the sudden changes in speed as problems with the ATCoach scenarios. However, ATCS 2 also expressed that "when everything works according to plan all the time, it's good," emphasizing that the ATCoach "gives you situations in which you need to ensure positive control." ATCS 2's statement aligns with Updegrove and Jafer's (2017) findings that when successful, simulation training provides students with enhanced or enriched learning experiences. ATCS 3 found that scenarios with 50% and 75% traffic volume are most useful because these are the levels and complexity most consistent with the day-to-day air traffic. ATCS 3, for example, stated, "you don't get that impact until you can feel it in the simulation, and when you're doing 50% to 75%, they're not trying to throw all the conflict at you." According to SME 1, ATCSs are not overwhelmed with a bombardment of aircraft when managing aircraft at the 50% and 75% traffic volume levels. Therefore, they can learn the traffic movement by getting the opportunity to see the traffic flow, visualize it, and visually understand it (ATCS 3). ATCS 4 stated when elaborating on their response to a nonresponsive aircraft, "You have to be able to go to the second plane, your third plane, your fourth plane to say, okay, well this person doesn't do this, then I have to go immediately to the other aircraft before it's a domino effect." ATCS 4 also emphasized that ATCSs can improvise to get the job done when working live air traffic by applying traffic flow knowledge.

Question 17 asked participants to describe a time when they had to actively and skillfully examine, break down, and incorporate information learned from their experience with the ATCoach to develop alternate ways of solving an ATC problem. Table 22 provides the responses to Question 17 on the IPG.

Table 25

Examine, Breakdown, and Incorporate Information Learned

Participant	Participants Responses to Question 17	Interview Date
ATCS 1	MVAs and altitude restrictions. Lots of airplanes in a small space that you're trying to move.	June 29, 2020
ATCS 2	ATCS 2 did not offer an answer to the question; instead, he pointed to his previous response outlined in Table 21.	June 23, 2020
ATCS 3	The ATCoach teach the basic information. This experience and knowledge are refined and enhanced by managing real airplanes, live traffic, winds, aircraft performance enhancements, etc.	June 25, 2020
ATCS 4	Some pilots don't want to fly a polished approach. I tend to vector a lot, so I give aircraft vectors to go to the airport.	June 24, 2020
ATCS 5	In reality, we're going to vector him just a little bit. We have to manipulate his flight plan routing to make the aircraft flash the right sector.	June 27, 2020

The question asked ATCSs to describe when they had to actively and skillfully examine, break down, and incorporate information learned from their experience with the ATCoach to develop alternate ways of solving ATC problems. ATCS 1 responded by stating that locations, such as the research site, which consists of multiple airports in close proximity to each other, create a higher level of operational complexity when directing air traffic to and from these facilities. ATCS 1 also indicated that MVAs and altitude restrictions are elements that sometimes create complications while managing traffic. Additionally, ATCS 1 credited the ATCoach for preparing ATCSs for moving high volume traffic in a small segment of the airspace. For example, in ATCS 1's own words, while referencing the complexity of air traffic, "I think learning that in a lab before you get to the floor is a really good thing." The term "the floor" refers to the operational ATC environment. ATCS 3 provided a similar response to ATCS 1. ATCS 3 stated that effectively vectoring real aircraft while factoring for winds and aircraft performance flying in, out, and through the airspace is a skill learned during the ATCoach. These skills are enhanced further with real-world experiences.

ATCS 4 stated that some pilots do not want to "fly a polished approach." The ATC procedures dictate that aircraft fly a certain way, however, according to ATCS 4, there are instances where some pilots want to circumvent these procedures. In situations where there are uncertainties regarding the aircraft's intended actions, ATCS 4 stated that knowing where to find that information is critical to solving such problems. Participants' responses suggested that knowing where to locate that information is a skill taught during the ATCoach. Additionally, ATCS 4 stated that vectoring is the participant's preferred navigation service over navigation fixes. ATCS 4 indicated that vectoring ensures that "you close that loop" and eliminates misunderstanding and miscommunication between ATCSs and pilots. According to ATCS 4, "closing the loop is an ATC term that means that there is no miscommunication in understanding a command given by an ATCS to the pilot." For example, "ATC says DAL123 fly heading 360°. Pilot replies 'DAL123 fly heading 350°.' ATC would then reply 'negative, fly heading 360°.' Pilot replies, 'sorry heading 360°,'" hence, closing the loop. Similarly, ATCS 5 referenced vectoring as a solution to issues related to tags failing to flash on the scope due to aircraft positioning between two ARTCC. The problems with failed tags can be remedied by manipulating aircraft flight plan routing to flash the correct sector. ATCS 2 did not offer an answer to the question; instead, the participant pointed to previous responses outlined in Table 21.

Question 18 asked participants to describe an ATC situation such as an equipment failure or emergency that caused them to reflect on their experience with the ATCoach. Table 23 provides the responses to Question 18 on the IPG.

Table 26

Equipment Failure or Emergency

Participant	Participants Responses to Question 18	Interview Date
ATCS 1	"No, … like I said before, is we don't use that equipment … they just don't seem to focus on that stuff."	June 29, 2020
ATCS 2	"No, we didn't really have any emergencies in our lab."	June 23, 2020
ATCS 3	"The actual simulation in the ATCoach? No way. I think it would be learned in real life."	June 25, 2020
ATCS 4	"I'm trying to think. I'm not sure if we really experienced anything on the floor compared to the lab."	June 24, 2020

Table 27

Equipment Failure or Emergency (Continued)

Participant	Participants Responses to Question 18	Interview Date
ATCS 5	"No, because we don't deal with emergencies in the Sims … that's not something they cover."	June 27, 2020

The question asked ATCSs to describe an ATC situation such as an equipment failure or emergency that caused them to reflect on their experience with the ATCoach. The participants unanimously dismissed the idea that the simulation training included equipment failures and emergencies. ATCS 1 responded by stating that the communication equipment aspect of the ATCoach did not incorporate equipment failures. ATCS 1 also indicated that communication failures are a relatively common occurrence while managing traffic. ATCS 2 provided a similar response to ATCS 1. ATCS 2 stated, "we didn't really have any emergencies in our lab." ATCS 2 added that the ATCoach scenarios also did not add any anomalies or unusual situations. ATCS 3 and ATCS 5 echoed the responses of ATCS 1 and ATCS 2. As ATCS 3 mentioned, ATCSs' exposure to emergencies only occurs when directing live traffic and not during the ATCoach. Similarly, ATCS 5 stated that ATCSs "don't deal with emergencies in the Sims." ATCS 5 added that emergencies are "not something the instructor and RPOs cover during the ATCoach." The response of ATCS 4 did not explicitly state whether the instructors covered equipment failures or emergencies during ATCoach. Instead, the participant highlighted a previous aircraft emergency during live traffic that called for the implementation of procedural knowledge learned in the ATCoach.

The responses from Question 18 on the IPG reinforce the USNTSB (2016b) findings. The USNTSB (2016b) interviewed ATCSs working at five ATC facilities (New Smyrna Beach, Florida; Hugheston, West Virginia; Palm Coast, Florida; Parkton, North Carolina; and Effingham, South Carolina) after aircraft accidents at each location. Like the participants in this study, ATCSs at all the above sites reported to the USNTSB (2016b) that they "could not recall any specific information about the training involving emergencies, unusual situations, or aircraft systems, … could not remember specifics of the training, or … did not understand the implications of the airplane" malfunctions requiring ATC intervention (p. 6). Like the USNTSB's (2016a) findings, the responses to Question 18 also suggest that the ATCoach training failed to incorporate the "emergencies" component stipulated by the FAA Order JO 3120.4.

I crafted four questions on the IPG to determine if the simulation training provided opportunities for learners to use judgment to solve complex problems and how ATCSs synthesize what they learn from their experiences with the ATCoach. By employing Level 5 of Bloom's taxonomy, the study found that ATCSs synthesize what they learn from their experiences with the ATCoach by using their knowledge of complex airspace elements to develop operational planning strategies and formulate alternative plans presuming their initial strategies were ineffective. The findings also suggest that ATCSs synthesize information through improvisation. By practicing ATC tasks during the ATCoach, ATCSs can develop skills that enable them to improvise to maintain positive separation and positive control, provide proper sequencing, control traffic flow, and vector overflights. The findings are consistent with the synthesis level of Bloom et al.'s (1956) taxonomy of the cognitive domain in that participants combined, integrated, and summarized information and ideas in a meaningful way (Hancock & Algozzine, 2017). For example, participants' responses indicated that they could differentiate and compare knowledge gathered from their experience with the ATCoach to develop solutions to ATC problems such as conflict resolution and aircraft separation. The findings also indicated that ATCSs truly understand critical aspects of ATC, airspace components, and operational requirements.

This study's findings are consistent with that of Georgiou et al. (2017), who concluded that participants' perception of ATC simulation-based training directly correlates to the development of their ability to solve complex problems. In their responses, participants displayed a thorough understanding of the fundamentals of an ATCS. Additionally, participants also discussed different approaches they devised to accomplish complex ATC tasks. This study supports the work of DeCarlo (2010), who found that the simulation was an effective mode of delivering initial airport operations training. This study's findings also show that Bloom et al.'s (1956) taxonomy supports the higher-order skills and problem-solving required for learners to engage in deep learning. This study is also consistent with DeCarlo's (2010) study that suggested simulation training framed by Bloom et al.'s (1956) taxonomy leads to higher-order thinking such as situational awareness, critical thinking, judgment, and decision-making. This finding contradicts the findings of de Smale et al. (2016), who disputed the effectiveness of Bloom's taxonomy for framing simulation-related research on the premise that the model does not consider the higher-order skills, like problem-solving and critical thinking. The study also adds to a level of certainty to previous research, such as Salden et al. (2006), who indicated that the effect of the level of simulation training on critical thinking skills is unclear.

Subordinate Research Question 6

Questions 19, 20, 21, and 22 on the IPG focused on the evaluation level of Bloom's taxonomy and ATCSs' experiences with the ATCoach in developing judgment, critical thinking skills, and self-confidence. This study asked participants to explain how their experiences with the ATCoach affected their ability to make value decisions about ATC-related issues. Table 24 presents the responses to Question 19 on the IPG.

Table 28

ATCoach Effect on the Ability to Make Value Decisions

Participant	Participants Responses to Question 19	Interview Date
ATCS 1	"For a new person, I think it's very effective for someone else that maybe not as much."	June 29, 2020
ATCS 2	"It gives you a baseline understanding of what's about to happen normally, so you can make decisions ahead of time knowing that this is what's going to happen because I learned this in the lab."	June 23, 2020
ATCS 3	"I think they show you the basics, and then you get to go upstairs and learn in real life—how to apply it, and what things means."	June 25, 2020
ATCS 4	"The ATCoach gives ATCSs a little idea of what's happening or what could potentially happen. The training is designed to expose you to different problems and different scenarios of what could potentially happen."	June 24, 2020
ATCS 5	"It is just knowing how planes are fed. That tells you the areas to avoid if you're sending some weird Aircraft, weird routing to somebody, you know where you know how to avoid their airplanes."	June 27, 2020

The study asked participants how their experiences with the ATCoach affected their ability to make value decisions about ATC related issues. The responses suggest that participants perceived that the ATCoach helped with decision-making, formulating planning strategies, and predicting traffic flow. With the knowledge acquired from the simulation training, ATCSs can discern ATC situations and conceive suitable responses. ATCS 2, for example, stated that the ATCoach did a decent job by giving ATCSs a baseline understanding of what's about to occur in live operation so they can make decisions ahead of time. ATCS 2 credited the ATCoach simulator for this foresight because participants learned site-specific patterns and behavior in the lab. ATCS 2 emphasized, "in some ways, it helps you understand what you need to do or plan ahead, which is the most, or the biggest part of being controllers is planning ahead and having a plan." ATCS 5 also indicated that the ATCoach aided in the decision-making process by teaching participants to decide which areas of the airspace to avoid and know how to route planes in and out of the airspace. As shared by ATCS 4, the ATCoach gives ATCSs an idea of what's occurring or what could potentially happen by exposing them to different problem scenarios. The knowledge and information obtained during the ATCoach inform decision-making on what to do when a particular situation arises.

The responses of ATCS 1 and ATCS 3 did not address the question surrounding their ability to make value decisions about ATC related issues. Instead, their reactions reinforced previous statements made by participants regarding the value the ATCoach has on acquiring ATC knowledge. The two participants offered less than enthusiastic responses to the question posed. ATCS 1 indicated that ATCSs can still accomplish the desired training outcome without the ATCoach. ATCS 1 stated, "it doesn't really help you that much because let's say it wasn't there and you just went directly to the floor; you're going to learn the same stuff." However, ATCS 1 added that an ATCS could be 80% prepared by solely participating in the ATCoach compared to 60% prepared by observing someone else. ATCS 3 offered a less favorable proportion, stating that learners are 30% prepared during simulation training and then they become fully trained by completing the training during live operations. ATCS 3 noted, “I would say only about 30%. I think they show you the basics, and then you get to go upstairs and learn in real life how to apply it and what it means.”

I then asked participants how their experiences with the ATCoach affected the way they prioritized ATC duties. Table 25 presents the responses to Question 20 on the IPG.

Table 29

ATCoach Effect on the Way ATCSs Prioritize ATC Duties

Participant	Participants Responses to Question 20	Interview Date
ATCS 1	The ATCoach offers opportunities to learn from their mistakes.	June 29, 2020
ATCS 2	The ATCoach makes you think I can make three transmissions here, and I need to prioritize what transmission I need to make first, which also goes hand in hand with having a plan ahead of time.	June 23, 2020
ATCS 3	Judgment and prioritizing activities used to manage air started with the ATCoach.	June 25, 2020
ATCS 4	It gives you a little idea of what’s happening or what to expect that could potentially occur. The instructors want you to expose you to different problems and different scenarios of what could possibly happen.	June 24, 2020

Table 30

ATCoach Effect on the Way ATCSs Prioritize ATC Duties (Continued)

Participant	Participants Responses to Question 20	Interview Date
ATCS 5	It teaches you how to prioritize the things in the scan quickly and then prioritize which aircraft you have to talk to first.	June 27, 2020

The theme that emerged from Question 20 on the IPG suggests that participants believed their experience with the ATCoach positively contributed to ATCSs' ability to exercise sound judgment in prioritizing ATC objectives and tasks based on knowledge and skills taught to them. ATC 5, for example, stated that the ATCoach "teaches you how to prioritize the things in the scan quickly and then prioritize which aircraft you have to talk to first." ATCS 5 also indicated that it is unrealistic to memorize every aircraft's location and behavior under control. Therefore, the ability to quickly scan the radar scope increases situational awareness, which influences ATCSs' decision-making and planning strategies since it plays a significant role in applying positive control judgments and interpreting and prioritizing objectives expeditiously.

ATCS 4 provided a similar response to ATCS 5's. ATCS 4 stated that the ATCoach equips ATCSs with the tools to think faster on their feet, predict difficult ATC situations, prepare them to promptly avoid conflicts, and provide positive separation. ATCS 1 expressed a genuine appreciation for the "learn by mistakes" opportunities the ATCoach offers. ATCS 1 stated, "You're going to get burned, and you're going to say, I'm not doing that again." ATCSs developed, revised, or improved decision-making approaches learned from poor judgment, decisions, or choices made during the ATCoach. ATCSs then used these newly enhanced decision-making and planning strategies during simulation training, post-simulation evaluation, and operational settings to manage live traffic.

ATCS 2 stated that the ATCoach is relatively beneficial because it incorporates scenarios that encourage ATCSs to prioritize work duties. ATCS 2 referenced communication between ATCSs and pilots as an example, stating, “You can only make one transmission at a time,” and the ATCoach “makes you think I can make three transmissions here, and I need to prioritize what transmission I need to make first.” ATCS 2’s responses indicated that ATCSs’ experiences influence decision-making and planning. ATCS 3 also believed that the ATCoach simulation is highly essential for making good judgment and prioritizing ATC activities. For example, ATCS 3 indicated that making decisions on tasks such as working traffic from the airport outwards, turning aircraft into the final landing route, making sure altitudes are correct, maintaining separation within the airspace, observing traffic coming from further out, taking handoffs, planning for weather buildups, deviating planes, and coordinating with other stakeholders started with the ATCoach. Emphasis was placed on the notion that priorities were placed, across the board, on the above-listed activities. Additionally, ATCS 3 expressed that the ATCoach taught the participants how to prioritize and make judgments regarding (a) where on the scope to look, (b) when one should focus on that area, and (c) the importance of learning specific ATC skills.

Question 21 on the IPG asked participants how their experiences with the ATCoach impacted their judgments about the values of methods, procedures, and other practices used in ATC. I designed the question to ascertain whether the ATCoach developed ATCSs’ ability to exercise their best control judgment. Table 26 presents the responses to Question 21 on the IPG.

Table 31

Judgments About the Values of Methods, Procedures, and Other Practices

Participant	Participants Responses to Question 21	Interview Date
ATCS 1	It helps you learn. You can pause and discuss things with the instructors. You can kind of make mistakes.	June 29, 2020
ATCS 2	It helps you become more comfortable working the traffic's specifically related to that facility.	June 23, 2020
ATCS 3	It helps you thoroughly understand why it is and why I'm doing what I'm doing.	June 25, 2020
ATCS 4	It's been helpful. I think it provided some knowledge as to what to expect when the traffic volume picks up.	June 24, 2020
ATCS 5	It teaches you how to protect certain areas within the airspace and why we do certain things.	June 27, 2020

The responses from Question 21 on the IPG suggest that the ATCoach impacted ATCSs judgment. The participants described how the ATCoach both assisted and inhibited their judgment. Below are some of the benefits mentioned by ATCS 2, ATCS 4, and ATCS 5. ATCS 2 gave credence to the importance of simulation training in allowing trainees the opportunity to experience a virtual environment that improves their competencies. For example, in ATCS 2's own words,

> to some degree, it helps you become more comfortable working the traffic; specifically, related to that facility … It helps you become a better controller at your respective facility because you're working the traffic that you see at that facility.

ATCS 2 also mentioned, “You have to implement the same rules in every facility,” but how traffic flows at each location differs, and the ATCoach gives ATCSs baseline knowledge and skills of how to manage the traffic at the research site. ATCSs’ previous and subsequent responses are indications that they believe an understanding of site-specific traffic behavior is an attribute of the ATCoach.

Like ATCS 2, other participants identified air traffic behavior as a valuable simulation learning outcome. For example, ATCS 4 stated that the ATCoach has been helpful because “it provided some knowledge as to what to expect when the traffic volume picks up” or whenever an ATCS is working final approach, running different sectors, or working a different scope. The term “scope” refers to another ATC workstation or TCW. ATCS 4 also indicated that the ATCoach is beneficial in the decision-making and planning processes as it enhances understanding of the complexities of the operational environment. ATCS 5 indicated that some areas within the controlled airspace require special attention because air traffic activities are erratic in those areas. For example, aircraft can suddenly appear on the radar scope, therefore, forcing ATCSs to pay special attention to those areas of the airspace. According to ATCS 5, the ATCoach teaches one “how to protect those areas … and why we do certain things.” Participants’ responses contradict Ennis’s (2009) position that simulation is not used to teach.

ATCS 1 referenced previous responses to discuss how the participant’s experiences with the ATCoach impacted the participant’s judgments about the values of methods, procedures, and other practices used in ATC. ATCS 1 initially indicated that the ATCoach was unimpactful. ATCS 1, for example, stated, “I don’t think it impacts you. I think it helps you learn, but I don’t think it impacts you at all.” However, after slightly rephrasing the question to ask how did the ATCoach influence or affected ATCSs’ judgments about the values of methods, procedures, and other practices used in ATC, ATCS 1 acknowledged that the ATCoach enhances learning outcomes by allowing trainees to make mistakes and learn from those mistakes. ATCS 1 expressed appreciation for the opportunity to pause the scenarios and discuss things with the instructors. ATCS 3's response indicated that the participant was ambivalent about the participant's experience with the ATCoach. ATCS 3 stated that many ATCSs view the ATCoach as a formality. ATCS 3 expressed,

> Everybody always says just get through the lab; we'll teach you how it's really done upstairs … It sometimes feels like the ATCoach and the instructors are maybe stuck a few generations behind what's currently happening in the traffic. So, you try to keep yourself from learning too much of what they say downstairs because when you get upstairs and work real airplanes with your instructors that they're going to be like, forget that, forget that, forget that.

However, ATCS 3 expressed deep appreciation for knowledge learned during the ATCoach instruction (a new change to a LOA or an SOP, or just the interpretation of a rule in the FAA Order 7110.65) and the opportunity to educate others of the latest changes. ATCS 3 also added that the ATCoach simulation helps trainees thoroughly understand the reasons and purpose of performing specific ATC tasks. This study's findings suggest that changes to current policies, practices, letters of agreement, rules, and standard operating procedures could improve ATCSs decision-making and planning strategies regarding air traffic management.

Question 22 on the IPG asked participants what impact their experience with the ATCoach had on their self-confidence to operate safely in the live air traffic environment. I developed the question to ascertain whether the ATCoach improved self-confidence among CPC-ITs after training. Table 27 presents the responses to Question 22 on the IPG.

Table 32

Impact of the ATCoach on Their Self-Confidences

Participant	Participants Responses to Question 22	Interview Date
ATCS 1	In some ways, it almost has the opposite effect because you get so frustrated because you know, better you know that this is not how it would be.	June 29, 2020
ATCS 2	My self-confidence hasn't changed from before, from pre-labs to post-labs. My confidence hasn't changed prior to or post labs.	June 23, 2020
ATCS 3	I hate the ATCoach simulation because it totally depletes my confidence level.	June 25, 2020
ATCS 4	I don't really know how much it really builds your confidence. I mean, you have to already have confidence.	June 24, 2020
ATCS 5	I can't say it gives you confidence because it's going to be so different when you hit the floor.	June 27, 2020

The theme that emerged from Question 22 on the IPG shows that participants believe that the ATCoach simulation activities had little to no impact on their self-confidence. The participants unanimously dismissed the idea that the simulation training improved their self-confidence. ATCS 2, for example, stated that the ATCoach simulation had no impact on the participant's self-confidence because it is only a part of what it takes to do the job of an ATCS. ATCS 2 stressed, "as a controller being a CPC-IT, I'm confident in my ability to work traffic. I don't think the labs really altered my confidence in any way, to be completely honest." ATCS 5 offered a corresponding response, "I can't say it really gives confidence because it's going to be different when you hit the floor, and then everybody's going to inform you to forget everything you just learned in the Sims." ATCS 1 indicated that if the ATCoach simulation had any impact on the participant's self-confidence, it was just minuscule, if any at all. Similarly, ATCS 4 believed that the ATCoach was helpful. However, ATCS 4 did not accept that the simulation training "builds you up because you have to have confidence already." When speaking of the ATCoach, ATCS 1 added, "it kind of makes you frustrated sometimes, like working final down there was so frustrating it almost deflates you in some ways." Consistent with previous responses to earlier questions that focus on the evaluation level of Bloom's taxonomy, ATCS 1 indicated that the ATCoach might increase the confidence of new ATCSs by at the least making them unafraid. ATCS 1's position is supported by Hurst (2015), who concluded that simulation training is less impactful on the self-confidence of senior students and those with prior industry experience. ATCS 1 shared, "for me personally, I would say like overall it didn't hurt me or help my confidence level." Like ATCS 1, ATCS 3 also expressed frustration with the ATCoach. ATCS 3 professed, "I hate ATCoach simulation because it totally depletes my confidence level" because the instructor imposes scenarios with excessive problems with a high level of complexity. This practice is believed to be counter-intuitive, because, as ATCS 3 puts it,

> For somebody who's trying to learn, I think that is the exact wrong way to do it because I'm just in panic mode the whole time … And that does nothing to help improve the controller's experience or confidence; it really tears you down.

I used Questions 19, 20, 21, and 22 on the IPG and the six classifications of Bloom's taxonomy of the cognitive domain collectively to determine how ATCSs perceived the simulation training impacted their judgment, critical thinking skills, and self-confidence to manage complex air traffic scenarios without instructor intervention to meet the minimum requirement for radar certification. The findings suggest that ATCSs perceive that their understanding of ATC-related situations from their ATCoach experiences improved their judgment, critical thinking, and decision-making skills in postsimulation evaluation and in ATC practice. For example, the ability to quickly scan the radar scope increases situational awareness, influences decision-making and planning strategies, and plays a significant role in making positive control judgments and interpreting and prioritizing objectives. ATCSs' experiences with the ATCoach helps in predicting difficult situations, avoiding conflicts, and providing positive separation, which also requires critical thinking. However, the usefulness of the ATCoach at helping with improving ATCSs self-confidence was rejected by all five participants. These findings are consistent with DeCarlo (2010) who suggested that simulation training framed by Bloom's taxonomy leads to higher-order thinking such as situational awareness, critical thinking, judgment, and decision-making. On the other hand, these findings do not support Hustad et al.'s (2019) findings that self-confidence increases after participating in simulation-based training. This study's findings contradict de Smale et al.'s (2016) statement that Bloom's taxonomy is not useful for framing simulation-related research. The study also contradicts de Smale et al.'s (2016) argument the taxonomy does not consider higher-order skills, like problem-solving and critical thinking, required for learners to engage in deep learning.

I crafted Question 23 on the IPG to capture ATCSs' perspectives on aspects of the simulation training they believed deserve additional attention. This question asked participants if they had anything else to share about their experience with the ATCoach before completing the study's data collection phase. The responses to Question 23 reinforced previous statements, clarified ambiguous answers, provided relevant feedback on the evaluation process, and rendered some unanticipated results. The Unexpected Findings section below addresses the unanticipated results.

