A Comparative Case Study of Nuclear Apprenticeship Participants' Perceptions of Self-Confidence in the Nuclear Workforce in South Carolina and Georgia

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ABSTRACT

The purpose of this study is to provide feedback about confidence-building and retention factors to institutions and businesses as they create programs to hire employees and help close the skills and labor gap in the nuclear industry. The United States currently suffers from a labor and skills shortage that has impacted several industries. The shortage resulted from increased Baby Boomer retirements (A.B. Krueger, 2017) and a lack of sufficient training programs to replace those vacancies (Christo-Baker et al., 2017; Lucas et al., 2018). Although many industries are affected, the nuclear field is of concern because of upcoming missions spearheaded by the U.S. government (National Nuclear Security Administration, n.d.; O'Sullivan, 2023; Trum, 2021; Volpe, 2015). Employers have partnered with local colleges to train new workers through apprenticeship programs that provide academic and workplace support for apprentices as they complete on-the-job and classroom training requirements. Program graduates must feel confident enough to thrive in the nuclear field, remain employed, and close the labor gap. For this study, a Comparative Case Study was conducted comparing nuclear apprenticeship graduates from schools and employers in Georgia and South Carolina to learn about their apprenticeship experiences. After analyzing the individual and focus group interviews, the findings revealed that the former apprentices were satisfied with their growth in confidence. Still, they sought increased financial stability, consistent instruction with hands-on learning opportunities, and a mentorship program during their training. These suggestions for improvements will be provided to higher education institutions, employers, and other stakeholders in the apprenticeship development process.

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DEDICATION

This dissertation is dedicated to my father, Heri Lee Polite, Sr., affectionately known as "Papa." As my biggest cheerleader, you were there with me when I started this doctoral journey, and you were so excited to see me tackle this new venture. Although you are no longer with us, I know you are still cheering me on, watching me, and feeling so proud. Thank you for loving me, encouraging me, and never giving up on me. I love you.

Chapter I

Introduction to the Study

A labor and skills gap exists in the workforce development sector. Two significant reasons are contributing to this gap. The first is a large retirement of workers over the past decade (A. B. Krueger, 2017). As knowledgeable workers leave their careers, they take their skills and experience with them (Burmeister & Deller, 2016). The number of United States citizens over the age of 65 is predicted to increase from 46 million to 98 million between 2015 and 2060, further exacerbating the problem (Henderson et al., 2017). Then, the lack of adequate training programs worsens the gap, slowing down the knowledge transfer needed to close the skills gap (Christo-Baker et al., 2017; Lucas et al., 2018). Training programs are designed to replace vacancies in multiple industries. Bilginsoy (2018) described the deficiency in the construction industry regarding trainees and their struggles in their apprenticeships. Various positions within the automation division also require adequate training to secure new workers (Cummins et al., 2019). In 2017, Christo-Baker et al. reported there were 600,000 unfilled skilled positions in the US manufacturing industry, and that number was projected to increase due to insufficient knowledge transfer practices. Even the Information Technology (IT) field is affected by subpar training practices, leading to a skills and labor gap (Christo-Baker et al., 2017; Hawk et al., 2012).

Further inquiry into this issue is needed because employers across the nation are having difficulty locating personnel with the necessary soft skills for entry-level positions (Oakes, 2016). They also struggle to locate workers for technical positions that require hard skills due to a lack of appropriate education, further reducing the pool of qualified applicants (Oakes, 2016). The gap in skilled labor presents a risk of economic decline in the United States if the citizens are not trained with the necessary hard skills (Henderson et al., 2017). The general productivity of the United States could be reduced with a decrease in the labor supply. However, a small increase in the number of people obtaining a bachelor's or an associate's degree could result in economic increases. For example, if this occurred in the state of California, there could be a $20 billion increase in economic output, $13 billion of improved worth, $1.2 billion more in yearly state and local tax profit, and 174,000 additional jobs (Oakes, 2016). Skilled laborers are needed to further the country and stimulate the economy.

Training professionals at all levels for these career paths is essential. Addressing this issue draws more attention to technical education and an alternative route to stability and success in one's career (Anderson & Keily, 2021). A four-year degree is not always required for every profession (Anderson & Keily, 2021; Chen, 2021). A technical degree may be more economically viable for those who want to join the workforce quickly (Farrington, 2022; Titus et al., 2021). For example, Farrington (2022) reported that the average cost of attending a public, four-year school in America was $10,740 for in-state students, while a trade or a technical school was almost half the cost. Additionally, a certificate, diploma, or degree from a community college can take six to 24 months to complete compared to four or more years for a bachelor's degree (Farrington, 2022).

Pursuing a technical credential could provide a faster path to gainful employment with smaller financial responsibilities for the student.

Like the workforce in general, the nuclear field is also experiencing a gap between available positions and the number of skilled workers, and that gap continues to widen as the nuclear field expands. The Department of Energy is pushing for the implementation of nuclear power and the increased use of electrical energy across the country (Trum, 2021; Volpe, 2015). Unit 4 at Plant Vogtle in Waynesboro, Georgia, entered commercial operation in 2024, and permits to build new nuclear plants in Wyoming, Texas, and Tennessee were submitted at the end of 2024 (Office of Nuclear Energy, 2024a). Additionally, at least 20 nuclear reactors in the United States are in various stages of the decommissioning process, which takes anywhere from 7 to 60 years (O'Sullivan, 2023; Today in Energy, 2017). Therefore, the need for skilled laborers is timely and pressing.

The existing literature highlights the need for programs to combat this issue (Christo-Baker et al., 2017; Kwok, 2022; Lucas et al., 2018). However, there is a lack of research pertaining to specific programs dedicated to educating and preparing young individuals for careers in the nuclear industry. Few sources describe programs that have successfully trained and secured employment for their participants in the United States. Industries in Europe and Australia have effectively created partnerships with higher education institutions to implement apprenticeships to train students and integrate them into the workforce (Fortwengel et al., 2021). Several journal articles report on these apprenticeships (Harris, 2015; Wiemann & Fuchs, 2018), but very few are available on workforce development and apprenticeship programs' efforts (or lack thereof) in the

United States. Harris (2015) reported that although a low percentage (27%) of employers in Australia were using apprenticeships for training, 79% were satisfied with the quality of the apprentices. He also noted that 71% of former apprentices remained employed in their occupation, and 15% left the occupation while still finding the training useful. Dual vocational education and training (VET), as described by Wiemann and Fuchs (2018), is one of Germany's major successes, contributing to its strong manufacturing sector and large pool of skilled workers. In Dual VET, a common choice for German citizens, apprentices attend a vocational school and work with a specialized company for 3 to 4 years (Wiemann & Fuchs, 2018). During this time, they learn soft skills and job-related proficiencies. The programs are regulated by legislation that receives input from employers, trade unions, educators, and state and federal authorities (Wiemann & Fuchs, 2018). These programs have been very successful, and the German government is attempting to implement the model in the Chinese, Indian, Brazilian, Russian, and Mexican economies (Wiemann & Fuchs, 2018).

Several factors are commonly associated with the success of registered apprenticeships in the nuclear workforce and their use in closing the labor and skills gap. One is the lack of apprenticeships and their use in the United States (Fortwengel et al., 2021). Increasing employer buy-in plays a significant role in growing the number of apprenticeship programs in this industry. Another factor of a thriving apprenticeship program is the collaboration between higher education institutions and employers when creating and implementing apprenticeship programs. Relly and Laczik (2022) discovered that programs have a greater overall success rate when all entities, including the students, communicate together and build a sense of trust. The desired skills of the employer,

which may include technical and soft skills, also play a role in how apprenticeships are developed to address the skills gap. This skills gap contributes to the labor gap, which is intensified by the large retirement of skilled workers, as stated by A. B. Krueger (2017). Finally, the last success factor, which is a central focus of this study, is understanding the types of support for the apprentices from the school and the employer. Support, or lack thereof, can influence the success rates of the individual and program (Fabian et al., 2022). This study seeks to discover the impacts of these support systems on former nuclear apprentices' self-confidence and intentions to remain employed in the nuclear field.

A deeper understanding of the role registered apprenticeships play in closing the labor and skills gap will make the following contributions to the field of study. First, after studying and gathering data from the available nuclear apprenticeships and programs already established to guide interested individuals to these occupations, approaches to increase their effectiveness at creating professionals with the necessary soft skills can be published for others to view. Secondly, components of the training can be analyzed to understand job preparation strategies better and uncover methods of encouraging apprentices and trainees to remain in the career long term. Lastly, the collection of results will aid higher education leaders, employers, and government officials with the most effective tools, resources, and models when designing and implementing new training programs. Collaboration between all parties is essential through all phases of workforce development plans. Understanding the best balance for each organization will allow for a seamless flow through hiring, training, graduating, and other processes.

Statement of the Problem

About 92 nuclear reactors at 54 plants throughout the United States currently support approximately 475,000 jobs (Nuclear Energy Institute, n.d.-a; U.S. Energy Information Administration, 2023). With new projects from the Department of Energy on the horizon, such as the production of plutonium pits at the Savannah River Site in South Carolina and Los Alamos National Laboratory in New Mexico (National Nuclear Security Administration, n.d.), and the increased push for clean, electrical energy across the country in addition to the continued waste cleanup, a supply of workers in the nuclear field will be needed (Department of Energy, 2022). However, according to Morris (2019), almost half of the current workforce is reaching retirement age. Mass retirement and resignation resulted in a large-scale loss of knowledge and expertise as far back as seven years ago, creating a labor and skills gap that still exists due to the lack of training programs that produce quality employees (Christo-Baker et al., 2017; Henderson et al., 2017; Lucas et al., 2018). Additionally, that loss may create a potential decline in economic growth if the positions are not filled (D. Park & Shin, 2023).

Various institutions currently use apprenticeships to train new workers for positions in the nuclear field.[1] However, what if the training does not build confidence in the apprentices in addition to the necessary skills needed for work? In that case, retention in the career may not occur, and the labor gap will persist. This study will investigate the

[1] All information regarding Site 1, Contractors 1, 2, and 3, and Institutions A, B, and C is from publicly accessible sources. Due to the nature of the study and the need to protect the anonymity of the study participants, references to the specific sources are not included in this dissertation. Should any interested parties wish for verification of this information, please contact the author of this dissertation. At their sole discretion, they may be willing to share this information with interested parties.

experiences of graduates of nuclear apprenticeships, indicating which factors impact feelings of confidence and intentions to remain in the nuclear field.

The existing empirical data in the literature also present a gap in this topic. For instance, Decker (2021) surveyed employers and higher education officials to understand the disconnect between the two when establishing apprenticeships for various industries that did not include nuclear. However, this study aims to uncover the nuclear apprentices' perspectives of the employer and higher education institution's relationship and the support it provides as they complete their training program. The study's results could supply additional information to influence the apprenticeship structure to maximize outcomes and increase employee retention, assisting in closing the skills and labor gap.

Other studies mention using apprenticeships to close the labor gap, but their participant group does not include the nuclear field. Hunt (2020) focused on closing the gap in the maintenance industry. Bona (1997) and Crewe (2020) explored the impact of apprenticeships in various industries such as manufacturing and welding. Crewe discovered that apprenticeships in Virginia are less likely to fill middle-skill occupations with a gap. Bona took a different approach and sought a relationship between registered apprenticeships and the high turnover rate in the skilled trades. His research concluded that the use of apprenticeships does not influence the turnover rate in the manufacturing industry. A study in British Columbia, Canada, by Myers (2003) collected data to improve teaching methods and include technology in informal settings for automotive, carpentry, mechanics, and welding apprenticeships. Another research study aimed to include women to increase the number of women and close the gap (L. J. Shaw, 2001). Lastly, To (2017) conducted a program evaluation of an apprenticeship for steam

generator operators to gather data on the effectiveness of their program. While all of these studies are pertinent and provide excellent knowledge to the academic and workforce development sectors, they do not delve into the nuclear field, an industry suffering from a large gap.