This Unexpected Findings section addresses feedback related to the ATCoach evaluation process, considering the process in itself is a testament to how ATCSs evaluate what they learn from their experiences with the ATCoach in developing job-related competencies (i.e., ATCSs evaluate the ATCoach by completing a post-training assessment, which is part of the ATC certification process). The themes that emerged from all the questions on the IPG suggest that participants perceive they evaluated what they learned during the ATCoach by using the knowledge, comprehension, application, analysis, and synthesis classifications of Bloom's taxonomy of the cognitive domain to varying degrees (Jones et al., 2009). Specifically, during the simulation assessment, ATCSs evaluate the knowledge learned during the ATCoach, applying and demonstrating the methods and procedures, control judgment, and separation job tasks. Table 28 presents a list of job tasks critical during the evaluation process.

Table 33

ATC Evaluation Knowledge and Tasks Performed during Assessment

Job Task	Job Subtasks
Separation	Ensured separation and solving conflicts.
	Managing air traffic at 50%, 75%, and 100% traffic volume without any separation loss.
Control Judgment	Provide control judgment. Applied good control Judgment.
	Maintaining air traffic while alleviating aircraft conflicts, visually understanding traffic flow.
	Prioritize ATC duties.

Table 34

ATC Evaluation Knowledge and Tasks Performed during Assessment

Job Task	Job Subtasks
Methods and Procedures	Controlling simulated traffic by applying ATC knowledge.
	Applying Proper application of separation standards outlined in the FAA Order 7110.65.
	Demonstrating knowledge of the local area. Applying knowledge of typical ATC situations.
	Demonstrating knowledge of SOPs and LOAs.

CPC-ITs operating at the evaluation level of the cognitive domain are expected to demonstrate critical ATC skills by solving conflicts and separation-related issues against the standards outlined in the FAA Order 7110.65. This demonstration of knowledge and skills takes place during simulation training and again during the post ATCoach assessment. The assessment is a systematic method used by the FAA to evaluate CPC-ITs' level of mastery, proficiency, and fluency to specific ATC tasks and processes required to safely and efficiently apply air traffic procedures. As stated by ATCS 2, "they're just evaluating you to see if you're capable of passing the labs because if you can't, they might not think you're capable of working live traffic." This study's participants were evaluated based on their "overall performance, which gives an indication of their learning achievements" (Talib et al., 2018, p. 2). The postsimulation assessment is a puzzle that ATCSs have to solve (SME 1). According to SME 1, the training practitioners at the research site created scenarios of varying levels of volume and complexity to ensure that ATCSs can complete the assessment without any loss in separation and while avoiding aircraft conflicts. The findings suggest that participants evaluate what they learn in the

ATCoach by completing the post-training assessment by demonstrating abilities to undertake evaluation and to make good judgment in the decision-making process without instructor intervention. As explained by ATCS 2, the ATCoach simulation instructors and RPOs coach the ATCSs through the entire simulation training up until the point where they are evaluated.

Unexpected Findings

The 23 questions on the IPG helped with answering the overarching research question: How do ATCSs at an air traffic facility in the southeastern region of the United States describe their experiences with the ATCoach in developing job-related competencies? The IPG also revealed three additional themes. These themes are (a) participants' perceptions of the evaluation process at the research site, (b) participants' perception of the fidelity of the ATCoach simulator, and (c) participants' perceptions of instructors at the research site. The three themes did not provide direct insight into the overarching research question but instead highlighted the CPC-ITs' perception from a training program or course evaluation perspective.

Participants' Perceptions of the Evaluation Process. One of the unanticipated themes that materialized was participants' unanimous opposition to using the ATCoach post-simulation training assessment as a pass/fail graded evaluation. ATCS 5, for example, stated, "I don't necessarily agree with the whole evaluation process." ATCS 5 believed there is an unrealistic expectation placed on CPC-ITs during evaluation that does not necessarily transfer to the operational setting. For example, making an error during evaluation equates to the trainee failing the evaluation phase. According to ATCS 5, this means "you're essentially fired." ATCS 5 explained that it is ironic that a similar mistake in an operational environment does not necessarily result in termination. ATCS 5 believed that failing the assessment would be a disservice.

ATCS 2 stated that the ATCoach is beneficial, but it should not be used for graded evaluation because there are many possibilities for human error on the part of the instructors/RPOs. The participant also argued that the number of CPC-ITs that fail the assessment is so insignificant that it does not justify making it a graded evaluation. Like ATCS 2 and ATCS 5, ATCS 1 believed that the ATCoach "serves its purpose as a whole" but should not be used as a graded evaluation. ATCS 1 shared,

> I don't think they should be graded. I don't think anyone should wash out of the labs. I think that's ridiculous. It's a learning tool, and you should get as much time in the lab as you want. I get the scenarios, and then I get graded on it; that's absurd.

ATCS 3 also rejected the need for post-training evaluation, claiming that the process is counterproductive. ATCS 3, for example, stated, "I walk in that morning knowing I'm going to have two evaluations that day, and either one of those evaluations can terminate my training, technically. And that does nothing to help improve the controller's experience or confidence." ATCS 3 added that the graded evaluation inhibits an ATCS' opportunity to become truly comfortable going through the process because of the fear of failing the assessment and learning what to do to pass. ATCS 4 stated that the evaluation was a matter of survival with the goal of getting to the floor.

Similarly, ATCS 2 and ATCS 5 indicated that ATCSs place more emphasis on trying to figure out how to beat the evaluation than actually learning the required tasks. For example, ATCS 2 expressed,

> I don't think putting unnecessary stress on people is worth it. I was trying to remember how I was going to get graded on the slide instead of trying to learn to be comfortable working the traffic. I was like, how is this traffic going to flow? And how am I going to

> execute the evaluation as opposed to just learning the traffic? I was trying to learn how to beat the test.

As ATCS 1 put it, “the simulation training helps teach ATCSs and get them ready for the floor; it should not be used to wash people out.” ATCS 2 also believed that ATCSs should be allowed to go into the lab and focus on a single skill until they are satisfied. This argument supports Dahlstrom et al.’s (2017) assertion that simulation inhibits learner-specific instruction.

The findings suggest that, to some degree, the end-of-course evaluation inhibited “true learning” because CPC-ITs put more emphasis on passing the assessment than digesting the course content. This finding is supported by Dahlstrom et al. (2017), who argued that that simulation systems encourage learners to take shortcuts when participating in simulation-based learning. The findings indicate that ATCSs believe that the evaluation process is counterproductive for assessing the ATCoach.

Participants’ Perceptions of the ATCoach Simulator’s Fidelity. Another theme that emerged suggests that participants believed that simulated aircraft performance during training is unrealistic and does not accurately mirror live air traffic behavior. ATCS 3, for example, stated that the aircraft performance in the ATCoach simulation is not accurate and true to life because how it reacts to ATC commands is not consistent with that of real aircraft. ATCS 3 explained, “When in ATCoach, you tell an aircraft to turn, it turns right away; you tell it to slow down, it goes from 300 knots to 170 knots in a matter of one sweep. That doesn’t happen in real life.” Likewise, ATCS 1 stated,

> In terms of aircraft performance, I would give it a two or three out of 10 because the speed in which the aircraft climb and change airspeed in the simulator is unrealistic. I think it’s crazy because it’s not necessarily realistic.

ATCS 1 added that the aircraft in the ATCoach simulation slows down, speeds up, climbs, and descents spontaneously, and there is no way that would occur in real life. ATCS 5 offered a similar response as ATCS 1 and ATCS 3. According to ATCS 5, when a command is given to the RPO to reduce aircraft speed, the speed reduces almost instantaneously, contrasting live traffic behavior, which gradually slows down.

ATCS 4 seconded the sentiments of the other participants. ATCS 4, for example, described the simulation experience in the following way: There are "some aspects of the ATCoach that is troubling like the planes not doing what you told them to do." ATCS 4 added that most parts are real, but some features really wouldn't be happening in the real world. For example, the way the aircraft changes speeds." This erratic and unrealistic aircraft behavior (rapid shift in speed, direction, and altitude) alters ATCSs' learning experiences.

ATCS 5 also had negative experiences with the ATCoach, much so that the participant described reluctance in engaging in future valuable simulation training opportunities due to fear of picking up bad habits that could be difficult to unlearn. ATCS 5's concerns reinforce Judy's (2018) conclusion that "negative training should be avoided since simulators can teach wrong responses" (p. 38). In ATCS 5's own words, "I think it would have been a really big help, but I just knew that the timing of aircraft turning and slowing was going to be so different than the real-life that I just was like, no, I'm not doing that again." This study's findings suggest that the physical fidelity of the ATCoach simulator has some limitations, and ATCSs perceive these limitations to have an adverse influence on their learning experience. Other fidelity limitations are discussed further in connecting the instructor/RPO interaction.

Participants' Perceptions of Instructor/RPO Interaction. The third unexpected theme that emerged suggests that most participants were dissatisfied with several aspects of the instruction, the instructors, and the delivery process. Most participants had a favorable perception of their overall interaction with the ATCoach instructors and RPOs. Still, participants expressed specific concerns regarding the instructors and RPOs preparedness, including the instructors and RPOs' possession of current ATC knowledge and practices at the research site and the unrealistic demands placed on RPOs to pilot multiple simulated planes. Two participants directly mentioned that the instructor/RPOs' support adversely affected participants' learning experiences. ATCS 2, for example, stated,

> I would say the biggest problem is that there are RPOs here that have never worked here, and there are instructors that have never worked here. Some instructors haven't worked here in 10 years, and they're acting as seven different pilots.

Another participant, ATCS 4, indicated that many instructors and RPOs had not controlled traffic at the research site in recent years. ATCS 4 believed that this lack of recent TRACON experience has resulted in the transfer of outdated or incomplete information and practices from training staff to trainees. ATCS 2 discussed the importance of instructor support in the simulation training. The participant mentioned that the instructors and the RPOs play a pivotal role in ATCSs' success in completing the simulation training. In ATCS 2's own words,

> I have to throw in the instructors in the lab. If you just sat me down at the radar lab and told me to work this problem. Obviously, I'm not going to get much out of it. The instructors are a huge part of the radar lab. They're the ones that are the experts.

This perspective is consistent with Coyne et al.'s (2017) findings. Coyne et al. found that the degree to which instructors provide support to learners and learners' stress levels during simulation training influences learning outcomes.

ATCS 2 also stated that the ATCoach simulator works fine, adding, "The labs are flawless" because it is a computer and "it's going to do what you want it to do. It's the people that are actually working the programs that either make it good or they make it bad." As Bauer (2005) explained, a simulation system's physical characteristics directly affect the level at which the learner acquires knowledge. ATCS 3 echoed the concerns of ATCS 1, ATCS 2, ATCS 4, and ATCS 5. As ATCS 3 mentioned, the instructors and RPOs "seem to have outdated information" and "they're not up to date with current practices."

One suggestion presented by ATCS 3 was that it would be beneficial for the ATCoach instructors and RPOs to periodically observe live traffic to become familiar with current information and practices. In ATCS 3's own words, "I don't even know when the last time was that I saw an instructor in the TRACON." Participants' responses suggest that they are satisfied with the physical fidelity of the ATCoach simulator but found the functional fidelity lacking. Participants believe that the functional fidelity problems of the ATCoach simulation are caused in part by instructors/RPOs errors, specifically, data entry errors made by the training staff when entering commands (commands given by ATCSs) into the system. However, some participants insisted that the issues were not the instructor's or RPO's fault. Perhaps the most crucial comment was a question raised by ATCS 2. The participant stated, "as I said, it's not necessarily their fault. … How can you expect one person to act as seven different aircraft?"

Relationship Between Bloom's Taxonomy, ATCoach, and ATC Competencies

This study sought to understand ATCSs' perceptions of the ATCoach and if they believed it was a valuable method of providing the experience to develop their ATC job-related competencies needed to perform safe operations in the real air traffic environment. Table 29 shows the six classifications of Bloom et al.'s (1956) taxonomy, the job-related competencies, and the correlation between the ATCoach simulation training and the development of the ATC job-related competencies.

Table 35

Research Finding Through the Lens of Bloom's Taxonomy and Competencies

Level	Bloom's Taxonomy	ATC Competencies	ATCoach
1	Knowledge	ATC Knowledge	No
2	Comprehension	ATC Knowledge	Yes
3	Application	Performance Skills	Yes
4	Analysis	Judgment and Critical Thinking Skills	Yes
5	Synthesis	Judgment and Critical Thinking Skills	Yes
6	Evaluation	Judgment and Critical Thinking Skills	Yes
		Self-Confidence	No

I used the lowest level, the knowledge level of Bloom's taxonomy to assess if knowledge of basic information took place during the ATCoach. The study found that ATC knowledge does not necessarily occur during the ATCoach training, but instead during previous classroom learning or experience. I used the second level, the comprehension level of Bloom's taxonomy, to assess if comprehension of basic information occurred during the ATCoach training. The findings suggest that the ATCoach training equipped ATCSs with a better understanding of site-specific airspace elements, which better prepared them to transfer the knowledge acquired from pre-simulation training to practice in their day-to-day ATC operations. I used the third level, the application level of Bloom's taxonomy, to determine if the application of information and performance skills occurred during the ATCoach: providing opportunities for ATCSs to apply what they know to practice directing and managing aircraft. This study's findings indicate that

ATCSs apply what they learn from their ATCoach training experiences by taking what they learned and executing it when participating in simulation training and controlling live air traffic (i.e., coordinating air traffic activities during the simulation, receiving and delivering airplanes in the airspace, separating the planes in the most efficient and safe way, extrapolating planning strategies).

I used the fourth level, the analysis level of Bloom's taxonomy, to determine if the ATCoach provided learners opportunities to use judgment and critical thinking to solve complex problems. The findings of this study suggest that ATCSs analyzed what they learned from their experiences with the ATCoach training by (a) identifying elements within the structure of the airspace, (b) recognizing patterns in traffic flow, (c) observing traffic volume, (d) predicting clutter, and (e) identifying hotspots. I used the fifth level, the synthesis level of Bloom's taxonomy, to determine if the ATCoach provided opportunities for learners to use judgment to solve complex problems and how ATCSs synthesized what they learn from their experiences with the ATCoach. The study found that ATCSs synthesized what they learned from their experiences with the ATCoach by using their knowledge of complex airspace elements to develop operational planning strategies and formulate alternative plans presuming their initial strategies were ineffective. I used the sixth level, the evaluation level of Bloom's taxonomy, to determine how ATCSs perceived the ATCoach impacted their judgment, critical thinking skills, and self-confidence to manage complex air traffic scenarios without instructor intervention to meet the minimum requirement for radar certification. The findings suggest that ATCSs perceived that their understanding of ATC-related situations from their ATCoach experiences improved their judgment, critical thinking, and decision-making skills in post-simulation evaluation and in ATC practice—not their self-confidence.

Advantages and Disadvantages of the ATCoach Simulation

Table 30 provides a list of perceived advantages and disadvantages of the ATCoach based on all ATCSs' responses to the 23 questions on the IPG.

Table 36

Advantages and Disadvantages of the ATCoach

Participant	Advantages	Disadvantages
ATCS 1	Can help inexperienced ATCSs practice phraseology.	It is not suitable for learning equipment.
	It helps with learning how to apply LOAs, SOPs, and the rules in FAA Order JO 7110.65.	The aircraft performance in the ATCoach simulator "is pretty bad because aircraft slow down, speed up, climb, and descend on a dime.
	Learning how to receive and deliver airplanes in the airspace.	Does not incorporate scenario with emergency situations.
	Enables ATCSs to learn all the chokepoints and the hotspots.	
	Gives ATCSs a good enough overview of ATC operation.	
	The ATCoach offers opportunities to learn from mistakes. "You don't have to worry about the real-life situations or repercussions."	
	Freedom to pause the scenario and discus things with the instructors or experiment.	

Table 37

Advantages and Disadvantages of the ATCoach Continued)

Participant	Advantages	Disadvantages
ATCS 2	Provides ATCSs with baseline knowledge of how the traffic flows at the research site.	One person acting as multiple aircraft pilots. "I can't speak as fast as I would in a real-life situation because I'm not talking to individual people. I'm giving the same person three different commands back-to-back to back."
	Enable ATCSs to get comfortable with the daily stereotypical traffic at the research site. It helps in becoming more comfortable working the traffic's specifically related to that facility.	"The instructors are a significant issue because some of the instructors and RPOs we have here have never worked traffic at this site."
	Incorporates scenarios that encourage ATCSs to prioritize work duties.	Many possibilities for human error on the part of the instructors/RPOs.
	It teaches the basics, most of the things an ATCS would typically see on a day-to-day basis.	
	The ATCoach simulation reinforces ATCSs' understanding of the traffic flow, sectors, site-specific airspace, and how it all works together.	
	It gives you a better understanding of what occurs in the airspace. It also helps ATCSs understand the airspace: MVAs, vector routes, etc.	

Table 38

Advantages and Disadvantages of the ATCoach Continued)

Participant	Advantages	Disadvantages
	Can help inexperienced ATCSs learn how to do handoffs and pointouts.	
	"The lab is beneficial because the scenarios force you to scan more and make you more aware of how much airspace you truly have."	
ATCS 3	Useful in the respect that trainees learning the traffic patterns and flow of the airspace.	Not a good tool to use for learning aircraft characteristics because it's not true to life.
	Helpful at teaching ATCSs the basics.	Aircraft performance and characteristics in the ATCoach simulation is not accurate and true to life.
	Helpful in teaching airspace components such as approaches, MVAs, altitude restrictions, and different obstacles aircraft encounters.	The instructors and RPOs "seem to have outdated information," and "they're not up to date with current practices."
	You learn techniques from instructors.	Sometimes things don't happen exactly as it says in the SOPs or LOAs.
	Understanding or getting familiar with giving approach clearances. Allows trainees to practice ATC tasks and try different techniques without risk of impact or injury to the flying public.	I think it prevents you from really looking at that scan.

Table 39

Advantages and Disadvantages of the ATCoach Continued)

Participant	Advantages	Disadvantages
	Experience high traffic volume before working live air traffic.	
ATCS 4	Helps with understanding the maps, practicing phraseology, aircraft characteristics, speeds, and handling the volume.	Many instructors and RPOs had not controlled traffic at the research site in recent years. The instructors have not managed traffic in a long time and are operating from outdated information.
	The ATCoach simulator allows ATCSs to access different site-specific maps used to control live air traffic.	The erratic and unrealistic aircraft behavior (rapid shift in speed, direction, and altitude) of the ATCoach simulator alters ATCSs' learning experiences.
	Learning traffic volume is one of the biggest things or getting to grasp that concept of going over different procedures for the airport that we have around the airspace.	Does not address language barrier between ATCSs and pilots.
	Helpful in that ATCSs practice how to safely and efficiently separate aircraft within the airspace.	
	Familiarization of site-specific procedures and learning why certain practices are important. Practice managing heavy volume of aircraft at once on the scope.	

Table 40

Advantages and Disadvantages of the ATCoach Continued)

Participant	Advantages	Disadvantages
	The ATCoach lab helps with scanning all over the airspace.	
	Good for relearning and for reinforcing new habits.	
	Provide knowledge as to what to expect when the traffic volume picks up.	
	Familiarization with routine site-specific aircraft behavior.	
ATCS 5	Enables ATCSs to learn all the chokepoints and hotspots.	Does not address aircraft classification beyond a heavy aircraft.
	Get ATCSs acclimated with what to expect in the real world or with what could potentially happen.	When a command is given to the RPO to reduce aircraft speed, the speed reduces almost instantaneously, contrasting live traffic behavior, which gradually slows down.
	The ATCoach reinforces what they teach in the classroom such as the airspace and the flow of traffic to the other sectors.	
	The simulation training teaches ATCSs the general traffic flow and “how airplanes fly through the airspace.	

Table 41

Advantages and Disadvantages of the ATCoach Continued)

Participant	Advantages	Disadvantages
	The ATCoach train your eyes to look at the edges of your scope, so you don't miss stuff. It teaches you how to prioritize the things in the scan quickly It teaches you how to protect certain areas within the airspace	

Comparing the perceived advantages and disadvantages for the ATCoach suggests that participants experienced various positive learning outcomes at the research site. These learning outcomes are as follows: basic knowledge of ATC operation, traffic flow, traffic volume, traffic patterns, site-specific maps, vector routes, and altitude restrictions, sectors, site-specific airspace, LOAs, SOPs, and FAA Order JO 7110.65, airspace scanning, chokepoints and hotspots, approaches, techniques, and phraseology. Learning the traffic flow at the research site is the most recurring activity mentioned by all five participants. Traffic volume, site-specific airspace components, maps, and LOAs, SOPs, and FAA Order JO 7110.65 were also frequently mentioned by participants.

These advantages confirm and add to the existing scholarly literature on instructional simulation. First, this study provides suggestive evidence that simulation technology supports the development of basic knowledge and skills. This evidence confirms Ghosh's (2015) study that simulation improves pilots' basic flying skills. A study conducted by Updegrove and Jafer (2017) also concluded that simulation technology enhances basic ATC skills. The advantages also contradicted the studies by Case (2013) that indicate that Bloom's taxonomy is not necessary to promote higher-level thinking and de Smale et al. (2016) that Bloom's taxonomy is an ineffective mode of framing simulation-related research and does not consider higher-order skills, like problem-solving and critical thinking, required for learners to engage in deep learning. This study found that simulation technology develops higher-level thinking and critical thinking skills. For example, this study's findings suggest that simulation technology help develop analytical thinking and understanding of complex ATC elements (airspace structure, sector boundaries, and patterns) that help ATCSs predict difficult situations, avoid conflicts, and provide positive separation. This study supports the work of DeCarlo (2010), who found that the simulation was an effective mode of delivering initial airport operations training.

Comparing the perceived advantages and disadvantages of the ATCoach also suggests that participants experienced some adverse learning outcomes at the research site. Participants perceived the following as undertakings that negatively affected their learning experiences: aircraft performance is not true to life (erratic and unrealistic aircraft behavior), inadequate RPOs to ATCSs ratio, inexperience instructors/RPOs on site-specific knowledge and practices, and human error caused by instructors/RPOs. This study found that simulation technology can alter learning experiences due to the simulation's erratic and unrealistic aircraft behavior. This disadvantage reinforces Judy's (2018) conclusion that "education practitioners should avoid negative training practices since simulators can teach wrong responses" (p. 38). Additionally, the disadvantages align with Jentsch et al.'s (2011) assertion that simulation does not guarantee learning outcomes. Participants reported dissatisfaction with inadequate RPOs to ATCSs ratio, inexperienced instructors/RPOs on site-specific knowledge and practices, and human error caused by instructors/RPOs. These disadvantages confirm Coyne et al.'s (2017) conclusion that the degree to which instructors support learners' and learners' stress levels during simulation training is a factor affecting learning outcomes.

Chapter Summary

The purpose of this study was to understand how ATCSs describe their experiences with the ATCoach in developing job-related competencies. Through the cognitive domain of Bloom et al. (1956), I studied the perspectives of five ATCSs at an air traffic facility in the southeastern region of the United States. This study used an IPG consisting of 23 questions framed by the six SRQs to collect data. Chapter 4 described the study's participants, including demographic information such as age, gender, race, ethnicity, hiring source, and certification status collected during the interview process.

This study logically presented the findings to align with the six SRQs. This study's major findings are as follows: (a) ATC knowledge does not necessarily occur during the ATCoach but instead during previous classroom learning or experience; (b) the ATCoach equipped ATCSs with a better understanding of site-specific airspace elements, which better prepared them to transfer the knowledge acquired from pre-simulation training to practice in their day-to-day ATC operations; (c) ATCSs apply what they learn from their ATCoach experiences by taking what they learned and executing it when participating in simulation training and controlling live air traffic; (d) ATCoach experience facilitated situational awareness, judgment, and decision-making; (e) ATCSs synthesize what they learn from their experiences with the ATCoach by using their knowledge of complex airspace elements to develop operational planning strategies and formulate alternative plans presuming their initial strategies were ineffective; (f) ATCSs perceive that their understanding of ATC-related situations from their ATCoach experiences improved their judgment, critical thinking, and decision-making skills in post-simulation evaluation and in ATC practice—not their self-confidence; (g) ATCSs evaluate what they learn in the ATCoach by demonstrating abilities to undertake evaluation and to make good judgment in the decision-making process without instructor intervention; (h) the end-of-course evaluation inhibited "true learning" because CPC-ITs put more emphasis on passing the assessment than digesting the course content; and (i) the physical fidelity of the ATCoach simulator has some limitations, and ATCSs perceive these limitations to have an adverse influence on their learning experience.

After presenting the findings, I offered a synthesis and thorough discussion of said findings and their implications through the lens of previous literature and the conceptual framework. This study will further discuss the major findings in Chapter 5. The purpose of Chapter 5 is to provide a summation of this qualitative exploratory case study design, including an overview of this study's problem, purpose, research questions, major findings, conceptual framework, and methodology.

Chapter 5: Summary, Conclusions, Implications, and Suggestions for Future Research

Chapter 5 is a summation of this qualitative exploratory case study design. This chapter's sections are presented in the following order. The first section provides a summary of the study's major findings. The second section presents the study's conclusions derived from the data analysis results. The third section of this chapter presents an interpretation of the study's findings and conclusions. The fourth section provides the implications drawn for this study's findings that may be critical to theory, practice, policy, and unexpected study outcomes. In the fifth section of Chapter 5, I provide some recommendations that future researchers may use to advance the study. The sixth section of this chapter presents limitations identified due to the research design issues. I also provide some self-reflective comments about my research experiences, followed by the chapter summary.