Although limited, there are existing studies that involve nuclear apprenticeships or the nuclear industry in general. In 2008, Schmidt (2008) conducted interviews about radiation curriculum development for an apprenticeship program. While beneficial, a limit of this study is that it did not indicate how the apprenticeship or new curriculum was implemented. A case study that followed 25 programs identified apprenticeships at The Apprentice School by Newport News Shipbuilding as a sufficient way to train people for Virginia's workforce needs (Christman, 2012). Only one of the 25 programs in this study, Nuclear Test Technician, was related to the nuclear field. Rintala and Hyttinen (2006) examined the transfer of tacit knowledge in the nuclear field, but their findings did not include apprenticeships as a potential method.

There is one existing study that is most compelling regarding this topic. Herrera (2019) researched retention factors of new hires in the nuclear industry, but his study population was centered on Science, Technology, Engineering, and Math (STEM) millennials. The new hires were interviewed, and the results were provided to Human Resources managers in an effort to retain new employees, save money, and close the labor gap. Apprenticeships were not mentioned as a training method for these new hires. Given the circumstances of the workforce and literature search, a qualitative study on using apprenticeships to close the skills and labor gap in the nuclear field is timely and necessary.

This study focuses on determining what apprenticeship program factors affect recent graduates' self-reported feelings of confidence and intentions to persist in the nuclear field. The results would assist agencies in improving or creating their apprenticeship programs, as S. Shaw et al. (2020) described, thus producing effective training methods to address the current labor shortage better. Longevity in the nuclear career is essential to addressing the shortage. Completing an apprenticeship program does not guarantee high retention rates for employers once the apprentices reach their permanent positions. The apprentices must graduate with the necessary job skills and the confidence to be successful in their careers and remain employed for a long time. Employers can potentially combat high turnover rates due to low confidence or a lack of skills with the knowledge unveiled from the results of this study.

Purpose of the Study

The purpose of this study is to provide key information about confidence-building and retention factors to institutions and businesses as they plan apprenticeship programs to acquire new talent and help close the skills and labor gap in the nuclear industry. The findings will unveil the experiences of apprenticeship graduates as they navigated the process of discovering a position in the nuclear field and becoming employed in it. Their self-confidence will be used to indicate their perception of career readiness as they begin a new position at a nuclear facility. The meaning of training experiences will be vital to understanding what it takes to help those interested in the field remain employed.

This study will include three factors that may affect self-confidence and retention. The first is the graduates' ability to balance work, school, and other responsibilities outside of those two domains during the program (i.e., life). The second factor will be the

availability and use of academic resources at the graduates' institutions. These resources may include, but are not limited to, the library, academic tutors, career and life coaches, the testing center, a computer lab, a STEM/STEAM room, and more. The last factor is workplace support systems such as mentoring programs, onboarding orientations, and employee assistance programs (EAP). Subfactors may emerge from these main factors. For example, financial stability and the need to secure a part-time job will fall under work/school/life balance. The study will not include a subfactor that cannot be placed under one of the three main factors.

Other factors may contribute to the self-confidence and career retention of the graduates. However, they will not be examined in this study. These factors include previous nuclear work experience, any academic or training experience after high school outside of the nuclear apprenticeship, mental and emotional well-being, physical health, leadership opportunities, and job performance. Although these factors may influence their experience in the program (Beiter et al., 2015; Maliszewski Lukszo & Hayes, 2020; McFadden, 2016), it does not impact the courses and training path of the individual programs. Most apprentices travel in a cohort, and all have the same academic requirements. An additional study should be considered at a later date to gather data about the relationships between these factors and self-confidence and retention.

Research Questions

Two qualitative research questions with two sub-questions were created to learn about the graduates' experiences in their nuclear apprenticeship program. Each question and sub-question strives to gather information about potential influences on self-

confidence from factors both in and out of the academic and work environment. The research questions and sub-questions are listed below:

1. What are the lived experiences portrayed by the graduates of a nuclear apprenticeship program?
2. How does engagement in a nuclear apprenticeship program affect graduates' confidence in their ability to succeed in their nuclear careers?
    2.1. How do graduates depict the impact of variety and utilization of academic resources available throughout the apprenticeship program on their level of confidence in job performance as they transition to their careers in the nuclear field?
    2.2 How do graduates portray the influence of support strategies provided by their employer for the duration of the apprenticeship program on their confidence levels of occupation-related duties as they prepare for their career in the nuclear field?

Research question one seeks to determine how factors including, but not limited to program length, financial issues, and work/school/life balance, affected the apprenticeship graduates' confidence levels throughout and after the program. This question may also assist in identifying a possible connection between those factors and the intention to persist in the nuclear field. Data collected through a protocol for this research question may identify potential areas in apprenticeship programs to be strengthened. This information could be used by policymakers at educational institutions and businesses to enhance future apprenticeship programs. By incorporating components employees need outside of academic and workplace training, there will be an increased

likelihood that the apprentices will be successful and remain in the field to close the labor and skills gap.

Research question two explores a different outlook. To foster the apprentices' success, which may lead to an increase in their confidence, various tools are supplied throughout the program. To effectively gather data on this aspect, two sub-questions are needed. The technical colleges that provided the classroom training portion of the apprenticeship made different resources available to aid in the learning process. Similarly, the apprentices' employers strategically arranged the schedules, training, and opportunities during the on-the-job segment of the apprenticeship to maximize the attainment and implementation of the newly acquired skills. Sub-questions 2.1 and 2.2 further explore these topics.

Research sub-question 2.1 addresses the problem by having graduates identify the academic resources that were most beneficial to their new career in the nuclear field while describing how and why these factors contributed to their confidence levels and intentions to remain in their career. Understanding the most important academic resources for nuclear apprentices will guide program developers as they create and modify apprenticeship programs to train individuals to close the labor and skills gap quickly.

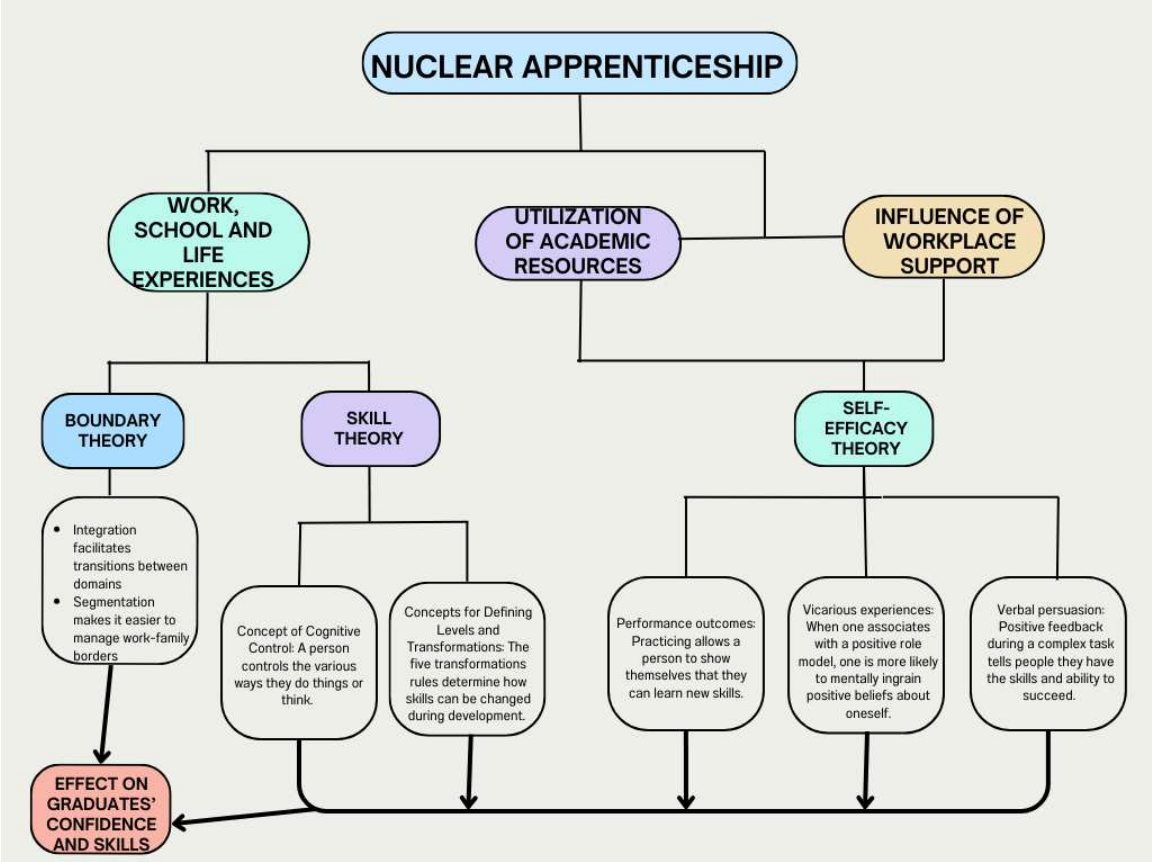
Research sub-question 2.2 aims to reveal the support strategies provided by the graduates' employer that were the most advantageous throughout the program, resulting in increased confidence and a higher likelihood of achievement in the nuclear field. Knowing what supports to put in place to achieve a higher retention rate will aid companies in hiring and maintaining new employees to close the labor and skills gap.

Theoretical Framework

Researchers and psychologists have developed many theories to explain human behavior. Several theories relate to skills, confidence, and work/life balance for this study. However, only a few were determined to capture the essence and purpose of the study entirely; their connections are shown in Figure 1 below. The Boundary Theory, by Nippert-Eng (1996) and Ashforth et al. (2000), discussed work/family borders, and the Self-Efficacy Theory (Bandura, 1977) supported the concept of motivation. Finally, the Skill Theory (Fischer, 1980) proposed a series of levels and tiers to correlate with each stage of development when learning a new skill. Similar theories that do not fulfill the study's needs are also discussed in this section.

Figure 1

Conceptual Framework Concept Map



Boundary Theory

For research question one, the Boundary Theory developed initially by Christina Nippert-Eng (1996) and later refined by Ashforth et al. (2000) can be used to explain the interactions between work, school, and life balance (Desrochers & Morgan, 2021). This theory explores how people transition between their roles at work, school, and other areas. Since research question one is focused on connections between these roles in life and confidence in the graduates' careers, this theory can be used to explore how and why graduates were able or unable to maintain a balance and see if that balance affected persistence in their careers. In this study, the Boundary Theory can be used to relate the factors of work, school, and life to confidence and retention. According to Desrochers and Sargent (2003), the main principles of the theory are:

- Keeping work and family separate makes it easier to manage work-family borders,
- Integrating work and family facilitates transitions between these domains,
- Both strategies can improve the well-being of employees, the meanings they attach to work and family, their preferences for integration versus segmentation, contextual factors, and the fit between their preferences and the boundaries allowed by their social context.