Summary and Major Findings

This section is a summary of the study's major findings, including the study's background, an overview of the problem, purpose statement, research questions, overview of major findings from the literature review, conceptual framework, overview of the methodology, and the major findings. This study investigated how well the use of the ATCoach radar simulator provides trainee ATCSs with the experience to develop the ATC job-related competencies (knowledge, performance skills, judgment, critical thinking skills, and self-confidence) needed to operate safely in the real air traffic environment. A substantial amount of research has shown a positive correlation between simulation technology and the enhancement of these five job-related competencies (e.g., Bauer, 2005; Cox, 2010; Lindenfeld, 2016; McDermott, 2005; Van Eck et al., 2015; Zhang, 2016). From an ATC safety perspective, the FAA should strive to provide ATCSs with academic and simulator competency-based training that would develop their skills, situational awareness, and judgment so that they may adequately assist pilots with navigating through the NAS (Alinier, 2013; Buck & Pierce, 2018; USNTSB, 2016a). Many ATCSs have received inadequate or inaccurate simulation training, increasing the likelihood of mid-air collisions and aviation-related fatalities (USNTSB, 2016a). Understanding the experiences of ATCSs who participate in simulation training can inform aviation education to improve public safety and the well-being of the NAS. The benefits of using simulation technology for aviation training are that simulators are “realistic, safe, cost-effective, and flexible” (Jentsch et al., 2011, p. 197). Though there are obvious benefits to instructional simulators, the research carried out thus far on the aviation industry has significantly underrepresented a critical component of the aviation community—the ATC function (Lee, 2017).

Despite its advantages and popularity in the aviation field, prior evaluation of the usefulness of computer-generated, scenario-based simulation on ATC job-related competencies is not completely defined or understood (Cox, 2010; Gheorghiu, 2013). A review of the current scholarly literature revealed that much remains to be learned about the appropriate use of simulation technology in ATC education. Also lacking in previous investigations was the comparison of the various air traffic simulators and simulation technology currently in use. Because this current study was conducted on the FAA’s use of computer-generated, scenario-based simulation in ATC training, this research addressed these assumptions and contributed to the gap in the research relating to aviation instructional simulation.

It is essential to fully understand the value of air traffic instructional simulation because simulators play a pivotal role in training ATCSs in the FAA. ATCSs receive some form of simulator competency-based training to develop their job-related competencies so that they may adequately assist pilots (USNTSB, 2016b). Allowing poorly trained and inexperienced ATCSs to control aircraft poses a safety risk to the NAS. The FAA is responsible for the flying public's safety as they travel through the NAS to their destinations (United States Congress, 2006). The American public trusts that the FAA's ATCSs will competently manage their flights by providing accurate directions to aircraft pilots. Still, there is an alarming number of reported incidents where ATCSs' mistakes contributed to planes flying dangerously close to each other, narrowly evading catastrophic disasters (Mohammed Amin, 2015; USNTSB, 2016b). In 2018, 269 pilots reported being involved in a near midair collision (Bureau of Transportation Statistics [BTS], 2019b). There were also occasions when ATC errors resulted in fatalities. For example, on July 7, 2015, two planes (Cessna 150M, N3601V, and Lockheed Martin F-16CM US Air Force Jet) collided in the sky over Moncks Corner, South Carolina, killing the Cessna pilot and passengers (USNTSB, 2016a). The final investigation report prepared by the USNTSB (2016b) indicated that ATC judgment errors were the primary contributing factor. A simple mistake can put the lives of the flying public in jeopardy (Withers, 1986). For instance, if two Airbus A380s were to collide in midair, it could render devastating consequences for passengers, putting approximately 1000 passengers' lives at risk. Consequently, ATCSs must be trained to manage air traffic under conditions of similar size and complexity. However, the safety risks of training in a live setting are too high to mitigate. For example, a training mishap during live operations could result in aircraft collisions and ultimately result in passenger fatalities.

The relevance and significance of this study lie in the fact that the FAA must provide the highest level of training to its ATC personnel. Studies by Treiber (1994) and Maldonado (2009) indicated the significance of this study. Both pieces of research revealed that ATCSs have one of the most stressful jobs in the nation. In addition to the job stressors, many ATCSs are also inadequately trained and inexperienced (USNTSB, 2016b). The stressful nature of ATC, inexperience, and inadequate training are all factors that can increase the likelihood of human error (Maldonado, 2009; USNTSB, 2016b; Treiber, 1994). Therefore, it is the responsibility of ATCSs to mitigate aircraft accidents and other aviation mishaps (United States Congress, 2006). The USNTSB has attributed inadequate or inaccurate air traffic instruction, inexperience, and inattention as common reasons for aircraft incidents. A central report published by the USNTSB (2016b) offered safety recommendations to the FAA, indicating that ATCSs should receive academic and simulator competency-based training to develop their skills, situational awareness, and judgment so that they may adequately assist pilots. However, the value of using a scenario-based simulator to provide ATCSs with the experience to develop the ATC job-related competencies necessary to operate safely in the real air traffic environment is uncertain (Salden et al., 2006; Updegrove & Jafer, 2017). The specific problem under investigation was determining how well the ATCoach simulator equips CPC-IT with the ATC job-related competencies needed to perform air traffic operations (Dow, 2015; Gheorghiu, 2013). Simulation training has been suggested as an alternative approach to alleviate the safety problems of allowing students to practice ATC procedures in environments where human lives are at risk or physical equipment is unavailable (Hamel & Jategaonkar, 2017; Lateef, 2010; Lawson et al., 2018; Wilson & Rockstraw, 2012; Wolf, 2010).

The purpose of this qualitative exploratory case study was to understand how ATCSs at an air traffic facility in the southeastern region of the United States described their experiences with the ATCoach in developing job-related competencies. The following overarching research question reflects the purpose of this study: How do ATCSs at an air traffic facility in the southeastern region of the United States describe their experiences with the ATCoach in developing job-related competencies? The classifications of Bloom's taxonomy of the cognitive domain guided the following SRQs:

SRQ 1: What knowledge do ATCSs at a Southeastern United States air traffic facility learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 2: How do ATCSs at a Southeastern United States air traffic facility comprehend what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 3: How do ATCSs at a Southeastern United States air traffic facility apply what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 4: How do ATCSs at a Southeastern United States air traffic facility analyze what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 5: How do ATCSs at a Southeastern United States air traffic facility synthesize what they learn from their experiences with the ATCoach in developing job-related competencies?

SRQ 6: How do ATCSs at a Southeastern United States air traffic facility evaluate what they learn from their experiences with the ATCoach in developing job-related competencies?

A thorough review of past and current peer-reviewed articles relating to ATC training simulators was conducted. The scholarly works from experts were reviewed to gain a thorough understanding of (a) ATC simulation and its value and effectiveness, (b) current research on air traffic simulation, (c) how these studies were conducted, and (d) what were the key issues relating to simulation technology (Roberts, 2010). The earliest published account of an aviation-related simulator was found in an article published in the January 1919 edition of the *Popular Science Monthly* magazine. Crossman (1919) provided a detailed history of the purpose and application of a training simulation system used during World War I by the U.S. military to train their gunners to shoot accurately in flight. Simulation is used across industries such as the military, aviation, and healthcare for training, measuring, OT&E, engineering and design, and testing (Heath & Yoho, 2017; Riotto, 2021; Sawyer & Anderson, 2018; Volkaner et al., 2016). Many of the simulators used in the FAA to train ATCSs are high-fidelity systems that present learners with the same level of intensity they would expect to experience while managing day-to-day air traffic (Chua et al., 2015). Additionally, these high-fidelity simulation systems are also used in ATC as instruments of measurement for research and development (Dow, 2015; Li et al., 2012; Thomas et al., 2001) and to measure ATCSs' performance, efficiency, situational awareness, and task complexity (Thomas et al., 2001; Zhang, 2016).

A desirable form of high-fidelity simulation technology incorporates scenario capabilities. Coyne et al. (2017) found high-fidelity simulation with multiple scenario options and sufficient capabilities to be essential features that should be included when designing the simulation. Many scenario-based simulators are highly adaptable, allowing learners to find solutions for a wide range of problems (Coyne et al., 2017). For example, Koskela and Palukka (2011) stated that simulators could be used as strategic teaching tools by preparing students for their respective professions' complexities. Because of its realism and ability to be manipulated, scenario-based simulation has been known to expedite skills development, especially in circumstances where learning must take place in a realistic environment without the risks generally associated with dangerous or safety-centric jobs (Fothergill et al., 2009; Macchiarella & Meigs, 2008; Manning, 2000; Surakitbanharn, 2017).

Instructional simulation is particularly useful in situations that do not justify actively training in unsafe environments (Vahdatikhaki et al., 2019). Across industries, simulation allows organizations to provide formal training to the employees they "would otherwise have to obtain through on-the-job training" (Coyne et al., 2017, p. 4; Noe et al., 2014). According to Koskela and Palukka (2011), simulators can be used as strategic teaching tools by preparing students for the complexities in their respective professions. Since its inception in the instructional setting, simulation has been utilized by the military, medical, law enforcement, first responders, aviation, transportation, education, and research institutions (Onggo & Hill, 2014). The military uses instructional simulation to improve military personnel's combat readiness, judgment, and decision-making skills (Child, 1997; Rice, 2016; Riotto, 2021). The medical field is one of the prominent users of instructional simulators as it plays a vital role in the training of medical practitioners (Moran et al., 2018). It is also an ideal mode of evaluating the aptitude of medical students (Havyer et al., 2016). Law enforcement and first responders are trained in simulation systems to acquire critical skills. Law enforcement personnel are trained on the appropriate use of force, tactical judgment, driving maneuver, and proper use of firearms (Baggett, 2001; Nepelski, 2019). Like the Army and Marine Corps, law enforcement also uses driving simulators to train police officers on the proper operation of their patrol cars (Ferrarin, 2014; Nepelski, 2019). The fire department and Emergency Medical Services professionals also capitalize on the benefits of simulation. They, too, use driving simulators such as fire trucks and ambulance simulators. Simulation technology is widely used in the aviation industry. Simulation training is a well-established approach to training pilots and ATCS (Updegrove & Jafer, 2017). Simulators are used to test theoretical and practical knowledge about aviation communication and strategies on vectoring aircraft through the NAS (Antosko et al., 2014). To ensure sufficient qualified employees, the FAA utilizes simulation for education and training (FAA, 2020d).

Literature was also reviewed regarding ATC training simulation, ATC facilities and functions, air traffic operating domain, responsibilities of an ATCS, and ATC training. The FAA utilizes instructional simulation to teach ATCSs at all three professional development phases: IQT, FQT, and GRT. The FAA also uses instructional simulation to develop ATCSs at ARTCC, ATCT, and TRACON domains. During IQT, the first phase of technical training, the FAA use simulation to train newly hired ATCSs basic ATC skills such as "air traffic academics, part-task training, and skills-building" before reporting to their duty locations (Updegrove & Jafer, 2017, p. 2). During FQT, DEVs receive site-specific simulation training on the new equipment, procedures, surrounding airspace, and airport terrain at the new duty location (FAA, 2018d). ATCSs in the GRT phase are considered CPC-IT. Like the FQT, ATCSs in GRT also receive site-specific simulation training. However, the type of simulation training depends on the air traffic operating domain (FAA, 2020d).

Individuals interested in becoming an ATCS must first take a federal civil service test and are examined in a way that measures their ability to cope with mental stress for extended periods (Updegrove & Jafer, 2017). The immense level of stress endured by ATCSs, the severe nature of ATC work, and the zero margin for error all contribute to the need for robust air traffic training and development programs in the FAA (USNTSB, 2016b; Updegrove & Jafer, 2017). As such, becoming a permanently hired ATCS in the FAA is contingent on how well an individual performs in the IQT phase. Failing the IQT will result in immediate removal from the agency (Updegrove & Jafer, 2017). In contrast, successful completion of the IQT will generally result in the assignment of the ATCS to their permanent field facilities such as ATCT, ARTCC, or TRACON.

The ARTCC, ATCT, and TRACON domains differ significantly in operation and scope. Hence, the simulation technologies used to train ATCSs in these domains is distinguished from each other in terms of capabilities (Chua et al., 2015; FAA, 2020d; Prevot et al., 2014). Despite their differences, simulation training in each of the three domains integrates similar elements within their simulation training that embodies the essential fast-paced, high-risk scenario environment conducive to training ATCSs (Chhaya et al., 2018). EnRoute ATC training simulation is equipped with the capabilities necessary to adequately train ATCSs for ARTCC operation. For example, the EnRoute Automation Modernization, commonly known as ERAM, simulator emulates contemporary tools, processes, and functionality capabilities for managing EnRoute airborne traffic in a realistic setting (Prevot et al., 2014). Terminal ATC simulation was built to accommodate the TRACON or ATCT operations. TRACON simulations, such as the Standard Terminal Automation Replacement System (STARS) ATCoach, also closely mimic airborne traffic activities but within defined terminal airspace (FAA, 2020c). During FQT, DEVs or CPC-ITs assigned to facilities with STARS must first complete the ATCoach simulation before performing terminal radar ATC operations (FAA, 2020c). ATCT ATC training simulation differs from the ARTCC and TRACON. These terminal simulators teach ATCSs to manage aircraft during landing, while on the runway and taxiway, and during takeoff (FAA, 2018d, 2020c). According to Chua et al. (2015), some of the ATCT simulation systems used by the FAA are full-sized 3D replicas of real ATCTs. For instance, the high-fidelity tower simulation system at the Orlando and FAA Academy simulation facilities has a visual display paneled around the room to emulate the windows in an ATCT (Chua et al., 2015).

In addition, the reviewed literature uncovered relevant studies on linking skill enhancement to instructional simulation. The findings in the most relevant literature reviewed concluded a positive correlation between simulation technology and the enhancement of skills. Bauer (2005), for example, found that knowledge can be attributed to the physical characteristics of the pilot simulation by measuring the degree to which control of a simulated helicopter is enhanced throughout the instruction program. Likewise, McDermott (2005) found that pilots' mental and physical proficiencies are realistically duplicated when exposed to aviation instructional simulation. McDermott (2005) met this conclusion by comparing the effectiveness of a computer-based aviation training simulator and an FAA-approved Flight Training Device at maintaining pilots' proficiency. Despite overwhelming positive support for simulation in education, a positive correlation between instructional simulation and learning outcomes is not shared universally among researchers. Jentsch et al. (2011) found that simulation technology has long superseded aviation training. Other researchers support Jentsch et al.'s argument. Ennis (2009), for example, stated that simulation is not used to teach; instead, simulation aims to closely replicate or simulate the experience.

Lindenfeld (2016) and Nadler (1996) conducted studies to determine the effectiveness of simulation for ATC training. Lindenfeld (2016) conducted a study to determine the influence ATC simulation has on a student's perception of ATC competencies and the impact of exposing students to ATC simulators before committing to a job in ATC. The study found that students showed significant changes in perceptions of their level of ATC "knowledge, ATC skill, academic self-efficacy, student motivation, and deep learning" (p. 6) after completing an ATC simulation course. Lindenfeld (2016) researched to analyze and quantitatively measure how useful instructional ATC simulators would be if they were to be deployed at complex high-traffic airports. The study revealed that simulation-trained ATCSs completed their training in 50.1 days less than a traditionally-trained controller, indicating a 25% difference in day-to-certification (Nadler, 1996).

High-fidelity simulators and simulation systems are also used in ATC in several ways: as a training tool, an instrument of measurement, and for research and development (Dow, 2015; Li et al., 2012; Thomas et al., 2001). Simulators are used in ATC to measure ATCSs' performance, efficiency, situational awareness, and task complexity (Thomas et al., 2001; Zhang, 2016). Zhang (2016) conducted a study to understand if administering Situation Presence Assessment Method (SPAM) questions to ATC students during simulation impacted their workload and performance. Zhang (2016) measured the participants' situational awareness by "the accuracy of their answers and the latency of their responses to the SPAM questions" (p. 3). Van Eck et al. (2015) sought to understand if "exposure to visually intensive technologies" such as playing videogames affected ATC students' performance (p. 198). Van Eck et al. conducted a study to measure the students' ATC simulation task performance. Antosko et al. (2014) conducted a psychological readiness study to assess how human factors affect concentration and work performance in fully qualified ATCSs. This study used the LETVIS simulator to test the theoretical and practical knowledge of ATCSs in a 24-hour period. Participants' psychological readiness was determined by reaction time, "correct motor function, and the reaction to audio and visual stimuli" while also considering circadian rhythm (Antosko et al., 2014, p. 6).

Lastly, the reviewed literature revealed important information about ATC training by exploring learners' perceptions. Learners' perceptions are a critical and commonly used approach to understanding simulation's value at providing learning outcomes. For example, several studies were conducted on the perception of aviation workers, specifically, the perceptions of ATCSs and learning the impact of simulation-based learning (Coyne et al., 2017; Dow, 2015; Georgiou et al., 2017; Lindenfeld, 2016). Students perceived ATC simulators to be a beneficial mode of delivering air traffic training (Coyne et al., 2017). Researchers Coyne et al. (2017) came to this conclusion by investigating learners in Air Traffic Collegiate Training Initiative (AT-CTI) programs at six universities throughout the United States. Researcher Dow (2015) studied participants' perceptions to determine how simulations of varying degrees of fidelity in the ATC EnRoute domain should be categorized and employed. The research showed "that simulation fidelity was not well defined for EnRoute ATC" (Dow, 2015, p. 154).

Georgiou et al. (2017) studied student perceptions to ascertain ATC simulation's value at preparing ATCSs for their jobs. They concluded that students found the simulation laboratory helpful in developing their communication skills, coordination, and ability to work well in a team environment. Lindenfeld (2016) evaluated an aviation degree program to determine if participants perceived they lacked the skills, awareness, and ability to use job-specific ATC technology and techniques. Lindenfeld came to this conclusion by studying the influence ATC simulation has on students' perception of ATC "knowledge, ATC skill, academic self-efficacy, student motivation, and deep learning" (p. 6) to stay the course and pursue a career as an ATCS. Mante (2019) conducted an exploratory, descriptive non-randomized study to explore if newly licensed graduate nurses perceive their simulation experiences impacted their self-confidence. Though Mante (2019) found that simulation technology directly affected participants overall anxiety level, the researcher found sufficient evidence that suggests that students perceive "their simulation experiences and determined that there is a lack of sufficient evidence to suggest that simulation has an impact on enhancing self-confidence" (p. 14). Another study conducted by Hurst (2015) "to determine the perceptions of selected aspects of high-fidelity simulation" among sophomore and senior baccalaureate nursing students and the impact of their perceptions on students' satisfaction and self-confidence in learning (p. 7). Hurst (2015) found evidence that indicates participants perceive simulation training as an effective instructional method for enhancing nursing skills.

This research incorporated Benjamin Bloom's work to explore the extent to which ATCSs perceive simulation as a valuable instructional method for enhancing ATC competencies, including the six major levels of cognitive learning. I chose Bloom's taxonomy of the cognitive domain (Bloom et al., 1956) to guide the investigation into the perceived value of the scenario-based ATCoach instructional training scenario configurations used for training ATCSs. Benjamin Bloom is an author, scholar, researcher, and education psychologist known in the education community for his contributions to the area of learning and development, specifically, the creation of Bloom's taxonomy. Bloom et al.'s (1956) taxonomy is comprised of three domains known collectively as the learning domains of Bloom's taxonomy. The three domains are cognitive, affective, and psychomotor.

In the 1950s, Bloom chaired a committee of educational practitioners from around the United States who collaborated to create the original version of Bloom's taxonomy (Bloom et al., 1956). Krathwohl (2002) stated that the original taxonomy was created to "serve as a common language about learning goals to facilitate communication across persons, subject matter, and grade levels" (p. 212). Additionally, Bloom et al. (1956) wanted to create a system to help educational practitioners design curriculum and evaluate learners. The cognitive domain, or original taxonomy, is the knowledge-based domain that consists of six categories (or levels) of learning that focuses on learners' intellectual abilities: comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956). Bloom believed that learning should occur incrementally and hierarchically (from easy to difficult) through the six categories of learning.

Since its creation, the model has undergone several minor modifications by Bloom and his colleagues (e.g., Anderson & Krathwohl, 2001; Krathwohl, 2002; Krathwohl et al., 1964). In 1964, Bloom et al.'s committee made the first set of modifications to the taxonomy. Bloom et al. (1956) published the modified taxonomy, which focused on the educational objectives for the affective domain. The affective domain is the attitudinal-based domain that consists of five categories of learning: receiving, responding, valuing, organization, and characterization (Krathwohl, 2002). These five categories focus on how a learner develops in "attitudes, emotions, interests, motivation, self-efficacy, and values" (Schroeder & Cahoy, 2010, p. 129). Like the cognitive domain, the categories outlined in the affective domain are also presented in a hierarchical manner in terms of lowest feelings to the most complex (Krathwohl, 2002).

In 2001, 45 years after it was initially published, a revision of Bloom's taxonomy was introduced. This revision credited authors Simpson (1966) and Harrow (1972) for providing the building blocks for what is known today as the psychomotor domain (Anderson & Krathwohl, 2001). The psychomotor domain addresses learners' physical abilities, such as basic motor skills, coordination, physical movement, speech development, and reading (Earle, 1981). The categories outlined in this domain are reflex movements, basic fundamental movement, perceptual, physical activities, skilled, and body language (Harrow, 1972). The psychomotor domain consists of seven categories of behavior presented hierarchically from simple to complex: perception, set, guided response, mechanism, complex overt response, adaptation, and origination (Simpson, 1966).

In addition to incorporating psychomotor learning into Bloom's taxonomy, Anderson and Krathwohl (2001) revised the six categories of Bloom's taxonomy of cognitive domain by (a) classifying the nouns with verbs to reflect how they are used in objectives, (b) changed the position of the synthesis level of the original taxonomy with the evaluation, and (c) placed at the highest level of the revised cognitive domain (Krathwohl, 2002). For example, Anderson and Krathwohl (2001) replaced the noun "knowledge" with the verb "remember" on the basis that learners are "expected to recall and recognize knowledge" (p. 213). The categories of the revised version of the cognitive domain of Bloom's taxonomy include remember, understand, apply, analyze, evaluate, and create (Anderson & Krathwohl, 2001).

I opted to employ the original version of the cognitive domain of Bloom et al.'s (1956) taxonomy to frame the evaluation of the value of ATC simulation training. The primary justification for using Bloom's taxonomy as the conceptual framework for this study is that it is widely accepted in the education arena as a credible and reliable model for underpinning training-related research (Jang et al., 2019; Judy, 2018; Knoesel, 2017). The original taxonomy is comprised of six levels of classification (Bloom et al., 1956; Krathwohl, 2002). The levels of classification under the original cognitive domain are comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956). I used the sixth level of classification to examine ATCSs' perceptions of their simulation experience as it relates to their perceived development of ATC job-related competencies: knowledge, performance skills, judgment, critical thinking skills, and self-confidence. These six categories of the original cognitive domain have helped in analyzing the learning objectives, activities, and assessments to be applicable in different educational settings (Bloom et al., 1956; Krathwohl, 2002).

The cognitive domain is a framework centered on the art of perception, reasoning, understanding, and intellectual skills (Bloom et al., 1956). Bloom believed that all learning should be constructed in a manner that allows students to progress through six categories of learning incrementally and hierarchically. Specifically, learning should be constructed from easy to difficult in the following six major stages: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956). At the knowledge level of Bloom's taxonomy of the cognitive domain, students learn to remember through memorization and recollection of relevant facts, concepts, and answers, with limited understanding (Bloom et al., 1956). On Level 2, students learn to understand. In this step, learners start to decode information and learn that ATC manages airplanes from takeoff to landing (through three domains) and, if not adequately controlled, can lead to air traffic congestion, mishaps, and accidents (Bloom et al., 1956). The third level provides opportunities for learners to apply what they know (Bloom et al., 1956). On the fourth level, students learn to analyze by examining and breaking down information into elements, determining the interconnection and relationship between the components (Bloom et al., 1956).

Additionally, learners will identify evidence to support generalization regarding ATC knowledge and understanding (Bloom et al., 1956). After the knowledge, comprehension, application, and analysis stages, learners are ready for the synthesis level. Students at this level should truly understand ATC and differentiate and compare it to other things (Bloom et al., 1956). Evaluation is the sixth and highest level, where learners analyze, critique, and compare facts, concepts, and answers regarding ATC (Bloom et al., 1956).

I used Bloom's taxonomy to hear, in participants' own words, about their experiences with the ATCoach and to what extent they perceive it as a valuable instructional method for enhancing these competencies. I used the six levels of the original cognitive domain to create six SRQs to answer the overarching research question and ultimately accomplish the study's purpose. Each of the six SRQs is guided by one of the six levels of classifications of the original taxonomy Bloom's taxonomy. To get participant's perspectives, I asked several questions about their experiences with the simulator using the six levels of the original cognitive domain to help me better understand participants' learning process.

Researchers have also used Bloom's taxonomy to examine the effectiveness of virtual airport simulation training (DeCarlo, 2010). DeCarlo (2010), Parmar (2017), Judy (2018), and Rupasinghe et al. (2010) have all used Bloom's taxonomy of the cognitive domain to underpin their studies. DeCarlo (2010) conducted a mixed-method study, using Bloom's taxonomy, to examine the effectiveness of a virtual airport simulation training program for developing professional competencies of diverse adult learners at commercial airports in North America. Judy (2018) employed Bloom's taxonomy of the cognitive domain to investigate which training mode (simulation or live) was the best predictor of "overall pilot effectiveness as measured by the Naval Standard Score" (p. 2). Parmar (2017) applied Bloom's taxonomy in combination with the Structure of Observed Learning Outcomes taxonomy, to determine if students' experiences with the VR simulation training would facilitate "embodied cognition, higher telepresence, social presence, and engagement as compared to the control condition" (p. 43). Rupasinghe et al. (2010) used the six levels of classification under Bloom et al.'s (1956) original cognitive domain to organize AMT course modules' objectives and outcomes and evaluate the effectiveness of the AMT program's students.