The Border Theory by Sue Campbell Clark (2000) is a competing theory for research question one. It has the same principles as the Boundary Theory, as previously stated. However, this theory is strictly limited to work and home domains, and this study aims to include the academic portion of the apprenticeship in the data. The Boundary Theory is appropriate for research question one because it investigates the transitions between roles in life. Unlike the Border Theory, the Boundary Theory includes more areas, so work, school, and life can be included in the analysis. Primary and secondary factors, such as financial stability and program length, can be addressed under this theory. An apprentice's financial stability will determine if they must secure a part-time job, potentially disrupting the balance. The program length will also affect the apprentices' work/school/life balance because a longer program may require more time away from family to study or work part-time to make ends meet.

The Boundary Theory meets the requirements for the qualitative data needed for this study. As the graduates discuss their roles at school, at home, and in other areas of life, they will also be given a chance to describe the confidence levels experienced during various points of the program and explain if those levels were affected by the balance or

lack thereof. This theory assists in improving the experiences of future employees who will be graduates of nuclear apprenticeships. Learning about the impacts of the work/school/life balance on self-confidence from recent graduates will provide the knowledge and insight needed to make changes and improve the program for future workers in the nuclear field.

The disciplines that utilize the Boundary Theory vary greatly. Some studies apply the theory to gender studies and marginalized groups (Nsair & Piszczek, 2021), while others focus on effectiveness in the household with families (Otonkorpi-Lehtoranta et al., 2022). Many explore the workplace and embrace employee achievement, satisfaction, mental health, and relationships (Daniel & Sonnentag, 2016; Dekel & Nuttman-Shwartz, 2016; Pillemer & Rothbard, 2018). This last area relates to the scope of this study. As of October 15, 2025, Nippert-Eng's (1996) book on the Boundary Theory had been cited at least 2528 times, with the latest citation being from 2025. The citations span several topics, such as availability for work, family and leisure (Gross, 2023), fatherhood (Gallais, 2023), employee retention (Unsworth & Seivwright, 2023), mental health in the construction industry (Lim & Francis, 2023), and more. It is used internationally and has even been cited in papers written in Spanish and German (Pinochet Cobos & Muñoz-Retamal, 2022; Wöhrmann et al., 2021).

Ashforth et al. (2000) published their work on the Boundary Theory 25 years ago, defining the concepts of boundaries and identities. They also debated whether the roles are segmented or integrated and if moving between them becomes more seamless over time. Their findings on the Boundary Theory resulted in their paper being cited over 4700 times when the article was accessed on October 15, 2025. Topics from their citations

include working from home (Allen et al., 2021), work/family conflict (Allen et al., 2013), work/family culture effects on job satisfaction (Aura & Desiana, 2023), and the effects of role conflict on applicant attraction (Rau & Hyland, 2002). This study can add to the plethora of information related to the Boundary Theory.

Self-Efficacy Theory

For research sub-questions 2.1 and 2.2, the Self-Efficacy Theory by Albert Bandura (1977) can be used to explain the interactions. A core belief of this theory is that self-efficacy can supply the foundation for motivation, well-being, and personal accomplishment (Lopez-Garrido, 2025). The Self-Efficacy Theory connects with both sub-questions because it focuses on various ways to improve one's self-efficacy and motivation, which may lead to more success and confidence in apprenticeship graduates. Hopefully, this confidence will result in higher retention rates.

The Self-Efficacy Theory by Bandura (1977) utilizes principles that support building self-confidence, which is explored in research sub-questions two and three. Lopez-Garrido (2025) listed four factors that affect the development of self-efficacy:

- Performance outcomes. Practicing allows a person to show themselves they can learn new skills.
- Vicarious experiences. When one associates with a positive role model, one is more likely to mentally ingrain positive beliefs about oneself.
- Physiological feedback. Properly managing moods and mental changes during difficult experiences can lead to higher success for individuals.
- Verbal persuasion. Positive feedback during a complex task tells people they have the skills and ability to succeed.

Academic and workplace support, including safety practices, mentorship, and communication/clear training plans, can be used to increase apprentice motivation, success, and confidence, which are areas the theory can be used to explore. Each support provided by the academic institution or employer could contribute to *Performance Outcomes*, *Vicarious Experiences*, *Physiological Feedback*, and *Verbal Persuasion* in ways that increase the chances of retention in the nuclear field. Collecting information from the graduates about which supports were available and if they were helpful and then relating them to one of the four factors associated with this theory could justify retaining or increasing the use of supports in future programs. Knowing if these supports were available to the graduates would guide program developers in making necessary changes.

A competing theory for research sub-questions 2.1 and 2.2 is the Attribution Theory by Fritz Heider (1958). Bernard Weiner (1974) later contributed to the theory (Instructional Design, n.d.). There are three key principles associated with this theory (Instructional Design, n.d.):

- Attribution is a three-stage process: the behavior is witnessed, the behavior is determined to be intentional, and the behavior is attributed to internal or external causes.
- Achievement can be attributed to effort, ability, level of task, or luck.
- The factors of behavior are the locus of control, stability, and controllability.

However, this theory is not suitable because Heider believed all behavior is determined by either external (situational) or internal (dispositional) factors, not a combination of both (Instructional Design, n.d.). Dispositional attribution looks to personality traits, personal beliefs, or emotions to explain the behavior, while situational

turns to situational or environmental factors (McLeod, 2023). This study seeks to discover how external factors (support and balance) affect internal factors (motivation and self-confidence). Additionally, the Self-Efficacy Theory acknowledges various ways to influence a person's behavior, including situational and dispositional causes (Lopez-Garrido, 2025). Lastly, the components of research sub-questions 2.1 and 2.2 can more easily be related to the key principles of the Self-Efficacy Theory. For these reasons, the Self-Efficacy Theory is a better choice for this study.

Another competing theory for research sub-questions 2.1 and 2.2 is the Social Cognitive Theory by Albert Bandura (1986). This theory focuses on learning in a social environment and assumes learning occurs through observing other's actions and the consequences of those actions (Nickerson, 2023). Self-efficacy is one feature of the Social Cognitive Theory, relating it to the Self-Efficacy Theory. However, it is just one of many features and plays a shared role (Nickerson, 2023). The features of the Social Cognitive Theory, as shown by Nickerson (2023), are:

- Reciprocal Determinism. Individuals aspire to cultivate a feeling of empowerment and assert influence over significant occurrences in their lives.
- Behavioral Capability. An individual's capacity to execute a behavior through the application of their knowledge and abilities. To complete a task, a person must know what and how to do it.
- Reinforcements. The internal or external reactions to an individual's behavior influence the probability of continuing or discontinuing the behavior. They can be self-initiated or in one's environment, positive or negative, or direct or indirect.

- Expectations. The expected outcomes that an individual associates with their behavior. Previous experiences usually influence them and may determine if the behavior is completed successfully.
- Self-Efficacy. The degree of an individual's self-assurance in their ability to effectively execute a behavior. It is influenced by a person's capabilities and individual and environmental factors.

The Social Cognitive Theory is not the best theory for this study because it emphasizes observational learning and modeling (Nickerson, 2023), which is not the focus of this study. Although observational learning and modeling are teaching methods that may affect skills retention and self-confidence, this study's core is the effects of internal and external factors on graduates' motivation and self-confidence. The Social Cognitive Theory also relies on consequences and positive or negative reinforcements to explain learning. While there are consequences to stopping out of the apprenticeship program and potential internal positive reinforcements, this study will not collect data on those aspects. Therefore, the Self-Efficacy Theory is the appropriate theory to use.

Bandura's (1977) initial paper on self-efficacy has been woven through the literature throughout the years. As of October 15, 2025, it has been cited 125,386 times. His paper introduced the idea of using the four aforementioned principles to influence the amount of effort exerted and the extent of the effort by an individual during times of duress or challenge. Other researchers have applied this study to address the achievement gap caused by the COVID-19 pandemic (Goudeau et al., 2021), climate anxiety (Clayton, 2020), healthcare interventions for rehab patients (L. G. Park et al., 2021), teacher self-efficacy and its impact on student academic adjustment (Zee & Koomen, 2016), and

more. The range of educational topics is great; several studies reviewed the relationship between self-efficacy and academic performance. Grit and planned behavior are also common themes that utilize the Self-Efficacy Theory. Grit is directly related to lifelong learning and achieving professional success (Duckworth & Gross, 2014), and grit and self-efficacy positively impact achievement goals and academic performance (Alhadabi & Karpinski, 2020). Not as many sources focus on employees or the workplace, but this study may provide new information to add to the body of knowledge surrounding the theory.

Skill Theory

Perhaps the most comprehensive theory that underlies the focal point and actual issue of the labor and skills gap is the Skill Theory by Kurt Fischer (1980). This theory states that skills develop in a step-by-step fashion organized into ten levels over three tiers. The tiers are sensory/motor, representation, and abstract skills. (Fischer, 1980). The levels correspond to complexity; higher-level skills are formed by combining skills from multiple lower levels. Further research described skill building as a web with multiple strands; each person has a unique web that allows them to achieve the same skill in a different manner (Fischer & Rose, 2001).

Fischer (1980) listed three main assumptions for the Skill Theory:

- Concept of Cognitive Control: A person controls the various ways they do things or think.
- Nature of Skills: Several classes or sets of skills vary based on the level and tier.
- Concepts for Defining Levels and Transformations: There are several ways to define levels, but it is important to note that higher levels include all the skills of

the lower level, and the level describes the skills of a person, not the person. The five transformation rules also determine how a skill can be changed during development.

Understanding how skills develop in people of all ages and affect their self-confidence will contribute to creating programs and learning materials for those in high-need industries. Combining the principles of the Skill Theory with those of the Boundary and Self-Efficacy Theories will provide a complete picture of how people set goals, manage their responsibilities, and increase their knowledge while under pressure or in a new environment. This study will attempt to relate each interview question to a theory and refer to the theories when analyzing the data and reporting the findings.

Significance of the Study

The loss of knowledge initiated the labor and skills gap in the nuclear field due to increased retirements (A. B. Krueger, 2017; Rintala & Hyttinen, 2006) and worsened by a deficit of training programs to locate and educate replacement workers properly (Christo-Baker et al., 2017; Lucas et al., 2018). The addition of new nuclear projects, as indicated by the National Nuclear Security Administration (n.d.) and Department of Energy (2022), increases the need for suitable training programs to supply qualified professionals to close the skills and labor gap in the nuclear industry. Although apprenticeship programs are already used to train new hires in this industry, the gaps still exist. Additionally, research has not shown the effectiveness of these programs from the apprentice or employer perspective.

Combating the skills and labor gap begins with addressing the desires of the employers. Hard and soft skills, which tend to overlap in the workplace, are evident in a

competent and sought-after employee (Lamri & Lubart, 2023). Hiring new, qualified workers becomes challenging when these skills are lacking or non-existent (Hawk et al., 2012). Hard skills refer to technical abilities related to using distinct equipment and are often measurable, while soft skills focus on workplace characteristics and are challenging to quantify (Lamri & Lubart, 2023). An example of a hard skill from the nuclear industry is using a probe to read radiation dosages at a contamination site. A soft skill can transcend multiple industries; common soft skills include critical thinking, conflict resolution, and time management (Hawk et al., 2012). An appropriately structured apprenticeship program can supply knowledge for hard and soft skills. Utilizing the apprentices' input from this study will shape future training programs' structure and delivery methods, helping attract and retain workers to close the skills and labor gap.

Collaboration between the employer and higher education institution (HEI) is critical to closing the labor and skills gap. Although it is not a central focus of this study, it is related to the concerns and outcomes. Relly and Laczik (2022) stated that apprentices' academic and workplace success are top priorities for both companies and HEIs. Support for these goals has been seen in the form of apprenticeships, internships, resume workshops, career fairs, and more (Dey & Cruzvergara, 2014). Strengthening the partnership between the HEI and the employer may lead to deeper involvement in the apprenticeship, including input from the hiring stage, curriculum planning, and scheduling (Martin et al., 2020). This level of immersion may lead to optimal training experiences and results, assisting in closing the skills and labor gap. To successfully implement the findings from this study's participants, both entities will need to work together to create or amend the apprenticeship as needed.