As Bloom's taxonomy gained notoriety, several scholars have analyzed the model, rendering critical exposition on the strengths, weaknesses, and credibility (i.e., Adams, 2015;

Bertucio, 2017; Case, 2013; de Smale et al., 2016; Pikhart & Klimova, 2019; Stanny, 2016; Van Hoeij et al., 2004). Case (2013) stated that the taxonomy is harmful because education practitioners often distort the model while ignoring its limitations. Case (2013) also strongly argued against the scaffolding of the six categories. Similarly, Stanny (2016) argued that the model is a useful taxonomy; however, it is an incomplete method for expressing measurable student learning outcomes. Bertucio (2017) argued that teaching under hierarchical systems of learning, such as Bloom's taxonomy of educational objectives, comes with a set of consequences that manifest in the classroom. de Smale et al. (2016) argued that the model does not take into account the higher-order skills, like collaboration, problem-solving, and critical thinking, required for learners to engage in deep learning.

Bertucio (2017) also shared positive views on the impact of Bloom's taxonomy on the education community, stating that the model forms "a universal language among teachers" (p. 485) and provides standardization and clarification to educators of all socio-professional situations within academia. Adams (2015) shared Bertucio's positive sentiments in a written summarization of Bloom's taxonomy of the cognitive domain, adding two critical reasons why Bloom's taxonomy is a viable method of training or instructing others: improve instructor preparedness and promoting the use of learning objectives to facilitate higher-order thinking. As stated by Pikhart and Klimova (2019), Bloom's taxonomy is very useful in remedying the decline of information transfer and information accuracy prevalent in the epoch of technology.

This study used a qualitative exploratory case study design with data collection from a purposive sample of CPCs who participated in the ATCoach in 2019. By design, qualitative investigations allow researchers to reserve the chronological flow and show the causal relationship between events and consequences (Amaratunga et al., 2002). I used the qualitative exploratory case study approach outlined by Yin (2018) to explore ATCSs' perception with scenario-based simulation and the relationship between simulation training and the readiness of ATCS. Qualitative research approaches focus on participants' lived experiences by honoring the respective meanings, structures, and essence of their lives (Merriam & Tisdell, 2016; Patton, 2014). Case study design is the comprehensive investigation and analysis of a social unit such as a person, group, organization, community, or society (Cooley & Angell, 1930; Goode & Hatt, 1952; Merriam & Tisdell, 2016; Young & Schmid, 1966) aimed at obtaining tremendous insight into a contemporary social phenomenon (Merriam & Tisdell, 2016; Robson, 1993; Yin, 2018).

The participants were intentionally chosen to determine the extent to which they perceive simulation as a valuable instructional method for enhancing ATC job-related competencies. This method of selection is called a "typical sampling," a form of a purposive sampling strategy that represents the "average person, situation, or instance of the phenomenon of interest" (Merriam & Tisdell, 2016, p. 97). Purposive sampling allowed me to deliberately recruit participants from the 2019 database of ATCoach simulation learners who completed the ATCoach. With purposive sampling, I had set specific criteria for choosing the ATCSs to study (Merriam & Tisdell, 2016). For example, professional federal ATCSs are categorized as CPC-IT at the time of simulation training, thereby omitting all ATCSs working for private contractors, in non-training status, and above the age of 56.

For this study, I selected a TRACON ATC facility located in the southeastern part of the United States. The ATC facility selected is among many U.S. locations that use simulation technology to develop the ATC job-related knowledge, performance skills, judgment, critical thinking skills, and self-confidence needed to operate safely in the real air traffic environment (FAA, 2020d). The site selection criteria for this study were based on the following four factors:

(a) facility classification and level of operation, (b) site and training simulator lab access, (c) a researcher's geographical proximity to the research site, and (d) the training population. The primary reason for selecting the site was its classification and level of operation. I selected an FAA ATC facility to serve as the research site for data collection because the facility holds a Level 10 classification.

This study's research population consisted of ATCSs from different hiring sources, age ranges, gender, and prior education and training. According to the facility STTAR, the air traffic operation consists of 80 personnel, including CPCs, CPC-ITs, SATCS with CPC credentials, management, support staff, and training staff. As such, the ATC facility contained ATCSs whose participation helped answer the research question. The participants of this study needed to be ATCSs. I sought to understand the value of simulation from the participants' perspectives (Merriam & Tisdell, 2016). Consistent with this goal, the study participants needed to be ATCSs who partook and completed simulation training. This goal was accomplished by gathering responses from five ATCSs who experienced the ATCoach—about their views and experiences with the simulator and the extent simulation training impacted the ATC competencies they need to operate in a real air traffic environment. The sample consisted of both male and female participants between the ages of 21 and 65 years, representing all genders and age groups. The current study also included ATCSs from all hiring sources, professional backgrounds, and work experience selected to maximize diversity among responses (Rubin & Babbie, 2007). In this study, five participants from the CPC group were interviewed, with five participants representing approximately 10% of the CPC group. The average age of the participants was 37.4 years. The youngest participant was 29 years old, and the oldest was 43 years old. Three of the ATCSs were male, and two were female. Four of the participants self-identified as White (Caucasian) and one as Latino (Spanish). All five participants were active employees of the FAA located at the research facility in the Southeastern United States at the time of data collection.

This study complied with all national, statewide, and university ethical standards and regulations for researching human subjects. Compliance was accomplished by following each UWF's IRB guidelines, the two written requests for the ATCM, and the signed informed consent forms. I also notified participants of their right to quit without fear of reprisal. I also advised participants that their confidentiality will be honored by assigning numbers instead of their names (Creswell & Creswell, 2018). Also, I informed all participants of any benefits rendered for participating in the study. There are multiple data collection sources in qualitative research, including interviews, observations, and existing documents and records (Yin, 2018). The data collection strategy for this study is interviewing. I used interview data as the centerpiece of the study because interviewing is an insightful and compelling approach to qualitative inquiry (Patton, 2014). I designed a semistructured IPG to guide and focus the conversation and allow me to navigate the topic's scope (Gordon & Todd, 2009). The IPG comprised 23 questions framed by the six SRQs to collect data.

The data analysis approach was to organize participants' perceptions and accounts from interview responses into manageable themes to understand better and explain the findings. This approach was accomplished by following the data logging, data coding, and thematic analysis steps recommended by Attride-Stirling (2001). Upon completing the interview sessions, I transcribed the audio recordings on the Otter.ai (2021) speech-to-text transcription application and then saved the text into a word document. I then followed Merriam's (2007) recommendation to review the interview transcripts as often as necessary to get familiar with the participant's responses and ensure that the word documents' content accurately represented the audio transcripts' content. After familiarizing myself with the interview transcripts' content, I uploaded the word document version of the transcript to an online data coding platform called Atlas.ti (2021). After uploading the interview transcript into the Atlas.ti online platform, I started conducting the data coding process. I prescribed the recommended steps outlined in Creswell (2015) for conducting data coding. First, I selected one of the interview transcripts and performed an intensive line-by-line coding of the data using the participants' words to form the categories. The six SRQs dictated the categories in the data coding process. Finally, I used the identified codes from the collected data to conduct a thematic analysis. The thematic analysis process identifies patterns and meaning in a data set and then groups the data by similarities (Creswell, 2015). I conducted a thematic analysis by consistently exploring similarities and relationships in the data (Creswell, 2015).

This study used the six SRQs to determine how ATCSs describe their experiences with the ATCoach in developing job-related competencies. The SRQs were answered during the semistructured interviews by applying 23 questions on the IPG. Considering Bloom et al. (1956) indicated that on the cognitive domain’s knowledge level, students learn to remember through memorization and recollection of relevant facts, concepts, and answers, with limited understanding, SRQ 1 was crafted to assess if knowledge of basic information took place during simulation training, and what knowledge was learned from ATCSs’ experiences with the ATCoach simulation. This study answered SRQ 1 by analyzing participants’ responses to Questions 5 and 6 on the IPG: “what knowledge (or information) they perceive they had learned from their experience with the ATCoach” and “how their experiences with the ATCoach affected how they recall ATC information such as air traffic concepts and facts.” The findings suggest that ATCSs experienced the lowest level of Bloom’s taxonomy of the cognitive domain by acquiring ATC knowledge and memorizing facts related to the ATC profession (knowledge of LOAs, SOPs, FAA Order 7110.65, rules, procedures, or practices). However, the theme also indicates that gaining ATC knowledge does not necessarily occur during the ATCoach but instead during previous classroom learning or experience.

I created SRQ 2 to assess if comprehension of basic information occurred during the simulation training and how ATCSs comprehended information learned from their ATCoach experiences. This study answered SRQ 2 by analyzing participants' responses to Questions 7 and 8 on the IPG: "what aspects of the ATCoach helped in their understanding of the knowledge learned" and "how the ATCoach impacted ATCSs ability to understand and describe ATC-related facts such as aircraft classification, prescribed phraseology, equipment status information, and equipment capabilities." The finding suggests that the ATCoach increased ATCSs knowledge of site-specific airspace elements, such as their understanding of airspace components. The simulation training reinforced ATC procedures, allowing ATCS to understand the LOAs, traffic volume, traffic flow, site-specific airspace elements, how to receive and deliver airplanes, traffic patterns, chokepoints, frequencies, and the sectors. This study corresponds to Lindenfeld's (2016) findings that instructional simulators help participants develop their ATC competencies. ATCSs gained a better understanding of site-specific ATC elements during the ATCoach, which improved their overall ATC knowledge.

This study used SRQ 3 to explored ATCSs' perceptions of their simulation experience related to their perceived performance skills development during simulation training. I used Bloom's taxonomy's application level to determine if the application of information and skills occurred during simulation training: providing opportunities for ATCSs to apply what they know to practice directing and managing aircraft. This study answered SRQ 3 by analyzing participants' responses to Questions 9, 10, and 11 on the IPG: "how they felt the activities or scenarios used in the ATCoach relate to real-world situations and problems" and "how the knowledge, techniques, and rules learned from the ATCoach impacted how they perform ATC duties such as handoffs/pointouts, coordination." The findings indicate that ATCSs apply their air traffic knowledge in a meaningful way by following the SOPs, LOAs, and FAA Order JO 7110.65, and knowledge of their understanding of traffic volume and flow, site-specific airspace, traffic patterns, chokepoints to (a) coordinate air traffic activities during the simulation, (b) receive and deliver airplanes in the airspace, (c) separate the planes the most efficient and safe way, and (d) and extrapolate planning strategies. The findings also indicate that participants perceive simulation as a valuable instructional method for enhancing specific ATC knowledge and skills and are consistent with that of Bauer (2005), Georgiou et al. (2017), Lindenfeld (2016), and Van Eck et al. (2015). These researchers discovered a positive correlation between simulation training and learning. The findings are also consistent with Coyne et al. (2017), who found that students perceive ATC simulators as a beneficial mode of delivering air traffic training. The findings are also consistent with the argument that simulator training results in better performance (Bauer, 2005). The findings also support Van Eck et al.'s (2015) conclusion that having experience in the ATC training program significantly contributed to students' task performance.

I created SRQ 4 to determine if the ATCoach provided learners opportunities to use judgment and critical thinking to solve complex problems. SRQ 4 focused on the analysis level of Bloom's taxonomy of the cognitive domain and ATCSs' experiences with the ATCoach to develop judgment and critical thinking skills. This study answered SRQ 4 by analyzing participants' responses to Questions 12, 13, and 14 on the IPG. The questions asked were: "how

ATCSs' experience with the ATCoach affected their ability to interpret complex ATC maps such as sector maps, geographic maps, minimum vectoring altitudes (MVA)/obstruction maps, approach plates, … and what they've learned about managing air traffic from their ATCoach simulation experience, allowing them to make good decisions and good control judgment when providing ATC service, … how their experience with the ATCoach impacted how they scan an entire control environment, gather clues, and use those clues to draw conclusions." The findings suggest that ATCSs analyze what they learn by (a) identifying elements within the structure of the airspace, (b) recognizing patterns in traffic flow, (c) observing traffic volume, (d) predicting clutter, and (e) identifying hotspots.

Additionally, the theme suggests that the simulation training develops ATCSs' analytical thinking and understanding of the airspace structure, sector boundaries, and patterns. The findings also suggest that the simulation training experience facilitated situational awareness, judgment, and decision-making. Additionally, the study's findings align with the fourth level of Bloom's taxonomy (Bloom et al., 1956), showing that participants analyze by examining and breaking down ATC information into elements; determining the interconnection and relationship between the components; and making aircraft predictions relating to time and space.

I crafted SRQ 5 to determine if the simulation training provided opportunities for learners to use judgment to solve complex problems and how ATCSs synthesize what they learn from their experiences with the ATCoach. This study answered SRQ 5 by analyzing participants' responses to Questions 15, 16, 17, and 18 on the IPG. The questions asked were: "how ATCSs used the different information learned from their experience with the ATCoach to develop their own unique ways of completing ATC duties, … describe 'positive control,' … how the integration of information and skills learned from their experience with the ATCoach affect their ability to apply positive control judgment," and "describe a time when they had to actively and skillfully examine, break down, and incorporate information learned from their experience with the ATCoach to develop alternate ways of solving an ATC problem." The study found that ATCSs synthesize what they learn from their experiences with the ATCoach simulation by using their knowledge of complex airspace elements to develop operational planning strategies and formulate alternative plans, presuming their initial strategies were ineffective. The findings also suggest that ATCSs synthesize information through improvisation. By practicing ATC tasks during ATCoach, ATCSs can develop skills that enable them to improvise to maintain positive separation and positive control, provide proper sequencing, control traffic flow, and vectoring overflights.

Additionally, the findings are consistent with the synthesis level of Bloom et al.'s (1956) taxonomy of the cognitive domain in that participants combined, integrated, and summarized information and ideas in a meaningful way (Hancock & Algozzine, 2017). ATCSs differentiate and compare knowledge gathered from their experience with the ATCoach to develop solutions to ATC problems such as conflict resolution and aircraft separation. The study also suggests that ATCSs truly understand critical aspects of ATC, airspace components, and operational requirements. The findings are consistent with that of Georgiou et al. (2017), who concluded that participants' perception of ATC simulation-based training directly correlates to the development of their ability to solve complex problems. In their responses, participants displayed a thorough understanding of the fundamentals of an ATCS.

Additionally, participants also discussed different approaches they devised to accomplish complex ATC tasks. This study's findings support that of DeCarlo (2010), who suggested that simulation training framed by Bloom's taxonomy leads to higher-order thinking such as situational awareness, critical thinking, judgment, and decision-making. This study's findings also show that Bloom et al.'s (1956) taxonomy supports the higher-order skills and problem-solving required for learners to engage in deep learning. This study's findings contradict the findings of de Smale et al. (2016), who disputed the effectiveness of Bloom's taxonomy for framing simulation-related research on the premise that the model does not take into account the higher-order skills, like problem-solving and critical thinking.

This study utilized SRQ 6 to determine how ATCSs perceived the simulation training impacted their self-confidence to manage complex air traffic scenarios without instructor intervention to meet the minimum requirement for radar certification simulation. The SRQ 6 question focused on the evaluation level of Bloom's taxonomy and ATCSs' experiences with the ATCoach in developing judgment, critical thinking skills, and self-confidence. This study answered SRQ 6 by analyzing participants' responses to Questions 19, 20, 21, and 22 and the six classifications of Bloom's taxonomy to assess the evaluation process for certification. I crafted Question 23 on the IPG to capture ATCSs' perspectives on aspects of the simulation training they believe deserve additional attention. The findings suggest that participants evaluate what they learn in the ATCoach by completing the posttraining assessment by demonstrating abilities to undertake evaluation and to make good judgment in the decision-making process without instructor intervention. As explained by ATCS 2, the ATCoach simulation instructors and RPOs coach the ATCSs through the entire simulation training up until the point where they are evaluated.

The 23 questions on the IPG answered the overarching research question: How do ATCSs at an air traffic facility in the southeastern region of the United States describe their experiences with the ATCoach in developing job-related competencies? The IPG also revealed the additional themes. The first unanticipated theme suggests that, to some degree, the end-of-course evaluation inhibited “true learning” because CPC-ITs put more emphasis on passing the assessment than digesting the course content. The findings indicate that ATCSs believe that the evaluation process is counterproductive and should not be utilized when assessing ATCSs for certification. For these participants, perhaps the fear of termination or reassignment might be the source of their anxiety and objection to graded evaluations. The second unanticipated theme suggests that the physical fidelity of the ATCoach simulator has some limitations, and ATCSs perceive these limitations to have a negative impact on important aspects of their learning experience. The third unexpected theme that emerged suggests that most participants were dissatisfied with several aspects of the instruction, instructors, and the delivery process. Participants expressed specific concerns regarding the instructors’ and RPOs preparedness, specifically, the instructors and RPOs’ possession of current ATC knowledge and practices at the research site and the unrealistic demands placed on RPOs to pilot multiple simulated planes. Two participants directly mentioned that the instructor/RPOs’ support adversely affected participants learning experiences.

Conclusions

This study’s findings support the following conclusions: (a) previous classroom training may be required to acquire specific theoretical ATC knowledge (b) simulation training is a valuable instructional method for enhancing ATC professionals’ knowledge and skill levels, (c) simulation training is not a valuable method of enhancing ATCSs’ self-confidence, (d) simulation training is not a substitute for real-world training, and (e) fidelity of simulation influences training value and outcome.

This study's findings also support the first conclusion that ATCSs acquire theoretical ATC knowledge from previous classroom learning and experiences before partaking in the ATCoach and reinforced in the ATCoach. The five ATCSs suggested that they acquired ATC knowledge of operating procedures, rules, agreements, practices, and general site-specific information by attending the presimulation face-to-face instructor-led classroom instruction. The participants also inferred that they acquired ATC knowledge from previous experience. Through the ATCoach simulation, theoretical ATC knowledge is reinforced to better understand the operational expectations and develop skills pertaining to acquired theoretical ATC knowledge. ATCS 5 noted that before partaking in the ATCoach, ATCSs attend a 2-week face-to-face classroom instruction to learn the letters of agreement and other critical information required before learning in the simulation laboratory. ATCS 4 indicated that ATCSs must know maps, routes, speeds, altitude, and other theoretical ATC knowledge before going to the ATCoach.

This study's findings also support the second conclusion that the ATCoach is a valuable instructional method for enhancing ATC professionals' knowledge and skill levels to coordinate aircraft movement through the NAS safely. The objective of using simulation technology is to help ATC students develop their ATC job-related competencies (Alinier, 2013). Participants' responses support the reviewed literature in that ATCSs perceive simulation as a valuable instructional method for enhancing ATC job-related competencies: knowledge, performance skills, judgment, and critical thinking skills.

Participating in the ATCoach helps improve ATCSs practical ATC knowledge and skills required to function as an ATCS. ATCSs validate and enhance the theoretical ATC knowledge learned during previous classroom learning when their experience results in understanding and/or applying that knowledge in the lab (Rodriguez-Blanco, 2018). Data analysis also indicates that participants perceive simulation as a valuable instructional method for enhancing specific ATC knowledge and skills and is consistent with that of Bauer (2005), Georgiou et al. (2017), Lindenfeld (2016), and Van Eck et al. (2015). This conclusion is in alignment with Lateef's (2010) assertion that simulation improves the overall quality of training, assessment, design, testing, safety, and evaluation. This conclusion also confirms Ghosh's (2015) study that simulation improves learners' basic skills. Similarly, this conclusion is supported by Updegrove and Jafer's (2017) conclusion that simulation technology enhances basic ATC skills. The conclusion is also supported by Hustad et al.'s (2019) statement that simulation training increased participants' preparedness for the transition to practice.

The ATCoach includes scenarios that improve ATCSs' performance. Participating in the ATCoach helps improve ATCSs' practical ATC knowledge and skills required to function as an ATCS. ATCSs validate and enhance the theoretical ATC knowledge learned during previous classroom learning when their experiences result in understanding and/or applying that knowledge in the lab (Rodriguez-Blanco, 2018). This finding is supported by Hustad et al.'s (2019) study that simulation increases participants' preparedness for the transition to practice, thus, improving task performance. This conclusion is consistent with Bauer's (2005) study, which found that simulation training improves learner's performance in all three simulation configurations studied. This conclusion is also supported by Jentsch et al.'s (2011) inference that simulation helps in the enhancement of skills.

Secondly, the ATCoach includes scenarios that improve ATCSs' performance. By developing ATCSs' practical knowledge, the ATCoach simulation increases participants' preparedness for the transition to practice, thus, improving task performance (Hustad et al., 2019). The study's results demonstrated that training in the simulation results in better performance. Participants indicated that the ATCoach experience significantly contributed to their task performance: coordinating air traffic activities, receiving and delivering aircraft in the airspace, separating planes, and extrapolating planning strategies. The analyzed data were also consistent with the argument that simulator training results in better performance (Bauer, 2005). The data also support Van Eck et al.'s (2015) conclusion that having experience in the ATC training program significantly contributed to their task performance.

Thirdly, ATCSs' experiences with the ATCoach develop ATCSs judgment, critical thinking, and decision-making skills. The analysis of participants' responses indicates that the ATCoach improves participants' judgment, critical thinking, and decision-making skills. Participants noted that their ability to scan the airspace increases situational awareness, which influences decision-making and planning strategies, and plays a significant role in making positive control judgments and interpreting and prioritizing objectives. ATCSs experiences with the ATCoach helped them predict difficult situations, avoid conflicts, and provide positive separation, which requires higher-level thinking and critical thinking skills. Further, several participants suggested that the ATCoach helps develop their analytical thinking and understanding of the airspace structure, sector boundaries, and patterns. ATCS 5 stated that the ATCoach aided in the decision-making processes, such as deciding which areas of the airspace to avoid and routing planes in and out of the airspace. The themes also indicate that the simulation training positively impacts ATCSs' ability to make positive control judgments by familiarizing them, through practice, with traffic flow with specific airspace sectors. These findings are supported by DeCarlo's (2010) study that suggested simulation training framed by Bloom's taxonomy leads to higher-order thinking such as situational awareness, critical thinking, judgment, and decision-making.

This study's findings also support the third conclusion that the ATCoach is not a valuable method of enhancing ATCSs' self-confidence, although the study provided evidence to support the practicality of utilizing an instructional simulator to help participants enhance ATC knowledge, performance skills, judgment, and critical thinking skills. The data analysis proves that the ATCoach simulator is not a valuable tool for enhancing ATCSs' self-confidence. All five participants rejected the notion that the ATCoach is useful at improving ATCSs' self-confidence. ATCS 2 stated that the ATCoach simulation had no impact on the participant's self-confidence. Similarly, ATCS 4 stated that ATCSs must already possess self-confidence. Though self-confidence is a competency needed to operate safely in the NAS, the findings indicate that the simulation training did not develop ATCSs' self-confidence. Instead, it was developed from years of prior experiences working at other ATC facilities. This conclusion is supported by Hurst (2015), who concluded that simulation training is less impactful on the self-confidence of senior students and those with prior industry experience. This conclusion is also in line with the findings of Salden et al. (2006), who suggested that the effect of the level of simulation training on self-confidence skills is unclear.

This study's findings also support the fourth conclusion that the simulator's fidelity influences the value of simulation training. Data analysis shows two fundamental problems with the simulation training: (a) the simulated aircraft does not accurately mimic real aircraft behavior, and (b) the ATCS to RPOs command/responses latency in the simulator does not match the ATCS to pilot command/response latency in real-world operations. These simulation problems inhibit ATCSs from properly implementing some scenarios' situations, negatively affecting learners' educational experiences. The participants unanimously suggested that the ATCoach simulator does not accurately mimic real-world operations. ATCS 1 noted that the manner in which aircraft change speed, direction, and altitude is unrealistic. ATCS 3 stated, "the aircraft performance and characteristics in the ATCoach simulation are not accurate and true to life." This study's findings are supported by Coyne et al. (2017), who found the degree to which instructors' support learners and learners' stress levels during simulation training as influential factors in the study.

Additionally, the findings show a latency problem between when an ATCS gives the RPO a command and the RPO executes it. This latency issue adversely affected participants' learning experiences. The findings indicate that the physical attributes of the ATCoach simulator do not cause the latency issue. Instead, it is caused by overextending the RPO's mental and functional capacity. ATCS 2, for example, stated there are RPOs at the research site serving as seven simulated pilots. The participants believe that the 1:7 ratio is overworking the RPOs, resulting in errors and delayed responses. Ideally, the ATCS orally instructs the RPO on what to do. The RPO then acknowledges those instructions and physically changes the simulated aircraft's behavior (maintain or change heading, speed, altitude, and spatial relationships) on the TCW display by entering commands into the ATCoach application. Participants believe that the fidelity problems are caused in part by RPOs' errors, specifically, data entry errors made by the training staff when entering commands. Hence, generating unrealistic ATC conditions. The participants' feedback also indicates that learners are satisfied with the learning experiences when the simulation works as design. Participants' feedback suggests that the agency could take simple steps to enhance the simulation's fidelity by allocating adequate human resources to pilot the simulated planes. Additionally, software programming can eliminate spontaneous aircraft behavior, allowing aircraft to naturally change heading, speed, altitude, and spatial relationships. These changes can improve the learning outcomes for ATCSs training on the ATCoach simulator. This finding is supported by Coyne et al. (2017), who found the degree to which instructors support learners during simulation training as an influential factor in the study. This study's finding is also supported by Bauer's (2005) findings that knowledge can be attributed to the simulator's physical characteristics.