At least three technical colleges already use nuclear apprenticeship programs at one Department of Energy site. These apprenticeships have academic and workplace support in place for their apprentices, stemming from the collaboration of the HEI and employer. These support systems, which include free tuition, access to tutors or academic coaches, no-cost textbooks, library and computer privileges, and more, are established to increase the program's effectiveness in building hard and soft skills. Fabian et al. (2022) reported that apprentices often have more positive experiences when access to academic support systems is available. The apprentices also exhibited an increased effort in their studies when a sense of belonging at the college was created (Fabian et al., 2022). Additionally, marginalized groups may need specialized support throughout the training program (Mollica, 2020). The support provided by the HEI and employer may vary based on the occupation and group of apprentices.

This study's central goal and focus is to understand the effectiveness of the academic and workplace support systems constructed by the HEI and employer on the apprentices' confidence in their skills in the workplace and their desire to remain employed in the nuclear field. Additionally, the ability to balance their work duties, academic requirements, and other aspects of life while using these supports will be examined, as this balance will influence their success in the program. The current support systems were created to assist apprentices in developing their hard and soft skills while being hired to close the labor gap. The results of this study will reveal if the current systems are adequate in helping to train apprentices to become confident, lifelong workers in the nuclear industry.

Methods

A comparative case study was employed to gather the data needed for the study. Qualitative data, such as interviews, was collected and analyzed to provide recommendations for employers and higher education institutions involved in the nuclear field and suggest directions for further research. A comparative case study analyzes two or more cases that strive to achieve the same goal and can be used without a control group (Goodrick, 2014). Often, as noted by Goodrick (2014), the impact of an intervention on the similarities and differences between the cases is tracked throughout the study's duration. Goodrick also stated that a comparative case study can use either qualitative or quantitative data or a mixture of both. For these reasons, this research design is suitable for this study.

Three cases were included in this study. Former apprentices of contractors at a Department of Energy complex, which is coded as Site 1, will be the participants. The three contractors are coded as Contractor 1, Contractor 2, and Contractor 3 to maintain participant confidentiality. Each contractor employs apprentices in various nuclear apprenticeships at local technical colleges. The contractors all have the same goals: quickly train and hire apprentices to replace retiring workers and close the labor gap. Additionally, the apprentices are also working towards similar goals: complete the apprenticeship program with the required scores and establish a career with financial stability. Since the contractors and apprentices are working towards the same outcomes, a comparative case study can be used to explore their experiences.

Interviews with apprenticeship graduates from each contractor will provide rich data for the study. The initial interviews were individual, and follow-up focus group

interviews occurred based on the results. After transcribing the interviews, coding and thematic grouping was conducted (Saldaña, 2021). The initial coding and post-analysis will confirm the findings, which were compiled into a narrative to be shared with stakeholders.

Assumptions, Delimitations, and Limitations

Assumptions

The assumptions of a research study are statements presumed to be true by the researcher (PhDStudent, 2024; Simon, 2011). The following are the assumptions of this study.

1. Participants will openly share their thoughts on the apprenticeship program with the researcher.
2. Many graduates from nuclear apprenticeship programs employed with Contractor 1, Contractor 2, or Contractor 3 will actively seek participants in this study to have the opportunity to share their experiences.
3. The data gathered from the interviews will reflect the apprentices' experiences from academic and workplace perspectives.
4. The information collection will impact the skills and labor gap.
5. My connection and knowledge of the apprenticeship programs will not affect the study outcomes.
6. I will control the potential for bias within the study.

Delimitations

Delimitations in a study are the boundaries and parameters set forth by the researcher to maintain control over the size and feasibility of the project (PhdStudent, 2024; Simon, 2011). Below are the delimitations of this study.

1. Participants will be graduates or stop-outs of nuclear apprenticeships at a company or contractor at Site 1.
2. The contractors are limited to only three of the Site 1 contractors.
3. The apprenticeship must be registered with the Department of Labor.
4. The graduates do not have to be currently employed in the nuclear field.
5. The following factors may have an impact on the apprentices' confidence, but they will not be covered in this study:
    a. Previous nuclear work experience
    b. Any academic or training experience after high school outside of the apprenticeship program
    c. Mental and emotional well-being
    d. Physical health
    e. Leadership opportunities
    f. Job performance

Limitations

Limitations are aspects of a research study that are outside the researcher's control and may be a source of weakness (PhDStudent, 2024; Simon, 2011). These are the perceived limitations of the study.

1. This study is bound by the type of data that can be collected. It is a qualitative study, so no quantitative data can be gathered and used to strengthen or refute any arguments during this study.
2. Most study participants are likely to be graduates employed in the nuclear field; stop-outs may be hard to locate since they are not connected to a nuclear employer. This deficiency of participants may leave a hole in the rich data needed for the study.
3. Findings from qualitative data cannot be generalized to larger populations.
4. Participants are limited to the states of Georgia and South Carolina.

Definitions

The following terms may make repeated appearances throughout this study. Knowing their definitions will aid in understanding the context and value of their place in the research.

- *Apprenticeship*. A work-based learning model where apprentices have supervised on-the-job training, along with job-related education, all while earning a wage (Apprenticeship TN, n.d.)
- *Baby Boomer Generation*. People born between 1946 and 1964 (Venter, 2017).
- *Confidence*. The feeling or belief that you can do something well or succeed at something (The Britannica Dictionary, n.d.).
- *Department of Energy*. A United States government agency that manages the nuclear infrastructure, administers the country's energy policy, and funds scientific research related to that field (U.S. Department of Energy, n.d.).