This study's findings also support the fifth conclusion that the ATCoach is not a substitute for real-world training. The analysis of interview data shows that simulation training is just a phase in the overall training. Participants learn a particular set of knowledge in the classroom, and that knowledge coupled with previous skills and experience is reinforced during simulation training. Upon completing simulation training, ATCSs' skills are strengthened further by participating in additional training in a live setting. Simulation is appropriately used in this regard since it serves as an alternative approach to alleviate the safety risks of allowing ATCSs to practice ATC procedures in environments where human lives are at risk (Hamel & Jategaonkar, 2017; Lateef, 2010; Lawson et al., 2018; Wilson & Rockstraw, 2012; Wolf, 2010). Simulation training is not a substitute for learning in a live environment; instead, it is part of a scaffold training process that builds upon previous knowledge and skills. As stated by ATCS 3, "they show you the basics, and then you get to go upstairs and learn in real life." ATCS 1 stated that a trainee could learn the same things without the ATCoach, stating, "let's say it wasn't there and you just went directly to the floor, you're going to learn the same stuff." This sentiment supports Judy's (2018) conclusion that simulators complement live training and should not be used to substitute said training.

Interpretation of Findings

This section explains and breaks down the study's findings and conclusions. Additionally, this section deciphers and explains the information through the lens of the study's purpose and the reviewed literature. The data analyzed in this study supports the purpose of this study to understand how ATCSs at an air traffic facility in the southeastern region of the United States describe their experiences with the ATCoach in developing job-related competencies.

The first interpretation suggests that the ATCoach develops three of the four ATC job-related competencies: knowledge, performance skills, and critical thinking skills. Many of this study's findings support those of previous studies on the value of simulation training in several aspects of ATC and different contexts (Bauer, 2005; Coyne et al., 2017; Georgiou et al., 2017; Hustad et al., 2019; Lindenfeld, 2016; Van Eck et al., 2015). Bauer (2005), Georgiou et al. (2017), Lindenfeld (2016), and Van Eck et al. (2015) found that simulation is a valuable instructional method for enhancing specific ATC knowledge and skills, which is consistent with this study. Georgiou et al. (2017) found that simulation helps develop their communication skills, coordination, and ability to solve complex problems. Similar to Lindenfeld's (2016) findings, this study successfully showed that participants believe the simulation training is beneficial to ATCSs working in the TRACON terminal environment. Lindenfeld (2016) found that students showed significant changes in their perception of ATC knowledge and skill after completing ATC simulation training.

This study has also identified how the simulation might negatively affect developing the three ATC job-related competencies, knowledge, performance skills, and critical thinking skills. This study's findings suggest that decision makers can alleviate problems by allocating adequate training staff to satisfy the training needs. This study found that participants perceive instructors play a critical part in their learning outcomes. Additionally, the study found that instructors' knowledge and preparedness can lead to student frustration and loss of confidence, ultimately influencing learning outcomes. This study's findings are supported by Coyne et al.'s (2017).

Coyne et al. (2017) found that instructors' role and their support during simulation training is significant because it directly affects learners' stress levels and influences learning outcomes. The instructors at the research site can mitigate the following problems to increase ATCSs' learners' confidence and learning outcomes; incorrect speed, direction, and altitude caused by improper data entry, and trainees' inability to communicate with RPOs at a normal rate because all simulated aircraft is piloted by one individual. As mentioned by ATCS 2, "I can't speak as fast as I would in a real-life situation because I'm not talking to individual people. I'm giving the same person three different commands back-to-back." These problems can teach trainees bad habits that could be difficult to unlearn. Additionally, to decrease learners' frustration due to ATCSs' firm belief that instructors and RPOs' time away from controlling life traffic and not ever managing traffic at the research site have resulted in them operating from outdated information. To avoid learners' frustration with the instructor and increase the learning experience, instructors and RPOs could simply participate in some refresher training by going to the floor and observing CPCs work live traffic to ensure they are familiar with current practices.

It is evident from participants' responses that they believe the ATCoach does not enhance self-confidence. The participants unanimously rejected the notion that the ATCoach helps ATCSs self-confidence. This study's findings align with Mante (2019), who found that students believe that their simulation experiences had no impact on improving their self-confidence. In this study, the source of this strong belief may be that the research site generally only accepts applicants with previous ATC experience (SME 2). All five participants worked previously at other FAA facilities and inferred that experience was the source of their self-confidence. It can be argued that a newly hired ATCS with no prior ATC experience may find that the simulation training improves their self-confidence. This very assertion was made by ATCS 1, who indicated that the ATCoach might increase the confidence of new ATCSs by the very least, making them unafraid. This assertion was confirmed by SME 3, a newly hired ATCS assigned to a different facility, who completed the ATCoach in February of 2021. SME 3 stated that the ATCoach developed her knowledge, performance skills, judgment, critical thinking skills, and self-confidence. This finding is supported by Hurst (2015), who concluded that simulation training is less impactful on the self-confidence of senior students and those with prior industry experience.

The second interpretation of this study is that Bloom's taxonomy of the cognitive domain is a viable conceptual framework for evaluating simulation-related research. Several researchers have used Bloom's to underpin many assessments that learners undergo, and it described how mastery is developed in students in many subject areas (DeCarlo, 2010; Judy, 2018; Parmar, 2017). Several researchers also rejected Bloom's taxonomy's usefulness (i.e., Bertucio, 2017; Case, 2013; de Smale et al., 2016). de Smale et al. (2016) disputed the effectiveness of Bloom's taxonomy for framing simulation-related research. de Smale et al. (2016) found that the theory does not consider the higher-order skills, like collaboration, problem-solving, and critical thinking, required for learners to engage in deep learning. However, this study found Bloom's taxonomy of the cognitive domain to be a valuable model for underpinning simulation research and contradicts the findings of de Smale et al. (2016) that the model does not consider the higher-order skills, like problem-solving and critical thinking. While there are apparent benefits to instructional simulators, the research carried out thus far on the aviation industry has significantly underrepresented a critical component of the aviation community—the ATC function (Lee, 2017). For example, there is no adequate analysis of the value or effectiveness of ATC simulation on ATC readiness (Dow, 2015; Mercer, 2015). Bloom's taxonomy is an appropriate lens through which to evaluate how ATCSs perceive simulation training on developing ATC competencies. The definitions outlined in the constructs (knowledge, comprehension, application, analysis, synthesis, and evaluation) of Bloom's taxonomy of the cognitive domain were beneficial in determining if the six levels of the cognitive domain took place during simulation training. Also, while researchers such as Stanny (2016) argued that the collections of verbs compiled in the taxonomy are misaligned with the taxonomy's six levels, I had a contrasting experience when analyzing the findings. I used Bloom's action verbs to identify themes and present the findings in an organized way.

The third interpretation suggests that instructor support and simulation technology are both essential components in developing complex ATC skills. This current study disagrees in part with Jentsch et al.'s (2011) assertion that simulation is a tool that helps strengthen skills and, therefore, does not guarantee learning outcomes. This study found that simulation training can successfully achieve positive educational outcomes when used with particular applications in mind. For example, this study found that the simulator's learning tasks have direct applications in controlling live traffic. Meaning, ATCSs use what they learn during the ATCoach to manage simulated air traffic during evaluation and live air traffic after completing the training. Additionally, this study's findings are in line with Coyne et al.'s (2017) research which found that simulation training can render positive learning outcomes when there is adequate instructor support. However, this study's findings show that there are some contingencies that directly affect learning outcomes. The simulation must closely mimic airborne attributes and activities of the natural environment, and there must be adequate instructor support to ensure learning occurs. Additionally, the simulation training program's instructional design can also be a contributing factor to how well learners perform (Caro, 1971).

Implications

This study explored ATCSs' perceptions of the ATCoach by exploring their ATC job-related competencies needed to perform safe operations in the real air traffic environment. This section provides reasons why this study contributes to the scholarly research in ATC training and simulation training. I explain the implication of this qualitative exploratory case study design as it relates to theory, practice, policy, and unexpected study outcomes.

Implications for Theory

There is a small body of previous research that utilized Bloom's taxonomy of the cognitive domain (Bloom et al., 1956) as a framework to explore students' performance in a simulated learning environment through the transformation of experience (de Smale et al., 2016; Jang et al., 2019; Knoesel, 2017). I found two studies that used Bloom's taxonomy to underpin studies on the aviation industry (i.e., Judy, 2018; Rupasinghe et al., 2010). I also found a single study that used Bloom's taxonomy of the cognitive domain to investigate ATC training (Mercer, 2015). In addition, I found no relevant research literature that used Bloom's taxonomy of the cognitive domain to evaluate ATC instructional simulators or simulation systems. This study adds to scholarly research by filling a gap. Researching the value of instructional simulators broadens the scholarly literature on Bloom's taxonomy. Based on the reviewed literature, this study adds to the current literature in the following ways. This appears to be the first study to apply Bloom's taxonomy of the cognitive domain (Bloom et al., 1956) as a conceptual framework for evaluating ATC training in a terminal domain.

This study supports the concept that learning is constructed to allow students to progress through six categories of learning incrementally and hierarchically. The findings reinforced the argument that Bloom's taxonomy provides theoretical scaffolds (building upon previous knowledge) for constructing the progression of simulation experiences that are most helpful in developing the competencies of ATCSs (Mulcare & Shwedel, 2017). Through the lens of the six classifications of Bloom's taxonomy of the cognitive domain, this study found that ATCSs develop job-related competencies by progressing through the training from lowest (acquiring knowledge) to highest (demonstrating their mastery, proficiency, and fluency) levels of complexity. This study also supports DeCarlo's (2010) argument that the simulation was an effective mode of delivering initial airport operations training. It is unclear if the training staff used Bloom's taxonomy to frame the course curriculum, viewed through the lens of the taxonomy; this study found that the model supports the higher-order skills and facilitates judgment, problem-solving, decision-making, and planning strategies for learners to engage in deep learning. This study also adds to a level of certainty to previous research, such as Salden et al. (2006), who indicated that the effect of the level of simulation training on critical thinking skills is unclear. However, this study found that ATCSs experiences with the ATCoach helped them predict difficult situations, avoid conflicts, and provide positive separation, hence, requiring higher-level thinking and critical thinking skills.

Case (2013) refuted the belief that Bloom's taxonomy provides theoretical scaffolding. Case strongly argued against the scaffolding of the six categories, indicating that though accomplishing the lower-levels subsumed tasks before achieving higher levels of complex assignments is helpful, it is otherwise unnecessary to promote higher-level thinking. This study's findings also contradict de Smale et al. (2016). de Smale et al. disputed that Bloom's taxonomy's effectiveness for framing simulation-related research on the premise that the theory does not consider the higher-order skills, like problem-solving and critical thinking. This study's findings also contradict de Smale et al.'s (2016) statement that Bloom's taxonomy is not useful for framing simulation-related research. This study's finding contradicts de Smale et al.'s (2016) argument the taxonomy does not consider higher-order skills, like problem-solving and critical thinking, required for learners to engage in deep learning. Lastly, this study's findings also do not support Hustad et al.'s (2019) findings that self-confidence increases after participating in simulation-based training.

This study's findings will contribute to scholarly research and literature on air traffic education and simulation training in the following ways. After a comprehensive review of existing literature on the FAA's incorporation of computer-generated, scenario-based simulation into ATC training (e.g., Bauer, 2005; Cox, 2010; Lindenfeld, 2016; McDermott, 2005; Van Eck et al., 2015; Zhang, 2016), I was unable to identify a single study on the value or effectiveness of ATC simulation technology in the development of ATCSs' job-related competencies in a TRACON environment. I found one study (Dow, 2015) that provided insight into how to use ATC simulation to train ATCSs. The difference is, Dow's (2015) study addressed CPC-ITs working at the EnRoute domain, whereas this study focused on the terminal domain. This study's findings are significant because it is the first research to investigate the development of job-related competencies via simulation training for the TRACON application. Previous research on ATC simulation training has been limited to using basic simulators to evaluate basic ATC skills (Updegrove & Jafer, 2017). This current study also differs from previous research in the following way. This study focuses on multiple higher-order skills and thinking strategies, like judgment, problem-solving, decision-making, situational awareness, critical thinking, and judgment necessary to apply air traffic procedures safely and efficiently. This study is consistent with DeCarlo's (2010) study that suggested simulation training framed by Bloom's taxonomy leads to higher-order thinking such as situational awareness, critical thinking, judgment, and decision-making.

This study's findings contribute to scholarly research and literature by moving the conversation forward on the types and uniqueness of the knowledge and skills ATCSs develop during the simulation training. There is a small body of previous research that focused on FAA simulation training (Updegrove & Jafer, 2017). Updegrove and Jafer (2017) investigated the ATC simulation training capacity to develop basic ATC skills such as "air traffic academics, part-task training, and skills-building" at the IQT phase of training. This current study defers from Updegrove and Jafer (2017) in that it explored the value simulation training to develop complex practical ATC job-related competencies of CPC-ITs at the FQT training phase. This study's findings point to a set of site-specific capabilities that may distinguish ATCSs working in a terminal TRACON environment from that of others assigned to facilities in other ATC domains.

When explicitly investigating existing literature related to the effective measures of simulators and simulation systems such as realism, fidelity, transfer of training, transfer of knowledge, the accuracy of representation, and knowledge acquisition as well as their application in ATC training (Dow, 2015; Fothergill et al., 2009; Macchiarella & Meigs, 2008; Surakitbanharn, 2017), this research adds to previous literature on the transfer of training in instructional simulation and ATC training. More specifically, the findings provide valuable insight into the current research about the value of ATC scenario-based simulation training in the TRACON environment. The findings of this study also narrow the gap identified in previous literature (Dow, 2015) by showing how "different levels of simulation fidelity impact training specific knowledge, skills, and abilities" (p. 23). This research also provides insight into the value and effectiveness of simulators used in ATC to facilitate training and proficiency (Mercer, 2015).

Implications for Practice

Below are the practical implications and benefits of this current study in improving ATC practice. First, this study's findings support implementing instructors/RPOs reoccurring training as a critical approach for enhancing training staff preparation and students' learning experiences. Learners have voiced concerns about receiving outdated content during simulation training. This study identified an overwhelming need for competent and qualified instructors/RPOs to facilitate learners' transfer of current information. Continuing emphasis should be placed on training the training staff to improve their knowledge, skills, attitudes, and experiences to effectively prepare them to fulfill their instructor/RPO duties. Although classroom learning is a useful and meaningful mode of refining knowledge, ATCS 3 suggested that instructors and RPOs could stay current by observing CPC's work live traffic to ensure they are familiar with current practices.

This study's findings suggest that simulation fidelity should accurately represent real-life when developing knowledge to facilitate higher-level thinking and complex skills. Decision makers at the research site can significantly improve students' educational experiences and learning outcomes by fixing issues surrounding scenario-driven aircraft's erratic and unrealistic behavior (rapid shift in speed, direction, and altitude). Correcting this problem may require reengineering the simulation's application software. However, rectifying the aircraft behavior would benefit the simulation training because the simulation would then accurately replicate the real air traffic environment. Also, closely simulating the real-world experience can even justify using the ATCoach to evaluate learners towards their ATC radar certification.

This research contributes to ATC education and training practices in training programs that utilize simulation technology to develop knowledge and skills. Integrating strong evidence on the value of ATC simulation training helps education practitioners in the FAA and other interested parties to employ the standard and process in this study in simulation training programs in different contexts (Jentsch et al., 2011; Lee, 2017). Since simulation is widely used in many aspects of ATC training, this study's findings help close the ATC education gap. The FAA leaders can incorporate simulated training on a broader scale to increase learners' understanding of core ATC content while enhancing learners' experience and fostering meaningful development. This study's findings could also be generalized to the larger air traffic population in all three ATC domains (Blaikie, 2009; Creswell, 2015). The study's findings could also improve ATCS training's efficacy by decreasing the time it takes to certify ATCSs.

Implications for Policy and Decision-Making

Decision makers can use the study's findings to shape policy and influence decision-making in the following ways. First, FAA policymakers can use this study's findings to enhance the evaluation process for measuring ATCSs performance upon completing simulation training. The FAA is actively and strategically taking action to improve the operational readiness of ATCSs to ensure they have the competencies necessary to apply air traffic procedures safely and efficiently. Ensuring that learners have the technical aptitude to be successful ATCSs is contingent on measuring and evaluating how well an individual performs. This study's findings can inform decision makers on how to improve the performance assessment measurement tool used to examine ATC students' readiness. Improving how ATCSs readiness is measured and assessed can help the FAA training deficiencies and performance gaps.

The FAA decision makers can use this study's findings to extend the scope of current simulation training to include teamwork. Students believe simulation training helps develop their communication skills, coordination, and the ability to work well in a team environment (Georgiou et al., 2017). This current study contradicts Georgiou et al.'s (2017) conclusion that simulation training is helpful in developing learners' ability to work well in a team environment. This study found that the current simulation training does not incorporate activities critical to fostering teamwork. ATCS 3 proposed implementing simulation-related training sessions with multiple trainees on the premise that ATCSs learn better when they go through the classes with someone else. From an ATC simulation training perspective, the FAA should include teamwork skill development activities in training to enhance ATCS-to-ATCS communication. Such changes to current simulation training programs could develop agile and adaptive communications skills needed to assist pilots with navigating through the NAS safely.

The ATC is a complex contemporary social phenomenon with ever-growing human, environmental, and ecological risks (Dabney & Brent, 1993; Fultz, 2015; Learmount, 2019), which requires an adaptive workforce of highly trained professionals. The FAA decision makers can use this study's findings to address the continuing need for a highly adaptive workforce of CPCs with the critical ATC job-related competencies and understanding of specific air traffic procedures (USNTSB, 2016b). Specifically, this study's findings could be used to inform decisions on the development of policies and procedures to improve end of simulation training assessment when evaluating high-level job-related competencies. The FAA policy makers should use this study's findings to draft policies that establish the acceptable fidelity level for simulation training evaluation at the FQT stage. Lastly, FAA decision makers could use this study's findings to support individualized training efforts that support task-specific training to target individuals' identified weaknesses.

Implications for Unexpected Study Outcomes

There were two surprising revelations from this study's findings. First, the most surprising results were that the ATCoach simulation was not accurate to life. I went into this study with the preconceived notion that the simulator accurately replicated the real ATC environment. I expected the scenarios to simulate aircraft that behaved similarly to real planes, but that was not the case. Instead, participants reported that the airplanes unrealistically change heading, speed, altitude, and spatial relationships. For additional context, the FAA and DOD, in a joint venture, allocated a significant amount of time and money to OT&E efforts to improve the system's functionality. I participated in several of the OT&E efforts and therefore imposed assumptions and worldviews into the study. I was surprised to find that the aircraft performance in such an expensive high-fidelity state-of-the-art platform would have such functionality flaws.

The second surprising findings were the overwhelming opposition and disdain for the evaluation process. Without inquest, all five participants eagerly offered their strong disagreement with the training assessment's pass/fail aspect. Understandably, learners will object to testing because some students experience test anxiety. In this case, there was an added level of anxiety in that failing the evaluation process would result in termination or reassignment. Another surprising element was that participants actively placed their focus on passing the evaluation instead of learning the material. This finding is supported by Dahlstrom et al. (2017), who argued that that simulation systems encourage learners to take shortcuts when participating in simulation-based learning.

Suggestions for Future Research

This study has the potential to inspire future investigation in the following ways. First, future researchers should evaluate the entire ATC training program that takes a learner from CPC-IT status to CPC. The current study's findings indicate that trainees must go through the following stages to attain CPC status. First, participate in instructor-led classroom training. Second, upon completion of the classroom training, trainees must participate in simulation training. Lastly, after completing the simulation training, learners move to the real air traffic environment to complete their training. Future researchers could interview participants on the experiences after they had completed all three phases or after each stage. Ideally, it would make sense to gather data in real-time. However, gaining access to the research site and participants for a prolonged time can be challenging for collecting qualitative data. It can take up to 3 years for an ATCS to go through the entire training at a new facility (SME 1; Updegrove & Jafer, 2017).

Second, this current study's findings suggest that prior ATC experience affects ATCSs' perception of the simulation training. Since all five participants worked previously at another ATC facility before transferring to the research site, I recommend repeating the investigation with DEVs. DEV is a status given to individual ATCSs when they graduate from the Mike Monroney Aeronautical Center until they are certified at their first duty location (Robello, 2017). This study focused on simulation training for developing ATC job-related competencies from the perspective of CPC-ITs but omitted its impacts on DEVs. Similarly, future studies on the value of ATC simulation for conducting reoccurring CPC training (GRT phase) can also add to current literature on ATC training. However, the matter of previous experiences may also apply to CPCs depending on their years of experience. Repeating this study with DEVs could support or negate this study's findings or provide insight into the role simulation play in enhancing self-confidence and other ATC job-related competencies needed to perform safe operations in the NAS.

Third, this study focused on the value of simulation training at a TRACON ATC facility in the terminal domain. Future researchers should repeat this entire study by exploring how ATCSs at an ATCT describe their experiences with the simulation in developing job-related competencies. ATCT simulators differ significantly in capability and function from that of TRACONs, and laboratory facilities generally have visual displays paneled around the room to emulate the windows in an ATCT. There are two possible research sites for data collection, the ATCT in Orlando, FL, and the FAA Academy in Oklahoma City, OK (Chua et al., 2015).

This research could also be repeated at a TRACON or ATCT using quantitative measures or a mixed-method approach. Future researchers could also repeat this study by selecting multiple ATC facilities within the same domain. A similar study completed and multiple TRACON facilities in the same geographical region could add to the generalizability of ATC education results. Simulation technology is an essential and growing component of ATC training (Mercer, 2015). Future research in air traffic simulation will provide valuable information on the value and effectiveness of instructional simulation.

Limitations and Reflexivity

This section provides some limitations identified during this study due to research design issues. I also provide some self-reflective comments about my experiences during this investigation.

Limitations

This study explored the perceptions of CPC-ITs at the research site to determine if they believe the ATCoach was a valuable method of developing ATC competencies. I believe that participants with simulation experience and at least 6 months of experience in the live ATC environment would provide the most reliable data. The reason for this assumption was that the participants would have had the opportunity to apply their knowledge and skills and therefore be better positioned to offer their perspective from a position of real experience. However, during data collection, only two of the five participants had obtained CPC status and moved on to working live traffic, and three were still in CPC-IT status. The reason the three participants were still in CPC-IT status was mainly due to the emergence of the COVID-19 virus. Nevertheless, I believe that participants' lack of experience in the real ATC environment at the research site could have prevented the collection of rich data, hence, limiting the data quality (Roberts, 2010).

The student population (CPC-ITs) at the research site differs from that of traditional learning institutions. CPC-ITs are ATCSs that transfer in from another FAA facility, and the size of the student body is contingent on the number of individuals hired into the facility. I was able to meet the minimum recommended sample size of five to twenty-five participants. Having five CPC-ITs available for data collection is rare at the research site (Creswell, 2013). The situation restricted the sample size of this study to five participants. This small sample may have limited the research by rendering inaccurate or false perceptions about the value of simulation training (Creswell & Creswell, 2018). Inconsistencies in participants' perceptions can "make it difficult to generalize the findings" (Foeckler, 2019, p. 66) to the larger air traffic population (Blaikie, 2009; Creswell, 2015).

Reflectivity

When deciding on the most important topic for me to study, I relied on my 22 years of industry experience working as an ATC systems specialist in the public sector. Conceivably I have always been subconsciously and subtly seduced by the careers and anecdotes of ATCSs.

Even though I have been entrenched in the FAA's ATO TechOps section my entire career and have wrestled with several technical training research ideas, this study ultimately landed on a topic that encroached on participants' lives to exploit their experiences and conjure their voices. Perhaps this is an endorsement of how my philosophical assumptions and worldviews as the researcher influence my choice of a research topic and my dissertation journey.

In this study, I collected data by conducting interviews. As an "insider researcher" working at the research site, I shared common knowledge and understanding of the FAA and the research site with the participants, which manifested in acquaintanceship and a sense of rapport. The connection with the participants has resulted in the collection of rich data. As a researcher, my insider status and shared epistemology with the participants made me feel part of the ATC world. I exchanged stories with the participants about ATC practices, the ATCoach, and had light conversations about work and training experiences and preferences. Although I maintained my position as the researcher, unrelenting in my efforts to answer the research question, I realized that I was a member of the ATO. Though not an ATCS, I understood that I am an employee of the FAA and, in some small way, am part of the team. As such, I reflected on the fact that I shared a similar professional identity with the interviewees, which gave me a sense of belonging and camaraderie. In retrospect, I recognize that maybe the participants are likely to be forthcoming and offer honest perspectives that are important to the meaningful findings of this study if researchers from outside the organization were interviewing them. As an insider, gaining access to the research site, the participants, the ATCM, and documents were relatively easy to accomplish; nevertheless, I also had to acknowledge that the participants may be reluctant to honestly respond if they fear their responses could be detrimental to their professional relationships. However, if a researcher from a different organization was interviewing participants, they may feel more comfortable accepting all their responses to the interview questions as true because outside researchers may not have insider knowledge or awareness of someone working for the FAA, working at the research site, or familiar with ATC practices.

As an individual, researcher, and scholar, I reflect on the perils of self-doubt regarding my academic preparedness and cognitive ability to embark on such a grand undertaking as crafting a manuscript from inception to completion. Much anxiety came from the possible methodological limitations (small sample size) and my efforts to accurately interpret participants' responses without tarnishing the study's findings or compromising the research altogether. Anxieties and self-doubt became more prominent as I became better informed. Fortunately, there was a point of transformation where self-doubt became less of a risk. I credit the renewed confidence in my ability to interpret and assign meaning to participants' experiences to my application of tested scholarly processes (e.g., those proposed by Creswell & Creswell, 2018; Merriam & Tisdell; Yin, 2018, 2016). In the end, the analysis process and the challenges of self-doubt helped me better understand the realities of the dissertation writing experience.

This study has given me a renewed appreciation for the tedious nature of qualitative research. The first undertaking is the large amount of data collected and the longitudinal effects of the case study design (Anderson, 2010; Creswell & Creswell, 2018). I underestimated the amount of data interviews generated and the time required to complete the data analysis. Upon completing the data collection process, I informed the dissertation committee members that the data analysis would take 30 days. In reality, the data analysis process took 6 months to complete.

The second undertaking involved replacing a participant before data collection began. After agreeing to participate, one of the individuals was unresponsive to phone calls and text messages. Consequently, I revisited the reserve list and selected a new participant. Fortunately, replacing the participant happened before data collection started and did not limit the study. Still, it speaks to the importance of having a plan in place in the event participants change their minds or are unable to participate.

Besides appreciating the tedious nature of qualitative research, I adapted a writing process that helped with staying focused and completing the manuscript. During the data analysis process, I decided to alternate between four tasks to overcome writer's burnout: writing tasks, read/reread the document, checking for plagiarism, formatting tables, figures, appendices, and references. I ranked the tasks in order of the amount of thinking and analysis involved. I found that writing the manuscript caused the most stress and anxiety and required the most analytical and critical thinking skills (critical-thinking tasks) and that formatting tasks required the least intellectual skills (routine tasks). I developed the system that whenever writer's fatigue or writer's block occurred, I moved to one of the less mentally challenging tasks, such as formatting the reference list or editing the in-text citations. This system allowed me to continue writing the document even when intellectually exhausted.

Chapter Summary

This final section summarizes the study: Air Traffic Control Specialists' Perceptions of Simulation for Developing Job-Related Competencies. This chapter included six sections. The first section discussed the summary of the entire study and the major findings, including the study's background, an overview of the problem, purpose statement, research questions, overview of major findings from the literature review, conceptual framework, overview of the methodology, and the findings. The section included the major findings derived from ATCSs' perceptions of scenario-based simulation and the extent to which they perceived simulation as a valuable instructional method for enhancing ATC knowledge, performance skills, judgment, critical thinking skills, and self-confidence.

The second section presented the study's conclusions derived from the data analysis findings. These conclusions were: (a) previous classroom training may be required to acquire specific theoretical ATC knowledge, (b) simulation training is a valuable instructional method for enhancing ATC professionals' knowledge and skill levels, (c) simulation training is not a useful method of enhancing ATCSs' self-confidence, (d) simulation fidelity influences the value of simulation training; simulation training is not a substitute for real-world training, and (e) the fidelity of simulation influences training value and outcome.

The third section of this chapter presented an interpretation of the study's findings and conclusions. These interpretations show that (a) the ATCoach develops knowledge, performance skills, and critical thinking skills, (b) Bloom's taxonomy of the cognitive domain is a viable conceptual framework for evaluating simulation-related research, and (c) instructor support and simulation technology are essential components in developing complex ATC skills.

The fourth section of this chapter explained the implication of this qualitative exploratory case study design as it relates to theory, practice, and policy as relating to ATCSs' perceptions of simulation for developing their job-related competencies. The most significant implications for theory were that this study is the first to investigate the development of job-related competencies via simulation training for the TRACON application. The most significant implications for practice were the need for instructors and RPOs reoccurring training as a critical approach for enhancing training staff preparation and students' learning experiences. The most significant implications for policy and decision-making were related to the continuing need for a highly adaptive workforce of CPCs with the critical ATC job-related competencies and understanding of specific air traffic procedures (USNTSB, 2016b).

In the fifth section of Chapter 5, I provided some recommendations that future researchers may use to advance the study. I suggested evaluating the entire ATC training program, repeating the investigation with DEVs, repeating the study at an ATCT, and repeating the study by employing a different research design.

The sixth and final section of this chapter presented limitations identified due to the research design issues. I also provided some self-reflective comments about my research experiences.

In conclusion, this study provided critical data that can help the problem of inexperienced and poorly trained ATCSs in the United States. The five participants in this study were active employees of the FAA located at the research facility in the Southeastern United States at the time of data collection who completed the ATCoach in 2019 or after. The participants revealed that the ATCoach was a valuable method of providing the experience to improve their judgment, critical thinking, and decision-making skills needed to perform safe operations in the real air traffic environment. However, the usefulness of the ATCoach in helping with improving ATCSs self-confidence was rejected by all five participants.

Some issues raised by participants are as follows. Participants unanimously opposed the use of the ATCoach post-simulation training assessment as a pass/fail graded evaluation because there is an unrealistic expectation placed on CPC-ITs during evaluation that does not necessarily transfer to the operational setting. Participants also believed that simulated aircraft performance during training is unrealistic and does not accurately mirror live air traffic behavior. Additionally, most participants were dissatisfied with several aspects of the instruction, instructors, and the delivery process. The participants expressed specific concerns regarding the instructors and RPOs preparedness, including the instructors' and RPOs' possession of current ATC knowledge and practices at the research site and the unrealistic demands placed on RPOs to pilot multiple simulated planes.

References

Adams, N. E. (2015). Bloom's taxonomy of cognitive learning objectives. *Journal of the Medical Library Association: JMLA*, *103*(3), 152–153. https://doi.org/10.3163/1536-5050.103.3.010

Aebersold, M. (2018). Simulation-based learning: No longer a novelty in undergraduate education. *OJIN: The Online Journal of Issues in Nursing*, *23*(2). https://doi.org/10.3912/ojin.vol23no02ppt39

Aerospace Medical Research Laboratories. (1963). *The UDOFT flight simulation system.* Aerospace Medical Research Laboratories, 280–431. Technical Documentary Report: AMRL-TDR-63-133.

Alinier, G. (2013). *Effectiveness of the use of simulation training in healthcare education* (Unpublished doctoral dissertation). The University of Hertfordshire.

Allen, L. (1993, August 09–August 11). *Evolution of flight simulation* [Paper presentation]. American Institute of Aeronautics and Astronautics Meeting. Monterey, CA, U.S.A. https://doi.org/10.2514/6.1993-3545

Allen, M. (2017). *The SAGE encyclopedia of communication research methods.* Sage.

Allerton, D. (2010). *Principles of flight simulation.* Wiley.

Amaratunga, D., Baldry, D., Sarshar, M., & Newton, R. (2002). Quantitative and qualitative research in the built environment: Application of "mixed" research approach. *Work Study*, *51*(1), 17–31. https://doi.org/10.1108/00438020210415488

American Society of Mechanical Engineers. (2000). *The Link flight trainer: A Historic mechanical engineering landmark, Roberson Museum and Science Center, Binghamton, New York, June 10, 2000*. ASME International, History and Heritage Committee.

Anderson, C. (2010). Presenting and evaluating qualitative research. *American Journal of Pharmaceutical Education*, *74*(8), 141. https://doi.org/10.5688/aj7408141

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing a revision of Bloom's taxonomy of educational objectives.* Longman.

Andresen, K. W., & Ewing, D. A. (1964). *Study of digital computers for a real time training simulation research system. Aerospace Medical Research Laboratories.* Technical Documentary Report: AMRL-TDR-64-22.

Antosko, M., Pil'a, J., Korba, P., & Lipovský, P. (2014). Psychological readiness of air traffic controllers for their job. *Nase More*, *61*(1–2), 5–8. https://hrcak.srce.hr/121591

Arbula, S., Capizzi, M., Lombardo, N., & Vallesi, A. (2016). How life experience shapes cognitive control strategies: The case of air traffic control training. *PlosOne*, *11*(6), e0157731. https://doi.org/10.1371/journal.pone.0157731

Archer, J. R. (2018). *A performance-based framework for guiding enroute air traffic control sector design* [Doctoral dissertation, Purdue University]. ProQuest Dissertations and Theses Global.

Aronne, J. F. (1963). *Managing the airspace: A study of air traffic control* (Publication No. 302095194) [Doctoral dissertation, New York University]. ProQuest Dissertations and Theses Global.

Atlas.ti. (2021). *The Qualitative Data Analysis & Research Software*. https://atlasti.com/.

Attride-Stirling, J. (2001). Thematic networks: an analytic tool for qualitative research. *Qualitative Research*, *1*(3), 385–405. https://doi.org/10.1177/146879410100100307

Ayhan, S., & Samet, H. (2016, August). *Aircraft trajectory prediction made easy with predictive analytics.* Proceedings of the 22nd ACM SIGKDD International Conference on

Knowledge Discovery and Data Mining (pp. 21–30). ACM.

Baggett, R. K. (2001). *Mobile firearm simulation training systems: Perceptions of officers from small and rural law enforcement agencies* (Publication No. 1039271959) [Master Thesis, Eastern Kentucky University]. ProQuest Dissertations and Theses Global.

Banks, J. (2001). *Discrete-event system simulation.* Prentice Hall.

Bauer, M. C. (2005). *Evaluating the effectiveness of training system approaches for highly complex flight training* (Publication No. 305363413) [Doctoral dissertation, University of Central Florida]. ProQuest Dissertations and Theses Global.

Beaubien, J. M., & Baker, D. P. (2017). The use of simulation for training teamwork skills in health care: how low can you go? In *Simulation in aviation training* (pp. 445–450). Routledge. https://doi.org/10.4324/9781315243092-22

Bernard, H. R. (2012). *Social research methods: qualitative and quantitative approaches.* Sage.

Bertucio, B. (2017). The Cartesian heritage of Bloom's taxonomy. *Studies in Philosophy and Education*, *36*(4), 477–497. https://doi.org/10.1007/s11217-017-9575-2

Blaikie, N. (2009). *Designing social research* (2nd ed.). Polity Press.

Bloom, B. S., Englehart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *The taxonomy of educational objectives: The classification of educational objectives. Handbook I: The cognitive domain.* David McKay Co., Inc.

Bloomberg, L. D., & Volpe, M. (2019). *Completing your qualitative dissertation: A road map from beginning to end.* Sage.

Bolczak, R., & Celio, J. (2005). *Accommodating ATC system evolution through advanced training techniques.* Proceedings from the AIAA 5th ATIO and 16th Lighter-Than-Air Sys Tech. and Balloon Systems Conferences. https://doi.org/10.2514/6.2005-7384

Booth, W. C., Colomb, G. G., & Williams, J. M. (2003). *The craft of research* (2nd ed.). University of Chicago Press.

Brinkmann, S., & Kvale, S. (2015). *InterViews: Learning the craft of qualitative research interviewing* (3rd ed.). Sage.

Broach, D. M., & Dollar, C. S. (2002). *Relationship of employee attitudes and supervisor-controller ratio to en route operational error rates*. (DOT/FAA/AM-02/9). Civil Aeromedical Institute.

Buck, J. L., & Pierce, L. G. (2018). *Understanding the air traffic control field training process from the perspective of the developmental ATCS.* (Report No. DOT/FAA/AM-18/13). Office of Aerospace Medicine. https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/2010s/media/201813.pdf

Bureau of Transportation Statistics. (2019a, March 21). *2018 traffic data for U.S. airlines and foreign airlines: U.S. flights.* https://www.bts.dot.gov/newsroom/2018-traffic-data-us-airlines-and-foreign-airlines-us-flights

Bureau of Transportation Statistics. (2019b). *Number of pilot-reported near midair collisions (NMAC) by degree of hazard.* https://www.bts.gov/content/number-pilot-reported-near-midair-collisions-nmac-degree-hazard

Cardosi, K., Brett, B. E., & Han, S. (1996). *An analysis of TRACON (terminal radar approach control) controller - pilot voice communications* [final report] (26244969). ProQuest.

Caro, P. W. (1971). *An innovative instrument flight training program*, *1–14.* (64241039). ProQuest.

Case, R. (2013). The unfortunate consequences of Bloom's taxonomy. *Social Education*, *77*(4), 196–200. https://www.socialstudies.org/system/files/publications/articles/se_7704196.pdf

Cheng, A., & Grant, V. J. (2016). *Comprehensive Healthcare Simulation: Pediatrics*. Cham: Springer International Publishing.

Chhaya, B., Jafer, S., Coyne, W. B., Thigpen, N. C., & Durak, U. (2018). *Enhancing scenario-centric air traffic control training: 2018 AIAA Modeling and Simulation Technologies Conference.* https://doi.org/10.2514/6.2018-1399

Child, D. A. (1997). Patterns of simulator use within a military training environment. *International Journal of Instructional Media*, *24*(1), 43–53. https://www.proquest.com/openview/cee5417ec4c67aeebb5c5754b2c393ee/1?pq-origsite=gscholar&cbl=30932

Chua, Z. K., Andre, F., & Cousy, M. (2015). *Development of an ATC tower simulator to simulate ground operations. AIAA Modeling and Simulation Technologies Conference.* https://doi.org/10.2514/6.2015-2494

Clark, R. (2009). Accelerating expertise with scenario-based learning. *T + D*, *63*(1), 84–85. http://www.clarktraining.com/content/articles/ScenarioBasedLearning.pdf

Colman, N., Doughty, C., Arnold, J., Stone, K., Reid, J., Dalpiaz, A., & Hebbar, K. B. (2019). Simulation-based clinical systems testing for healthcare spaces: From intake through implementation. *Advances in Simulation*, *4*(1). https://doi.org/10.1186/s41077-019-0108-7

Comitz, P. (2013). A domain-specific language for aviation domain interoperability. *2013 Integrated Communications, Navigation and Surveillance Conference (ICNS)*. https://doi.org/10.1109/icnsurv.2013.6548596

Cooley, C. H., & Angell, R. C. (1930). *Sociological theory and social research, being selected* *papers of Charles Horton Cooley.* H. Holt and Company.

Cooper, J. B., & Taqueti, V. R. (2004). A brief history of the development of mannequin simulators for clinical education and training. *Quality and Safety in Health Care*, *13*(Suppl_1), I11-I18. https://doi.org/10.1136/qhc.13.suppl_1.i11

Cox, B. (2010). *Scenario based training in an aviation training environment* (Unpublished doctoral dissertation). Regis University. https://epublications.regis.edu/theses/2/

Coyne, W., Rice, S., Winter, S., Tamilselvan, G., & Drechsel, P. (2017). Simulation challenges: Student perception of air traffic control simulation. *International Journal of Aviation, Aeronautics, and Aerospace*, *4*(3). https://doi.org/10.15394/ijaaa.2017.1088

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed.). Sage.

Creswell, J. W. (2015). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Pearson.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage.

Creswell, J. W., & Poth, C. N. (2017). *Qualitative inquiry and research design: Choosing among five approaches*. Sage.

Crossman, E. C. (1919). Dry shooting for airplane gunners. *Popular Science Monthly*, *94*(1), 13–14.

Curry, L. (2015, June 23). *Fundamentals of qualitative research methods: Data analysis* (Module 5) [Video file]. https://www.youtube.com/watch?v=opp5tH4uD-w

Dabney, B., & Brent, J. (1993). Case Studies in Environmental Medicine: Jet Fuel Toxicity. U.S. Department of Health & Human Services. *Toxic Substances and Disease Registry*, *32*.

https://stacks.cdc.gov/view/cdc/7641/cdc_7641_DS1.pdf

Dahlstrom, N., Dekker, S., Winsen, R. V., & Nyce, J. (2017). Fidelity and validity of simulator training. *Simulation in Aviation Training*, 135–144. https://doi.org/10.4324/9781315243092-9

Darlington, E., & Bowyer, J. (2017). Undergraduate mathematics students' views of their pre-university mathematical preparation. *Research Matters: A Cambridge Assessment Publication*, *24*(2). https://www.cambridgeassessment.org.uk/Images/424746-undergraduate-mathematics-students-views-of-their-pre-university-mathematical-preparation-.pdf

DeCarlo, J. (2010). *Virtual airport simulation technology: Perceptions of airport operations initial training program variables and effectiveness for airside professional competence* (Publication No. 3420669) [Doctoral dissertation, Dowling College]. ProQuest Dissertations and Theses Global.

DeGarmo, M., & Nelson, G. (2004, September). Prospective unmanned aerial vehicle operations in the future national airspace system. In *AIAA 4th Aviation Technology, Integration and Operations (ATIO) Forum* (6243). https://doi.org/10.2514/6.2004-6243

Dehmel, R. C. (1950). *Means for Aircraft Flight Training* (U.S. Patent No. 2494508). U.S. Patent and Trademark Office. https://www.simulationinformation.com/hall-of-fame/members/richard-c-dehmel/

Dekker, S., Dahlström, N., Van Winsen, R., & Nyce, J. M. (2016). *Crew resilience and simulator training in aviation.* In *Resilience Engineering Perspectives, Volume 1* (pp. 133–140). CRC Press.

Dennis, B. K. (2014). Understanding participant experiences: Reflections of a novice research participant. *International Journal of Qualitative Methods*, *13*(1), 395–410. https://doi.org/10.1177/160940691401300121

Denzin, N. K., & Lincoln, Y. S. (2018). *The Sage handbook of qualitative research* (5th ed.). Sage.

de Smale, S., Overmans, T., Jeuring, J., & van de Grint, L. (2016). The effect of simulations and games on learning objectives in tertiary education: A systematic review. In A. De Gloria, & R. Veltkamp (Eds.) *Games and learning alliance*. GALA 2015. Lecture Notes in Computer Science (vol. 9599). Springer, Cham. https://doi.org/10.1007/978-3-319-40216-1_55

Dismukes, R. K., & Smith, G. M. (2017). *Facilitation and debriefing in aviation training and operations.* Routledge.

Dow, C. (2015). *Developing an objective definition of simulation fidelity for enroute air traffic control* [Unpublished master's thesis]. University of Waterloo. https://core.ac.uk/download/pdf/144148214.pdf

Durso, F. T., & Manning, C. A. (2008). Air traffic control. *Reviews of Human Factors and Ergonomics*, *4*(1), 195–244. https://doi.org/10.1518/155723408x342853

Dutta, D. (1999). Simulation in military training: Recent developments. *Defense Science Journal*, *49*(3), 275. https://doi.org/10.14429/DSJ.49.3840

Earle, J. A. (1981). *The effect of the integration of language arts objectives with motor development objectives in the physical education curriculum: Kindergarten through second grade* (Publication No. 303159658) [Doctoral dissertation, University of Illinois at Urbana-Champaign]. ProQuest Dissertations and Theses Global.

Embry Riddle Aeronautical University. (2018). *Flight simulation & training devices.* Retrieved July 6, 2018, from http://daytonabeach.erau.edu/college-aviation/flight/simulation-training-devices/index.html

Endsley, M. R. (2017). Toward a theory of situation awareness in dynamic systems. *Situational Awareness*, 9–42. https://doi.org/10.4324/9781315087924-3

Ennis, E. A. (2009). *The evolution of simulation in aviation flight training* (Publication No. 305181151) [Doctoral dissertation, Embry-Riddle Aeronautical University, Daytona Beach]. ProQuest Dissertations and Theses Global.

Federal Aviation Administration. (1989). *National airspace system plan: Facilities, equipment, associated development and other capital needs* (annual report) (No. AD-A215882). ProQuest Technology.

Federal Aviation Administration. (1997, December 18). *Standard Terminal Automation Replacement System Human Factors Review (Volume I)*. https://rosap.ntl.bts.gov/view/dot/8729/dot_8729_DS1.pdf?

Federal Aviation Administration. (2009). *FAA Airport Compliance Manual Document Information* (United States, Federal Aviation Administration, Airport Compliance and Field Operations Division [ACO-1]). Department of Transportation.

Federal Aviation Administration. (2010). *Establishment of Federal Aviation Administration next generation facilities special program management office* (FAA Order No. 1110.154). U.S. Department of Transportation.

Federal Aviation Administration. (2015). *A plan for the future, 2016-2025: 10-year strategy for the air traffic control workforce*. Federal Aviation Administration.

Federal Aviation Administration. (2016a, March 30). *Terminal radar approach control facilities (TRACON)*. https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/air_traffic_services/tracon/

Federal Aviation Administration. (2016b). *Airplane flying handbook: Faa-h-8083-3a.* W. W. Norton.

Federal Aviation Administration. (2017a, July 24). Safety: The foundation of everything we do. Retrieved July 02, 2018, from https://www.faa.gov/about/safety_efficiency/

Federal Aviation Administration. (2017b, November 14). Air traffic by the numbers. Retrieved July 02, 2018, from https://www.faa.gov/air_traffic/by_the_numbers/

Federal Aviation Administration. (2018a, December 3). *Automation. Automation – In the operation*. https://www.faa.gov/nextgen/how_nextgen_works/new_technology/automation/in_depth/

Federal Aviation Administration. (2018b). *Air traffic controller workforce plan* (2018-2027 ed.) Federal Aviation Administration. https://www.faa.gov/air_traffic/publications/controller_staffing/media/cwp_2018.pdf

Federal Aviation Administration. (2018c). *FAA strategic plan: FY 2019-2022. DOT strategic plan.* Federal Aviation Administration. https://www.faa.gov/about/plans_reports/media/FAA_Strategic_Plan_Final_FY2019-2022.pdf

Federal Aviation Administration. (2018d). *Air traffic organization policy: Air traffic technical training* (FAA Order No. AJO 3120.4P). Department of Transportation. https://www.faa.gov/documentLibrary/media/Order/JO_3120.4P_Chg_1.pdf

Federal Aviation Administration. (2019, January 31). *History*. https://www.faa.gov/about/history/

Federal Aviation Administration. (2020a, February 26). *FAA contract tower program*. https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/mission_support/faa_contract_tower_program/.

Federal Aviation Administration. (2020b). *Aeronautical information manual - AIM - ATC clearances and aircraft separation*. https://www.faa.gov/air_traffic/publications/atpubs/aim_html/chap4_section_4.html

Federal Aviation Administration. (2020c). *TI 6191.407 STARS ATCoach user's manual Revision 18: Technical manual instruction book*. Raytheon Company.

Federal Aviation Administration. (2020d, October 23). *National simulator program*. National Simulator Program – Data and Lists. https://www.faa.gov/about/initiatives/nsp/data_lists/.

Federal Aviation Advisory Committee. (2018). *Solutions for simulation training.* https://www.faac.com/simulation-training/

Ferrarin, E. (2014). New simulator gives Elgin police real-life drama. *Daily Herald.* https://search.proquest.com/docview/1558740269/5DCA828B4FDF4604PQ/2

Ferroukhi, M. Y., Abahri, K., Belarbi, R., & Limam, K. (2017). Integration of a hygrothermal transfer model for envelope in a building energy simulation model: Experimental validation of a HAM–BES co-simulation approach. *Heat and Mass Transfer*, *53*(6), 1851–1861. https://doi.org/10.1007/s00231-016-1944-9

Fink, L. D. (2017). *Creating significant learning experiences: An integrated approach to designing college courses*. Langara College.

Flexman, R. E. (1950). Evaluation of school Link and special methods of instruction in a ten-hour private pilot flight-training program. *Aeronautics Bulletin*, *8.* https://www.ideals.illinois.edu/bitstream/handle/2142/45719/evaluationofscho08flex.pdf?sequence=2

Flick, U. (2014). *Mapping the field. In U. Flick (Ed.), The SAGE handbook of qualitative data analysis* (pp. 3–18). Sage. https://doi.org/10.4135/9781446282243

Foeckler, J. J. (2019). *Discernable patterns in teachers' perceptions, attributions, and responsiveness to students learning to read: A case study* (Publication No. 2455798920) [Doctoral dissertation, Cardinal Stritch University]. ProQuest Dissertations and Theses Global.

Forehand, M. (2005). Bloom's taxonomy: Original and revised. In M. Orey (Ed.), *Emerging perspectives on learning, teaching, and technology* (E-Book). https://textbookequity.org/Textbooks/Orey_Emergin_Perspectives_Learning.pdf

Fothergill, S., Loft, S., & Neal, A. (2009). ATC-lab sup advanced: An air traffic control simulator with realism and control. *Behavior Research Methods*, *41*(1), 118–127. https://doi.org/10.3758/BRM.41.1.118

Frey, B. (2018). *The SAGE encyclopedia of educational research, measurement, and evaluation* (Vols. 1–4). Sage. https://doi.org/10.4135/9781506326139

Fritz, R. L., & Vandermause, R. (2017). Data collection via in-depth email interviewing: Lessons from the field. *Qualitative Health Research*, *28*(10), 1640–1649. https://doi.org/10.1177/1049732316689067

Fultz, A. J. (2015). *Fatal weather-related general aviation accidents in the United States: 1982 – 2013* (Publication No. 1722054838) [Master's thesis, Northern Illinois University].

ProQuest Dissertations and Theses Global.

Futrell, K. R. (1998). *A historical study of pilot training at united airlines, 1931–1996* (Publication No. 304493589) [Doctoral dissertation, Tennessee State University]. ProQuest Dissertations and Theses Global.

Gay, R. L. (1976). *Educational research competencies for analysis & application.* Merill Publishing Co.

Georgiou, A. M., Wertheimer, M. E., & Snodgrass, M. E. (2017). Student perceptions on the usefulness of simulation-based training. *19th International Symposium on Aviation Psychology*, 136–141. https://corescholar.libraries.wright.edu/isap_2017/69

Gheorghiu, A. (2013). Flight simulation in air force training: A knowledge transfer efficiency perspective. *Journal of Defense Resources Management*, *4*(2), 153–158. https://go.gale.com/ps/i.do?id=GALE%7CA356354327&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=20689403&p=AONE&sw=w&userGroupName=anon%7E1fe3eac4

Ghosh, S. (2015). *Distributed systems: An algorithmic approach.* CRC Press.

Gibbs, G. (2008). *Analysing qualitative data.* Sage.

Given, L. M. (2008). *The Sage encyclopedia of qualitative research methods* (Vol 2). Sage.

Glaser, B. G., & Strauss, A. L. (2017). *The discovery of grounded theory: Strategies for qualitative research.* Routledge.

Goode, W. J., & Hatt, P. K. (1952). *Methods in social research.* McGraw-Hill.

Gordon, C. A., & Todd, R. J. (2009). *Evidence based practice in school libraries: A compilation of articles from evidence-based library and information practice.* Hi Willow Research & Publishing.

Gordon, W. R., Oliva, P. F., & Taylor, R. (2019). *Developing the curriculum*. Pearson.

Gray, K. P., & Rabb, J. W. (1971). *An Overview of the National Airspace System* [ATC Automated Systems, Discussing National Airspace System En Route Stage A and Advanced Radar Terminal System] (21626210). ProQuest.

Green, S. C., & Bavelier, D. (2006). Enumeration versus multiple object tracking: The case of action video game players. *Cognition*, *101*, 217–245. https://doi.org/10.1016/j.cognition.2005.10.004

Guest, G. (2013). *Collecting qualitative data. A field manual for applied research.* Sage.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? *Field Methods*, *18*(1), 59–82. https://doi.org/10.1177/1525822x05279903

Hackshaw, A. (2008). Small studies: strengths and limitations. *European Respiratory Journal*, *32*(5), 1141–1143. https://doi.org/10.1183/09031936.00136408

Hall, J. C. (2011). Survey of flight instructors' experiences in communication training. *Collegiate Aviation Review*, *29*(1), 45–56. https://doi.org/10.22488/okstate.18.100417

Hamel, P. G., & Jategaonkar, R. V. (2017). *In-flight simulators and fly-by-wire/light demonstrators: A historical account of international aeronautical research.* Springer.

Hancock, D. R., & Algozzine, R. (2017). *Doing case study research: A practical guide for beginning researchers.* Teachers College Press.

Hanson, C. (2015). *Automated meta-aircraft operations for a more efficient and responsive air transportation system.* NASA/Langley Research Center. https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20150010984.pdf

Harrow, A. (1972). *A taxonomy of the psychomotor domain: A guide for developing behavioral objectives.* David McKay.

Havyer, R. D., Nelson, D. R., Wingo, M. T., Comfere, N. I., Halvorsen, A. J., McDonald, F. S., & Reed, D. A. (2016). Addressing the interprofessional collaboration competencies of the Association of American Medical Colleges: A systematic review of assessment instruments in undergraduate medical education. *Academic Medicine*, *91*(6), 865–888. https://doi.org/10.1097/acm.0000000000001053

Hays, R. T. (2006). *The science of learning: A systems theory perspective.* Brown Walker Press.

Hays, R. T., & Singer, M. J. (1989). *Simulation fidelity in training system design: bridging the gap between reality and training.* Springer.

Heath, S., & Yoho, K. D. (2017). Using simulation to illuminate process improvement opportunities in a U.S. naval aircraft overhaul facility. *Production Planning & Control*, *28*(14), 1152–1164. https://doi.org/10.1080/09537287.2017.1348561

Hite, R. C. (2004). *Air traffic control: Good progress on interim replacement for outage-plagued system, but risks can be further reduced*. Diane Pub.

Holstein, J. A., & Gubrium, J. F. (2008). *Handbook of constructionist research*. Guilford Press.

Hopkin, V. D. (1995). *Human factors in air traffic control.* Taylor & Francis.

Hopkin, V. D. (2017). *Human factors in air traffic control.* CRC Press.

Humphrey, W. S. (1987). MOBIDIC and field data. *Annals of the History of Computing*, *9*(2), 137–182. https://doi.org/10.1109/MAHC.1987.10018

Hurst, K. S. (2015). *High fedelity simulation: Its impact on self-confidence and satisfaction in learning among sophomore and senior students* (Doctoral dissertation). Louisiana State University. https://digitalcommons.lsu.edu/cgi/viewcontent.cgi?article=2686&context=gradschool_dissertations

Hustad, J., Johannesen, B., Fossum, M., & Hovland, O. J. (2019). Nursing students' transfer of learning outcomes from simulation-based training to clinical practice: A focus-group study. *BMC Nursing*, *18*(1). https://doi.org/10.1186/s12912-019-0376-5

Jang, A. R., Lee, I. K., Cho, H. N., & Mikiewicz, P. (2019). Simulation scenarios in Korea according to the learning objectives of adult health nursing: A literature review. *Cogent Education*, *6*(1). https://doi.org/10.1080/2331186x.2019.1678795

Jensen, R. S. (2017). *Pilot judgment and crew resource management*. Routledge.

Jentsch, F., Curtis, M., & Salas, E. (2011). *Simulation in aviation training.* Routledge. https://doi.org/10.4324/9781315243092

Jeon, C. (2015). The Virtual Flier: The Link trainer, flight simulation, and pilot identity. *Technology and Culture*, *56*(1), 28–53. https://doi.org/10.1353/tech.2015.0017

Jones, F., Passos-Neto, C., & Braghiroli, O. M. (2015). Simulation in medical education: Brief history and methodology. *Principles and Practice of Clinical Research Journal*, *1*(2), 56–63. https://doi.org/10.21801/ppcrj.2015.12.8

Jones, K. O., Harland, J., Reid, J. M., & Bartlett, R. (2009). *Relationship between examination questions and Bloom's taxonomy.* 2009 39th IEEE Frontiers in Education Conference. https://doi.org/10.1109/fie.2009.5350598

Judy, A. (2018). *A study of flight simulation training time, aircraft training time, and pilot competence as measured by the naval standard score* (Publication No. 2046892084) [Doctoral dissertation, Southeastern University, Lakeland]. ProQuest Dissertations and Theses Global.

Keating, S. B., DeBoor, S. S., & Keating, S. B. (2018). *Curriculum development and evaluation in nursing education*. Springer.

Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education*, *6*(5), 26. https://doi.org/10.5430/ijhe.v6n5p26

Knoesel, J. (2017). *Effect of implementation of simulation on critical thinking skills in undergraduate baccalaureate nursing students* (Publication No. 1898178990) [Doctoral dissertation, The City University of New York]. ProQuest Dissertations and Theses Global.

Koenig, H. G. (2011). *Spirituality and health research: Methods, measurements, statistics, and resources.* Templeton Press.

Kolb, A. Y., & Kolb, D. A. (2005). Learning styles and learning spaces: Enhancing experiential learning in higher education. *Academy of Management Learning & Education*, *4*(2), 193–212. https://doi.org/10.5465/amle.2005.17268566

Kolb, D. A. (1984). *Experimental learning: Experience as the source of learning and development.* Prentice-Hall.

Koskela, I., & Palukka, H. (2011). Trainer interventions as instructional strategies in air traffic control training. *Journal of Workplace Learning*, *23*(5), 293–314. https://doi.org/10.1108/13665621111141902

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice, 41*(4), 212–218. https://doi.org/10.1207/s15430421tip4104_2

Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1964). *Taxonomy of educational objectives: The classification of educational goals, Handbook II: Affective domain*. David McKay Company.

Kupfer, M., Mercer, J., Cabrall, C., Homola, J., & Callantine, T. (2013). *Designing scenarios for* *controller-in-the-loop air traffic simulations.* NASA/Langley Research Center.

Landriscina, F. (2013). *Simulation and learning a model-centered approach.* Springer.

Lateef, F. (2010). Simulation-based learning: Just like the real thing. *Journal of Emergencies, Trauma, and Shock*, *3*(4), 348. https://doi.org/10.4103/0974-2700.70743

Lavrakas, P. J. (2008). *Encyclopedia of survey research methods.* Sage.

Lawson, S., Reid, J., Morrow, M., & Gardiner, K. (2018). Simulation-based education and human factors training in postgraduate medical education: A Northern Ireland perspective. *The Ulster Medical Journal*, *87*(3), 163–167. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6169420/

Learmount, D. (2019). Automation mismatch. *Flight International*, *195*, 22–25.

Lee, A. T. (2017). *Flight simulation: Virtual environments in aviation*. Routledge.

Li, X. S., Li, G., Xiao, C., & Lan, S. Y. (2012). A simplified method of simulation for aircraft performance parameters in air traffic control. *Applied Mechanics and Materials*, *235*, 198. https://doi.org/10.4028/www.scientific.net/amm.235.198

Lincoln, Y. S. (1995). Emerging criteria for quality in qualitative and interpretive research. *Qualitative Inquiry*, *1*(3), 275–289. https://doi.org/10.4135/9781412986267.n19

Lincoln, Y. S., & Guba, E. G. (2006). *Naturalistic inquiry.* Sage.

Lindenfeld, M. (2016). *A comparative analysis of aviation student knowledge, skill, self-efficacy, motivation, deep learning, and commitment to an air traffic control career before and after air traffic control simulation* (Publication No. 1827586280). ProQuest Dissertations and Theses Global

Link, E. A. (1929). *Flight simulator* (U.S. Patent No. 1825462). U.S. Patent and Trademark Office.

Link, E. A. (1930). *Combination training device for student aviators and entertainment apparatus* (U.S. Patent No. 1825462A). U.S. Patent and Trademark Office. https://patents.google.com/patent/US1825462A/en

Locke, L. F., Spirduso, W. W., & Silverman, S. J. (2014). *Proposals that work: A guide for planning dissertations and grant proposals* (6th ed.). Sage.

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2010). *Methods in educational research: from theory to practice*. Jossey-Bass.

Loveland, T., & Dunn, D. (2014). Teaching engineering habits of mind in technology education. *Technology and Engineering Teacher*, *73*(8), 13–19. https://files.eric.ed.gov/fulltext/EJ1049175.pdf

Lynch, M. D. (2005). Developing a scenario-based training program: Giving officers a tactical advantage. *FBI Law Enforcement Bulletin*, *74*(10), 1–8. https://www.ojp.gov/ncjrs/virtual-library/abstracts/developing-scenario-based-training-program-giving-officers-tactical

Macchiarella, N. D., & Meigs, C. D. (2008). Virtual air traffic flight training device automated air traffic control. *Journal of Aviation/Aerospace Education & Research*, *18*(1). https://commons.erau.edu/jaaer/vol18/iss1/4/

Macchiarella, N. D., & Mirot, A. (2018). Scenario development for unmanned aircraft system simulation-based immersive experiential learning. *Journal of Aviation/Aerospace Education & Research*, *28*(1). https://doi.org/10.15394/jaaer.2018.1773

Maggio, L. A., Sewell, J. L., & Artino, A. R. (2016). The literature review: A foundation for high-quality medical education research. *Journal of Graduate Medical Education*, *8*(3), 297–303. https://doi.org/10.4300/jgme-d-16-00175.1

Maldonado, M. M. (2009). *Legal aspects of safety management systems and human factors in air traffic control* (Publication No. 763621680) [Master's thesis, McGill University, Canada]. ProQuest Dissertations and Theses Global.

Malheiro, A., Ribeiro, F., Jamil, G. L., Rascao, J. P., & Mealha, O. (2018). *Handbook of research on knowledge management for contemporary business environments.* Business Science Reference.

Manning, C. A. (2000). Measuring air traffic controller performance in a high-fidelity simulation final report. *Star*, *38*. https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/2000s/media/00_02.pdf

Mante, R. P. (2019). *The effect of simulation on the self-confidence of newly licensed graduate nurses* (Doctoral dissertation). Texas Woman's University. https://twu-ir.tdl.org/bitstream/handle/11274/12248/Mante_DNP.pdf?sequence=1&isAllowed=y

Marshall, C., & Rossman, G. B. (2016). *Designing qualitative research* (6th ed.). Sage.

Mart, D. T. (2011). *Perceived district-level leadership influences upon student achievement* (Publication No. 894343577) [Doctoral dissertation, Iowa State University]. ProQuest Dissertations and Theses Global.

Marzano, R. J., & Kendall, J. S. (2008). *Designing & assessing educational objectives: applying the new taxonomy*. Corwin Press.

Mavin, T. J., & Murray, P. S. (2010). *The development of airline pilot skills through simulated practice. In Learning through Practice* (pp. 268–286). Springer, Dordrecht.

McDermott, J. T. (2005). *A comparison of the effectiveness of a personal computer-based aircraft training device and a flight training device at improving pilot instrument* *proficiency: A case study in leading regulatory change in aviation education* (Publication No. 305028534) [Doctoral dissertation, Bowling Green State University]. ProQuest Dissertations and Theses Global.

McDermott, M. (2017). *Debriefing with reflection: Best practice for learning in simulation in pre-licensure nursing education* (Publication No. 1972645952) [Doctoral dissertation, Seton Hall University]. ProQuest Dissertations and Theses Global.

McQuillan, K. A., Makic, M. B. F., & Whalen, E. (2009). *Trauma nursing: from resuscitation through rehabilitation.* Saunders/Elsevier.

Meller, G. (1997). A typology of simulators for medical education. *Journal of Digital Imaging*, *10*(S1), 194–196. https://doi.org/10.1007/bf03168699

Mercer, L. M. (2015). *Program evaluation: A federal agency's air traffic control train-the-trainer program* (Doctoral dissertation, Walden University). https://scholarworks.waldenu.edu/cgi/viewcontent.cgi?article=2958&context=dissertations

Merriam, S. B. (2007). *Qualitative research and case study applications in education* (2nd ed.). Jossey-Bass.

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

Merrill, M. D. (2008). Reflections on a four decade search for effective, efficient and engaging instruction. In M. W. Allen (Ed.), Michael Allen's *2008 e-Learning Annual* (Vol. 1, pp. 141–167). Wiley Pfieffer.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook*. Sage.

Mohammed Amin, R. J. (2015). *Using associative processing to simplify current air traffic control* (Publication No. 1775393624) [Doctoral dissertation, Kent State University]. ProQuest Dissertations and Theses Global.

Moir, I., Seabridge, A., & Jukes, M. (2013). *Civil avionics systems.* Wiley.

Mollard, R., Cabon, P., Bourgeois-Bougrine, S., & David, H. (2000). Measurement of fatigue and sleepiness in ATC simulation. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *44*(19). https://doi.org/10.1177/154193120004401906

Moran, J., Briscoe, G., & Peglow, S. (2018). Current technology in advancing medical education: Perspectives for learning and providing care. *Academic Psychiatry*, *42*(6), 796–799. https://doi.org/10.1007/s40596-018-0946-y

Morgan, G. M., Fischoff, B., Bostrom, A., & Atman, C. (2002). *Risk communication: a mental models approach*. Cambridge University Press.

Morse, J. M. (1994). Designing funded qualitative research. In Denizin, N. K. & Lincoln, Y. S. (Eds.), *Handbook of qualitative research* (2nd ed.). Sage.

Mulcare, D. M., & Shwedel, A. (2017). Transforming Bloom's taxonomy into classroom practice: A practical yet comprehensive approach to promote critical reading and student participation. *Journal of Political Science Education*, *13*(2), 121–137. https://doi.org/10.1080/15512169.2016.1211017.

Munshi, F., Lababidi, H., & Alyousef, S. (2015). Low- versus high-fidelity simulations in teaching and assessing clinical skills. *Journal of Taibah University Medical Sciences*, *10*(1), 12–15. https://doi.org/10.1016/j.jtumed.2015.01.008

Nadler, E. (1996). E*valuation of an out-of-the-window air traffic control tower simulation for controller training* (Technical report). United States. Federal Aviation Administration.

National Air Traffic Controllers Association. (2019). *What is an air traffic controller?* https://www.natca.org/index.php/acronyms-breakdown/what-is-an-air-traffic-controller

National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. (1979). *The Belmont report: Ethical principles and guidelines for the protection of human subjects of research.* U.S. Department of Health and Human Services. https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/read-the-belmont-report/index.html

Nepelski, M. (2019). A simulator supporting the training of police officers who process traffic incident scenes. *Safety & Fire Technology*, *54*(2), 90–97. https://doi.org/10.12845/sft.54.2.2019.6

Noe, R. A. (1986). Trainees' attributes and attitudes: Neglected influences on training effectiveness. *Academy of Management Review*, *11*(4), 736–749. https://doi.org/10.2307/258393

Noe, R. A., Clarke, A. D., & Klein, H. J. (2014). Learning in the twenty-first-century workplace. *Annual Review of Organizational Psychological Behavior*, 1(1), 245–275. https://www.annualreviews.org/doi/abs/10.1146/annurev-orgpsych-031413-091321

Northup, J. (2018). *Strategies to Develop Skills for Positive Training Transfer: Adult Higher Education Alliance, Paper presented at the Annual Meeting of the Adult Higher Education Alliance* (42nd, Orlando, FL, March 8–9, 2018). Education Resources Information Center. (No. ED590264).

Nuutilainen, P. R. K. (1997). *The effects of automation on situational awareness in an air traffic control simulation* (Publication No. 304344503) [Master's thesis, University of Guelph]. ProQuest Dissertations and Theses Global.

Onggo, B. S. S., & Hill, J. (2014). Data identification and data collection methods in simulation: A case study at ORH Ltd. *Journal of Simulation*, *8*(3), 195–205. https://doi.org/10.1057/jos.2013.28

Onwuegbuzie, A. J., Jiao, Q. G., & Bostick, S. L. (2004). *Library anxiety: Theory, research, and applications.* University Press of America.

Orlich, D. C., Harder, R. J., Brown, A., Trevisan, M. S., & Miller, D. (2018). *Teaching strategies: a guide to effective instruction*. Cengage Learning.

Otter.ai. (2021). Otter voice meeting notes. https://otter.ai/.

Page, R. L. (2000). *Brief history of flight simulation.* Penn State University, CiteSeerX Database. https://doi.org/10.1.1.132.5428

Parke, R. B. (1953). C-124 simulator. *Flying Magazine,* (September 1953), 60.

Parmar, D. (2017). *Evaluating the effects of immersive embodied interaction on cognition in virtual reality* (Publication No. 1986801781) [Doctoral dissertation, Clemson University]. ProQuest Dissertations and Theses Global.

Passiment, M., Sacks, H., & Huang, G. (2011). *Medical simulation in medical education: Results of an AAMC survey.* Association of American Medical Colleges. https://www.aamc.org/download/259760/data/medicalsimulationinmedicaleducationanaamcsurvey.pdf.

Patton, M. Q. (2014). *Qualitative research and evaluation methods: Integrating theory and practice* (4th ed.). Sage.

Pikhart, M., & Klimova, B. (2019). Utilization of linguistic aspects of Bloom's taxonomy in blended learning. *Education Sciences*, *9*(3), 235. https://doi.org/10.3390/educsci9030235

Pisano, D. A. (2000). *Link, Edwin Albert, Jr. (1904-1981), inventor and businessman.* American National Biography Online. https://doi.org/10.1093/anb/9780198606697.article.1302098

Popular Mechanics Magazine. (1954, September). Airline Pilots Fly Anywhere in World—Without Leaving the Ground. *Popular Mechanics Magazine*, *102*(4).

Povenmire, H. K., & Roscoe, S. N. (1971). An evaluation of ground-based flight trainers in routine primary flight training. *Human Factors*, *13*(2), 109–116. https://doi.org/10.1177/001872087101300203

Powell, C. (2003). The Delphi technique: Myths and realities. *Journal of Advanced Nursing*, *41*, 376–382. https://doi.org/10.1046/j.1365-2648.2003.02537.x

Prevot, T., Smith, N. M., Palmer, E., Callantine, T. J., Lee, P. U., Mercer, J., Martin, L., Brasil, C., & Cabrall, C. (2014). *An overview of current capabilities and research activities in the Airspace Operations Laboratory at NASA Ames Research Center.* 14th AIAA Aviation Technology, Integration, and Operations Conference. https://doi.org/10.2514/6.2014-2860

Protection of Human Subjects, 45 C.F.R. § 46.115. (2018). https://www.hhs.gov/ohrp/regulations-and-policy/regulations/45-cfr-46/revised-common-rule-regulatory-text/index.html

Radisic, T., Andrabi, P., Novak, D., Juridic, B., & Antulov-Fantulin, B. (2020). Air traffic complexity as a source of risk in ATM. *Risk Assessment in Air Traffic Management*. https://doi.org/10.5772/intechopen.90310

Ray, S. J. (1999). *Strategic communication in crisis management: Lessons from the airline industry.* Quorum Books.

Rice, D. A. (2016). Weaponizing affect: A film phenomenology of 3D military training simulations during the Iraq War. *Catalyst: Feminism, Theory, Technoscience*, *2*(1), 1–39. https://doi.org/10.28968/cftt.v2i1.28830

Riotto, A. M. (2021). Teaching the Army: Virtual learning tools to train and educate twenty-first-century soldiers. *Military Review, 101*(1), 89–99. https://www.armyupress.army.mil/Portals/7/military-review/Archives/English/JF-21/Riotto-Teaching-the-Army-1.pdf

Robello, S. M. (2017). *Collegiate training initiative – training methods as a predictor to success* (Publication No. 1940032652) [Master's thesis, University of North Dakota]. ProQuest Dissertations and Theses Global.

Roberts, C. M. (2010). *The dissertation journey: A practical and comprehensive guide to planning, writing, and defending your dissertation* (2nd ed.). Corwin.

Robson, C. (1993). *Real world research: A resource for social scientists and practitioner-researchers.* Blackwell.

Robson, C., & McCartan, K. (2016). *Real world research* (4th ed.). Wiley.

Rodriguez-Blanco, V. (2018). Is practical knowledge prior to theoretical knowledge in action? Reflecting on Anscombe's institutional transparency. *The Journal of Value Inquiry*, *52*(3), 257–267. https://doi.org/10.1007/s10790-018-9656-7

Rodwell, M. K. (1998). *Social work constructivist research*. Garland Publishing.

Rosen, K. R. (2008). The history of medical simulation. *Journal of Critical Care*, *23*(2), 157–166. https://doi.org/10.1016/j.jcrc.2007.12.004

Rubin, A., & Babbie, E. R. (2007). *Essential research methods for social work.* Thomson/Brooks/Cole.

Rupasinghe, T. D., Kurz, M. E., Gramopadhye, A. K., & Washburn, C. (2010). Improving aircraft maintenance technology education: Bloom's taxonomy perspective. *IIE Annual Conference Proceedings*, 1–6. https://doi.org/10.13140/2.1.3929.8240

Saidin, K., & Yaacob, A. (2017). Insider researchers: Challenges & opportunities. *Proceedings of the ICECRS*, *1*(1). https://doi.org/10.21070/picecrs.v1i1.563

Salden, R. J., Paas, F., & Van Merriënboer, J. J. (2006). Personalised adaptive task selection in air traffic control: Effects on training efficiency and transfer. *Learning and Instruction*, *16*(4), 350–362. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.491.2018&rep=rep1&type=pdf

Santiago, F. A. (1988). *The training of air traffic controllers: A case study* (Publication No. 303707800) [Doctoral dissertation, Columbia University]. ProQuest Dissertations and Theses Global.

Savin-Baden, M., & Major, C. H. (2013). *Qualitative research: The essential guide to theory and practice.* Routledge.

Sawyer, T., & Anderson, M. (2018). Healthcare simulation research in simulation and gaming: Past, present, and future. *Simulation & Gaming*, *49*(5), 475–478. https://doi.org/10.1177/1046878118803686

Schaefer, B. E. (1989). *Test and training simulator for ground-based teleoperated in-orbit servicing*. ProQuest Document (ID. 25532506).

Schroeder, R., & Cahoy, E. S. (2010). Valuing information literacy: Affective learning and the ACRL Standards. *Portal: Libraries and the Academy*, *10*(2), 127–146. https://doi.org/10.1353/pla.0.0096

Sconfienza, S. R. (1996). *Finding safety in the skies: The Federal Aviation Administration and* *the process of regulation* (Publication No. 304297281) [Doctoral dissertation, The City University of New York]. ProQuest Dissertations and Theses Global.

Simpson, B. J. (1966). The classification of educational objectives: Psychomotor domain. *Illinois Journal of Horne Economics*, *10*(4). https://files.eric.ed.gov/fulltext/ED010368.pdf

Smith, J. K. (1984). The Problem of Criteria for Judging Interpretive Inquiry. *Educational Evaluation and Policy Analysis*, *6*(4), 379–391. https://doi.org/10.3102/01623737006004379

Stake, R. E. (2015). *Multiple case study analysis.* Guilford Press.

Stanny, C. (2016). Reevaluating Bloom's taxonomy: What measurable verbs can and cannot say about student learning. *Education Sciences*, *6*(4), 37. https://doi.org/10.3390/educsci6040037

Strachan, I. W. (2000). Technology leaps all around propel advances in simulators. *National Defense*, *85*(564), 86–91. https://www.nationaldefensemagazine.org/articles/2000/10/31/2000november-technology-leaps-all-around-propel-advances-in-simulators

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research techniques and procedures for developing grounded theory.* Sage.

Surakitbanharn, C. A. (2017). *Analyzing critical pair identification as a human controlled function in air traffic control* (Publication No. 1975468016) [Doctoral dissertation, Purdue University]. ProQuest Dissertations and Theses Global.

Talib, A. M., Alomary, F. O., & Alwadi, H. F. (2018). Assessment of Student Performance for Course Examination Using Rasch Measurement Model: A Case Study of Information Technology Fundamentals Course. *Education Research International*, 2018.

https://doi.org/10.1155/2018/8719012

Telfer, R. A. (2018). Approaches to pilot training. *Aviation Instruction and Training*, 89–202. Routledge. https://doi.org/10.4324/9780429463273-8

Thomas, R. P., Willems, B., Shanteau, J., Raacke, J., & Friel, B. (2001, October). Measuring the performance of experts: An application to air traffic control. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *45*(4), 286–290. Sage.

Tokadli, G., Marzuoli, A., & Boidot, E. (2016). *Resilience of the national airspace system: A case study of the fire at the Chicago ARTCC.* 2016 IEEE/AIAA 35th Digital Avionics Systems Conference (DASC). https://doi.org/10.1109/dasc.2016.7778105

Treiber, K. M. S. (1994). *Exploring virtual reality: Air traffic control training in a collegiate setting* (Publication No. 304106133) [Doctoral dissertation, University of Minnesota]. ProQuest Dissertations and Theses Global.

Underwood, M. C., Merlino, D. K., Carboneau, L. M., Wilson, C. L., & Wilder, A. J. (2016). *Proof-of-concept demonstrations of a flight adjustment logging and communication network.* NASA/Langley Research Center.

United States Congress. (1958). *Federal Aviation Act of 1958: Public law 85-726 (S. 3880), approved August 23, 1958, 85th Congress, 2nd session (72 Stat. 731): Legislative history (pp. 731-811) [Cong. S. 3880 from 101 Cong.].* U.S. Government Publishing Office.

United States Congress. (2006). *Departments of Transportation, Treasury, HUD, the judiciary, District of Columbia, and independent agencies appropriations for 2007: Hearings before a subcommittee of the Committee on Appropriations, House of Representatives, One Hundred Ninth Congress, second session*. Government Publishing Office.

United States Government Accountability Office. (2019). *Federal research: Additional actions* *needed to improve public access to research results*. https://www.gao.gov/products/GAO-20-81

United States National Transportation Safety Board. (2016a). *Safety recommendation report: Educating Controllers on Two Midair Collisions.* https://www.ntsb.gov/investigations/AccidentReports/Reports/ASR1606.pdf#search=WPR15MA243A

United States National Transportation Safety Board. (2016b). *Safety recommendation report: Emergency training for air traffic controllers.* https://ntsb.gov/investigations/AccidentReports/Reports/ASR1604.pdf

United States Office of Personnel Management. (2018). *Air traffic control series (2152); Individual occupational requirements.* Classification & Qualifications. https://www.opm.gov/policy-data-oversight/classification-qualifications/general-schedule-qualification-standards/2100/air-traffic-control-series-2152/

University of West Florida. (n.d.). *Curriculum & Instruction, Ed.D.* https://uwf.edu/programs/ceps/curriculum-instruction-edd/

Updegrove, J. A., & Jafer, S. (2017). Optimization of air traffic control training at the Federal Aviation Administration Academy. *Aerospace*, *4*(4), 50. https://doi.org/10.3390/aerospace4040050

Vagner, J., & Pappová, E. (2014). Comparison of radar simulator for air traffic control. *Nase More*, *61*(1), 31–35. https://hrcak.srce.hr/121597

Vahdatikhaki, F., Langroodi, A. K., Makarov, D., & Miller, S. (2019). *Context-Realistic Virtual Reality-based Training Simulators for Asphalt Operations*. IAARC. https://doi.org/10.22260/ISARC2019/0030

Van Eck, R. N., Fu, H., & Drechsel, P. V. (2015). Can simulator immersion change cognitive style? Results from a cross-sectional study of field-dependence-independence in air traffic control students. *Journal of Computing in Higher Education*, *27*(3), 196–214. https://doi.org/10.1007/s12528-015-9099-0

Van Hoeij, M. J. W., Haarhuis, J. C. M., Wierstra, R. F. A., & van Beukelen, P. (2004). Developing a classification tool based on Bloom's taxonomy to assess the cognitive level of short essay questions. *Journal of Veterinary Medical Education*, *31*(3), 261–267. https://doi.org/10.3138/jvme.31.3.261

Van Merrienboer, J. J. G., & Kirschner, P. A. (2013). *Ten steps to complex learning: A systematic approach to four-component instructional design* (2nd ed.). Routledge.

Vela, J. C. (2020). *Teaching and learning in counselor education*. American Counseling Association.

Vengal, J. S. (2011). *Integration of unmanned aerial systems in Class E airspace: The effect on air traffic controller workload* (Publication No. 1431180739) [Doctoral dissertation, Embry-Riddle Aeronautical University, Daytona Beach]. ProQuest Dissertations and Theses Global.

Vidulich, M. A., Tsang, P. S., & Flach, J. M. (2017). *Advances in aviation psychology. Using scientific methods to address practical human factors needs* (Vol. 2). Routledge.

Volkaner, B., Sozen, S. N., & Omurlu, V. E. (2016). Realization of a desktop flight simulation system for motion-cueing studies. *International Journal of Advanced Robotic Systems*, *13*(3), 85. https://doi.org/10.5772/63239

Vortac, O. U., Edwards, M. B., Fuller, D. K., & Manning, C. A. (1994). Automation and cognition in air traffic control: An empirical investigation. *PsycEXTRA Dataset.*

https://doi.org/10.1037/e645572007-001

Walker, G. K. (2012). *Definitions for the law of the sea: terms not defined by the 1982 Convention*. Martinus Nijhoff.

Weikert, C., Pham, M., Montan, H., & Johansson, C. R. (2001, October). A Comparison between a 2-D and a 3-D simulation of airport tower air traffic control. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 45, No. 2, pp. 149–152). Sage.

Willig, C., & Stainton-Rogers, W. (2013). *The SAGE handbook of qualitative research in psychology.* Sage.

Wilson, L., & Rockstraw, L. (2012). *Human simulation for nursing and health professions*. Springer.

Withers, J. (1986). *Rail track and structures*. Transportation Research Board, National Research Council.

Wolf, T. (2010). Assessing student learning in a virtual laboratory environment. *IEEE Transactions on Education*, *35*(2), 216–222. https://doi.org/10.1109/TE.2008.2012114

Yin, R. K. (2018). *Case study research and applications: design and methods* (6th ed.). Sage.

Young, P. V., & Schmid, C. F. (1966). *Scientific social surveys and research: An introduction to the background, content, methods, principles and analysis of social studies* (4th ed.). Prentice-Hall.

Zazula, A., Myszor, D., Antemijczuk, O., & Cyran, K. (2013). Flight simulators – From electromechanical analogue computers to modern laboratory of flying. *Advances in Science and Technology – Research Journal*, *7*(17), 51–55. https://doi.org/10.5604/20804075.1036998

Zhang, C. (2016). *The effect of situation presence assessment method (SPAM) on air traffic control students' workload and performance in high-fidelity simulations* (Publication No. 1822503249) [Doctoral dissertation, Arizona State University]. ProQuest Dissertations and Theses Global.

Zoom. (2020). *Video conferencing, cloud phone, webinars, chat, virtual events: zoom*. Zoom Video Communications. https://zoom.us/.

Appendices

Appendix A: Permission to Conduct Study

Permission to Conduct Study

Date

RE: Permission to Conduct Research Study

Dear [redacted]:

I am writing to request permission to conduct a research study at the air traffic training lab located at the [redacted]. I am currently a doctoral from the Department of Instructional Design and Technology at the University of West Florida and am in the process of writing my dissertation. The study is entitled *Air Traffic Control Specialists Perceptions of Simulation for Developing Air Traffic Control Competencies*.

I hope that you will allow me to recruit five (5) Air Traffic Control Specialists (ATCSs) from the facility to participate in a 1-hour interview (copy enclosed). Interested ATCSs, who volunteer to participate, will be given a consent form to be signed (copy enclosed) and returned to the primary researcher at the beginning of the interview process.

If approval is granted, the interview will take place in my office or other quite setting at the facility at a time permitted by the Air Traffic Manager. If the COVID 19 pandemic persists, the interview will be conducted via Zoom video conferencing. The interview process should take no longer than 1 hour. I would like to audio record the interview sessions. The audio recorded interview data will be transcribed to a word document, and then the recordings will be deleted from the devices used to record them once transcription has been completed. After the study concludes, all of the material will be kept for 3 years, then the material will be permanently destroyed by deleting the files. The names of the participants and the name and location of this facility will remain absolutely confidential and anonymous. Should this study be published, only the combined finding of all the participants will be documented. No costs will be incurred by the organization, the facility, or the individual participants.

Your approval to conduct this study will be greatly appreciated. I will follow up via email next week and would be happy to answer any questions or concerns that you may have at that time. You may contact me at (850) 450-1060 or by email at charris@students.uwf.edu.

At any time, if you have any questions or concerns regarding this project, please feel free to contact my Committee Chair, Dr. Mark Malisa in the Department of Educational Research and Administration at The University of West Florida at (850) 474-6042 or by email at mmalisa@uwf.edu.

If you have any questions regarding your rights as a research participant, please contact the Institutional Review Board University of West Florida, (850) 474-2824.

If you agree, kindly sign below and return the signed form in the enclosed self-addressed envelope. Alternatively, kindly submit a signed letter of permission on your institution's letterhead acknowledging your consent and permission for me to conduct this study at your organization. Sincerely,

Colin Harris

Appendix B: Site Specific Authorization to Conduct Research

Site Specific Authorization to Conduct Research

Date:

Dear UWF Institutional Review Board:

The purpose of this letter is to inform you that I give Colin A. Harris permission to conduct the research titled Air Traffic Control Specialists Perceptions of Simulation for Developing Air Traffic Control Competencies at the [redacted] Air Traffic Control Facility. We have agreed to the following study procedures. Colin A. Harris will recruit five (5) ATCSs, interview 5 ATCSs, and audio record the interviews to be transcribed into Microsoft Word. The recordings will be deleted once transcription has been completed.

I understand that Colin A. Harris will receive consent for all participants. Colin A Harris has agreed to provide my office a copy of all University of West Florida IRB-approved consent documents before he recruits participants on site. I understand that the names of the participants and the name and location of this facility will remain absolutely confidential and anonymous. Any data collected by Colin A. Harris will be kept confidential and will be stored securely. Colin A. Harris has agreed to provide to us a copy of the aggregate results from his study.

Sincerely,

[redacted]
Air Traffic Manager
[redacted]
Federal Aviation Administration

Appendix C: Participant Recruitment Script

Participant Recruitment Script

Dear [*insert name*],

Hello, and thank you for your time.

My name is Colin Harris, and I am a doctoral student from the Department of Instructional Design and Technology at the University of West Florida. I am writing to invite you to participate in my research study about the value of using the ATCoach simulator (Radar Lab) to enhance ATC knowledge, performance skills, judgment, critical thinking skills, and self-confidence. You're eligible to be in this study because you have participated in simulation training in 2019. I obtained your contact information from the Federal Aviation Administration's MyProfile directory.

As part of my research study, I am required to interview ATCSs better to understand the value of ATC simulation on job-related competencies. If you decide to participate in this study, you will be asked to participate in a face-to-face interview. The interview will take place in my office with no other persons present. If the COVID 19 pandemic persists, the interview will be conducted via Zoom video conferencing. I would like to audio record your interview session. The audio recorded interview data will be transcribed to a word document, and then the recordings will be stored securely for 3 years after the completion of the investigation, then the data will be permanently destroyed by deleting the files.

Additionally, I will not share your identity, your duty location, or anything we discuss with anyone except my committee without your permission. To minimize risks associated with disclosure of confidential information, I will a number instead of your name on the interview transcript.

While there is no compensation for your participation, there are benefits to participating in this research. The data you provide will be used to inform education and development practices and strategies. Knowing what learning think about their training experience can help future Air Traffic Control Specialists.

Remember, this is completely voluntary. You can choose to be in the study or not. If you'd like to participate or have any questions about the study, please email or contact me at cah38@students.uwf.edu.

Thank you very much.

Sincerely,

Colin Harris

Appendix D: Copies of Human Subjects Research Training Certificates

CITI PROGRAM

Completion Date 01-Jul-2018
Expiration Date 30-Jun-2021
Record ID 27698061

This is to certify that:

Colin Harris

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Social and Behavioral Responsible Conduct of Research (Curriculum Group)
Social and Behavioral Responsible Conduct of Research (Course Learner Group)
1 - RCR (Stage)

Under requirements set by:

University of West Florida

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wb76a77ce-32be-4a86-90c6-634bcd63896f-27698061

Appendix E: UWF IRB Approval

UNIVERSITY of WEST FLORIDA

Research Administration and Engagement
11000 University Parkway
Building 11, Office 110
Pensacola, FL 32514

Mr. Colin Harris

May 29, 2020

Dear Mr. Harris:

The Institutional Review Board (IRB) for Human Research Participants Protection has completed its review of your proposal number IRB 2020-244 titled, "Air Traffic Control Specialist Perceptions of Simulationfor Developing Air Traffic Control Competencies," as it relates to the protection of human participants used in research, and granted approval for you to proceed with your study on 05-29-2020. As a research investigator, please be aware of the following:

* You will immediately report to the IRB any injuries or other unanticipated problems involving risks to human participants.

* You acknowledge and accept your responsibility for protecting the rights and welfare of human research participants and for complying with all parts of 45 CFR Part 46, the UWF IRB Policy and Procedures, and the decisions of the IRB. You may view these documents on the Research and Sponsored Programs web page at http://research.uwf.edu. You acknowledge completion of the IRB ethical training requirements for researchers as attested in the IRB application.

* You will ensure that legally effective informed consent is obtained and documented. If written consent is required, the consent form must be signed by the participant or the participant's legally authorized representative. A copy is to be given to the person signing the form and a copy kept for your file.

* You will promptly report any proposed changes in previously approved human participant research activities to Research and Sponsored Programs. The proposed changes will not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the participants.

* **You are responsible for reporting progress of approved research to Research and Sponsored Programs at the end of the project period 09-30-2020. If the data phase of your project continues beyond the approved end date, you must receive an extension approval from the IRB.**

* If using electronic communication for your study, you will first obtain approval from the authority listed on the following web page: https://uwf.edu/offices/institutional-communications/resources/broadcast-distribution-standards/.

Good luck in your research endeavors. If you have any questions or need assistance, please contact Research and Sponsored Programs at 850-857-6203 or irb@uwf.edu.

Sincerely,

Dr. Matthew Schwartz, Assistant Vice President
Research Administration

Dr. Carla Thompson, Chair, IRB for
Human Research Participant Protection

Appendix F: Informed Consent Documents

Consent Form

Title of Research: Air Traffic Control Specialists Perceptions of Simulation for Developing Air Traffic Control Competencies

Researcher: Colin A Harris

You are being asked to participate in research. For you to decide whether you want to participate in this project, you should understand what the project is about and the possible risks and benefits to make an informed decision. This process is known as informed consent. This form describes the purpose, procedures, possible benefits, and risks. It also explains how your personal information will be used and protected. Once you have read this form and your questions about the study are answered, you will be asked to sign it. This will allow your participation in this study. You should receive a copy of this consent document to take with you.

Explanation of the Study

This study is being conducted to explore Air Traffic Control Specialists' perceptions of the ATCoach simulator (Radar Lab) and the extent to which they perceive it as a valuable instructional method for enhancing ATC knowledge, performance skills, judgment, critical thinking skills, and self-confidence. If you agree to participate, you will be asked to participate in a one-on-one interview lasting approximately one hour. You will be asked a series of questions relating to your background and air traffic control experiences. You have the right to answer the questions. You may pass on any question that makes you feel uncomfortable. At any time, you may notify the researcher that you would like to stop the interview and your participation in the study. There is no penalty for discontinuing participation. You should not participate in this study if you have not previously participated in simulation training at your current ATC facility. Your participation in the study will last approximately four weeks.

Risks and Discomforts

No risks or discomforts are anticipated. However, if you feel at risk or uncomfortable at any time, you may notify the researcher that you would like to stop the interview and your participation in the study. There is no penalty for discontinuing participation.

Potential Benefits

I am hopeful that this study can help to identify areas of the simulation education that is significantly valuable and area that might need additional attention and resources. The fact that you have been solicited to participate in this study is a testament to the wealth of knowledge you possess about ATC operation and your experience with simulation training, and yet you may recognize the role you play in advancing air traffic training. By participating in this study, your answers will not only be assisting the researcher in gathering important information but might also help other future Air Traffic Control Specialists. I genuinely appreciate your participation.

Confidentiality and Records

Information you generate in support of this study will be kept confidential. Your confidentiality will be honored by assigning you will a number which will be used throughout the process. The interview will be tape-recorded to help me accurately capture your insights in your own words; however, your name will not be recorded on the tape. The tapes will only be heard by me for the purpose of this study. If you feel uncomfortable with the recorder, you may ask that it be turned off at any time. Your name and identifying information will not be associated with any part of the written report of the research. All of your information and interview responses will be kept confidential. The researcher will not share your individual responses with anyone other than the research committee. You also have the right to withdraw from the study at any time. In the event you choose to withdraw from the study, all information you provide (including recorded audio) will be destroyed and omitted from the final paper.

Compensation

None

Contact Information

If you have any questions regarding this study, please contact Colin Harris at (850) 450-1060 or by email at charris@students.uwf.edu.

At any time, if you have any questions or concerns regarding this project, please feel free to contact my Committee Chair, Dr. Mark Malisa in the Department of Educational Research and Administration at The University of West Florida at (850) 474-6042 or by email at mmalisa@uwf.edu.

If you have any questions regarding your rights as a research participant, please contact the Institutional Review Board University of West Florida, (850) 474-2824.

Statement of Consent

By signing below, I agree that I have read this consent form and have been given the opportunity to ask questions and have them answered. I have been informed of potential risks, and they have been explained to my satisfaction. I understand the University of West Florida has no funds set aside for any injuries you might receive as a result of participating in this study. I am 18 years of age or older. My participation in this research is completely voluntary. I may leave the study at any time. If I decide to stop participating in the study, there will be no penalty to me, and I will not lose any benefits I am otherwise entitled to. I will be provided a copy of this consent form.

Signature____ Date __________

Printed Name_____________________________________

Institutional Review Board
The University of West Florida

Recorded Media Addendum to Informed Consent

Project Title: *Air Traffic Control Specialists Perceptions of Simulation for Developing Air Traffic Control Competencies*

Date: *5/22/2020.* Investigator: *Colin Harris* Email Address *cah38@students.uwf.edu*

Phone *(850) 450-1960*

Description and Purpose of Recording:
The researcher would like to record the audio of each one-on-one interview for the purposes of transcribing verbal language into exact written language.

Confidentiality:
All identifying information in the interview will be redacted from the transcripts immediately. The interviewees will be assigned a number that will be used to replace the name. All interviews will be recorded, referencing the assigned number. A master list will be created, linking the assigned numbers to the participants. Only the researcher will have access to the Master List. All data will be stored electronically to the researcher's Western Digital private cloud storage server using a secured MacBook Pro computer and on a secure folder on the University of West Florida's (UWF) student Google Drive cloud storage. The Western Digital private cloud storage server, the MacBook Pro computer, and the secure folder on the UWF's student Google Drive cloud storage are all secured with encrypted passwords. Recorded audio files will be deleted from the devices used to record them. After the study concludes, all material will be kept securely for 3 years, then the data will be permanently destroyed by deleting the files.

Voluntary Consent:
By signing below, you are granting to the researchers the right to use your likeness, image, appearance, and performance – whether recorded on or transferred to videotape, film, slides, photographs, or other media – for preserving, presenting or publishing this research. No use of recorded media will be made other than for the reasons stated herein.

Your participation is voluntary and your refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue participation and withdraw this consent at any time without penalty or loss of benefits to which you are otherwise entitled.

If you have any questions regarding this study, please contact Colin Harris at (850) 450-1960 or by email at charris@students.uwf.edu.

If you have any questions regarding your rights as a research participant, please contact:

University of West Florida Institutional Review Board
11000 University Parkway, Building 11
Pensacola, FL 32514
(850) 857-6378
irb@uwf.edu

Subject's Printed Name & Signature	Date
Parent / Legally Authorized Representative's Printed Name & Signature (If applicable)	Date
Investigator's Printed Name & Signature	Date

Appendix G: Interview Protocol

PROTOCOL INTERVIEW GUIDE

Interviewer Name: ____

Interviewee Name: ____

Interviewee Age: ______________________ Interviewee Gender: ________________

Interviewee Race: ______________________ Interviewee ethnicity: __________________

Interviewee Hiring source: ____

Interviewee certification status: ____________________________________

Introduction

Good morning (afternoon). My name is Colin Harris. Thank you for agreeing to participate in this study. This interview consists of a series of specific questions relating to your experiences with the ATCoach simulator (Radar Lab).

Instructions

Tape Recorder Instructions

If it is okay with you, I will be recording our conversation. The purpose of this is so that I can get all the details and accuracy of your responses but, at the same time, be able to carry on an attentive conversation with you. I assure you that all your comments will remain confidential. I will be compiling a report which will contain all interviewees' comments without any reference to individuals.

Consent form instructions

Before we get started, please take a few minutes to read and sign this informed consent form.

Interview Instructions

Air traffic control *knowledge, performance skills, judgment, critical thinking skills, and self-confidence* are said to be key competencies all ATCSs need to manage air traffic. This study is interested in ATCSs perception of the simulation training used to develop these competencies. Specifically, I would like to hear, in your own words, about your experience with the ATCoach simulator (Radar Lab) and to what extent you perceive it as a valuable instructional method for enhancing these competencies. To get your perspective, I will ask you several questions about your experiences with the simulator. There are no right or wrong or desirable or undesirable answers. I will be using a framework called Bloom's Taxonomy to help me better understand your learning process. Bloom's Taxonomy states that learning should occur from easy to difficult in the following six levels: knowledge, comprehension, application, analysis, synthesis, and evaluation – knowledge being the lowest and evaluation the highest. Don't' worry; you don't need to know Bloom's Taxonomy to participate in this interview. The questions that I will be asking will be broken down into six sections, and each section will represent one of Bloom's Taxonomy levels. I would like you to feel comfortable with saying what you really think and how you really feel.

Interview Questions

Before we get started;

1. Please, tell me a little about your job as an ATCS and what does it consist of.
2. How do you describe the characteristics of the simulation training you have taken at your current duty location?

The next set of questions will focus on the six levels of Bloom's Taxonomy.

*The first set of questions will focus on the lowest level, the **Knowledge** level, and your experiences with the ATCoach simulator in developing your ATC Knowledge.*

3. What does the word "knowledge" mean to you in reference to air traffic control?
4. What type of knowledge (information) do you perceive you need to learn to be an ATCS?
5. What knowledge (or information) do you perceive you've learned from your experience with the ATCoach Simulator?
6. How have your experiences with the ATCoach simulator affected the way you recall ATC information such as ATC concepts and facts?

*The second set of questions will focus on the **Comprehension** level and your experiences with the ATCoach simulator in developing the ATC job-related knowledge competency.*

7. What aspects of the ATCoach simulator training helped in your understanding of the knowledge learned?
8. How do you think your experiences with the ATCoach simulator impacted your ability to understand and describe ATC-related facts such as aircraft classification, ATC phraseology, equipment status information, equipment capabilities, etc.?
    a. **Follow up:** If you were asked to explain or describe one of those ATC facts, what specific activities or scenarios from the ATCoach simulation training do you believe helped you understand those facts?

*The third set of questions will focus on the **Application** level and your experiences with the ATCoach simulator in developing the Performance skills ATC job-related competency.*

9. How do you feel the activities or scenarios used in the ATCoach simulation training relate to real-world situations and problems?
10. How has the knowledge, facts and techniques learned from the ATCoach simulator impacted how you perform ATCS duties such as handoffs/pointouts, coordination, etc.?
    a. **Probing:** In what ways have you applied the knowledge, facts, techniques, and rules learned on the ATCoach simulation to solve real ATC problems?
11. How has your daily performance as an ATCS changed after your experience with the ATCoach simulator?

*The fourth set of questions will focus on the **Analysis** level and your experiences with the ATCoach simulator in developing the Judgment and Critical Thinking ATC job-related competencies.*

12. How has your experience with the ATCoach simulator affected your ability to interpret complex ATC maps such as sector maps, geographic maps, MVA/obstruction maps, approach plates, etc.?
13. What have you learned about managing air traffic from your ATCoach simulation experience that has allowed you to make good decisions and "good control judgment" when providing ATC services?
14. In what ways has your experience with the ATCoach simulator impacted the way you scan an entire control environment, gather clues, and use those clues to draw conclusions?

*The fifth set of questions will focus on the **Synthesize** level and your experiences with the ATCoach simulator in developing the Judgment and Critical Thinking ATC job-related competencies.*

15. How have you used the different information learned from your experience with the ATCoach simulator to come up with your own unique ways of completing ATC duties?
16. Can you please explain "positive control?"
    a. **Follow up:** How do the integration of information and skills learned from your experience with the ATCoach simulator affect your ability to make positive control judgment?
17. Can you please describe a time when you had to actively and skillfully examine, break down, and incorporate information learned from your experience with the ATCoach simulator to come up with alternate ways of solving an ATC problem?
18. Can you describe an ATC situation such as an equipment failure or emergency that caused you to reflect on your experience with the ATCoach simulator?

*The sixth and final set of questions will focus on the **Evaluation** level and your experiences with the ATCoach simulator in developing judgment, critical thinking skills, and self-confidence.*

19. How have your experiences with the ATCoach simulator affected your ability to make value decisions about ATC related issues?
20. How do you think your experiences with the ATCoach simulator affected the way you prioritize ATC duties?
21. How have your experiences with the ATCoach simulator impacted your judgments about the values of methods, procedures, and other practices used in ATC?
22. What impact does your experience with the ATCoach simulator have on your self-confidence to operate safely in the live air traffic environment?

Closing Question

23. Is there anything else you would like to share about your experience with the ATCoach simulator before we complete this phase of the study?

This is the end of the interview. Thank you for your participation.