- *Department of Labor*. A United States government agency that administers federal labor laws to guarantee workers' rights to fair, safe, and healthy working conditions (U.S. Department of Energy, n.d.).
- *Hard Skills*. Technical, tangible, and quantifiable abilities related to the use of equipment for a specific job that are typically acquired through training and education and are a requisite for performing job duties (Lamri & Lubart, 2023).
- *Nuclear Industry*. An industry with two branches of careers. The commercial nuclear industry supplies clean electrical and heat energy. The Department of Energy, in partnership with the Department of Defense, fulfills the nuclear weaponry missions of the United States (Nuclear Energy Institute, n.d.-b; U.S. Energy Information Administration, 2023).
- *Registered Apprenticeship Program*. A proven model of apprenticeship that has been validated by the Department of Labor or State Apprenticeship Agency that is known for its structure, rigor, and quality (Apprenticeship USA, n.d.-b).
- *Registered Apprenticeship Partners Information Database System (RAPIDS)*. The primary platform for managing apprentices, occupations, job openings, and other relevant program information for states that use RAPIDS (Apprenticeship USA, n.d.-a).
- *Skill*. The ability to retrieve knowledge and apply it to a task in a proficient manner (Lamri & Lubart, 2023).
- *Skilled Trades*. Occupations that require an apprenticeship or qualifications obtained through formal vocational education and training for entry. Also known as manual trades or the crafts (Wulff et al., 2022).

- *Soft Skills*. Non-technical abilities that are harder to measure and quantify and involve personal, interpersonal, and intrapersonal aptitudes (Lamri & Lubart, 2023).
- *Stop-Out.* To temporarily withdraw from enrollment at a college or university (Merriam-Webster, n.d.).

Chapter Summary

The labor shortage, exacerbated by the skill shortage and many retirements, affects many industries across the United States. The nuclear industry is of particular concern due to government initiatives to increase green and clean energy (Department of Energy, 2022; National Nuclear Security Administration, n.d.). Nuclear apprenticeships are currently being used to attempt to combat the shortage, but a consistent, more efficient training path is needed to supply the workers for the upcoming missions effectively. Understanding the long-term outcomes on graduates' skills and self-confidence will aid higher education institutions and employers in making decisions when designing and implementing future apprenticeship programs.

To gather information from apprenticeship graduates, four research questions that focus on how work/school/life balance, academic resources, and workplace support influenced levels of self-confidence during the apprenticeship program were created. The Boundary, Self-Efficacy, and Skill Theories support the questions. A qualitative comparative case study was employed to gather qualitative data about nuclear apprenticeship graduates' experiences in the training programs at Site 1. The factors that influenced the research questions and the history of apprenticeships are described in Chapter II.

Chapter II

Review of the Literature

In Chapter I, the essential elements of this comparative case study are brought together. An understanding of the labor and skills gap plaguing multiple industries was narrowed down to focus on the nuclear field's ongoing and upcoming missions. The purpose of the study is to uncover substantial details about the ability to build confidence in nuclear apprentices through specific retention factors. The findings will be provided to higher education institutions and businesses to assist in developing training programs to adequately prepare new employees and possibly close the skills gap. Research questions grounded in the Self-Efficacy Theory, Boundary Theory, and Skills Theory will be used to collect relevant data for analysis and interpretations. This literature review will synthesize noteworthy components of the research topic from applicable sources to prepare for the data collection phase.

A review of the literature revealed a skilled labor shortage in several industries, such as the automation and construction industries (Bilginsoy, 2018; Cummins et al., 2019). Specifically, this shortage is impacting the nuclear field in the United States as the Department of Energy continuously advocates for the use of electrical energy fueled by nuclear power around the nation, even as nuclear sites are decommissioning some reactors (O'Sullivan, 2023; Today in Energy, 2017; Trum, 2021; Volpe, 2015). Additionally, the United States is increasing its production of plutonium for its nuclear

weapon stockpile at the Los Alamos National Laboratory in New Mexico and the Savannah River Site in South Carolina, which requires more knowledgeable workers to maintain the workload (National Nuclear Security Administration, n.d.). Each of these projects emphasizes the need for skilled workers.

A deeper search found that a combination of excessive retirements and a small, qualified applicant pool were the top contributing factors to the shortage (A. B. Krueger, 2017; Oakes, 2016). Oakes (2016) noted that many applicants lacked soft and hard skills that are critical for skilled workers in this field. Utilizing work-study training programs where part of the learning happens on the job and the rest occurs in a classroom or technical environment (better known as apprenticeships) could serve as a tool to provide the necessary training to new employees in a short amount of time (Cantor, 1997; Voeller, 2022). Although some higher education institutions (HEIs) already use apprenticeships as a training method, creating new training programs and improving the current ones in use may be one way to educate potential workers quickly and reduce the labor shortage (Christo-Baker et al., 2017). As Relly and Laczik (2022) described, doing so requires the cooperation of HEIs and employers to create a plan of action and target the careers in their area.

Another aspect must be explored to further understand the labor and skills shortage in the nuclear industry. As part of this study, new nuclear workers' desire to persist in the field and their confidence in this ability should be examined. Understanding what influences a new employee to leave their nuclear training program, a new position in the nuclear field, or the nuclear industry permanently may assist educators and managers in educating and retaining the workers. Confidence, which relies on many

factors, could have been sharpened or diminished during the training program (Lopez-Garrido, 2025). The Self-Efficacy Theory by Bandura (1977) has four main principles that can be observed and researched during a program such as an apprenticeship. These principles will be discussed in greater depth in a later section of this chapter.

As briefly discussed in Chapter I, this study will employ a comparative case study with three contractors at Site 1, to gather information about nuclear workers' confidence. Additionally, information about their experiences in their apprenticeship program will be collected. The research and sub-questions below will be used to gather qualitative data from former nuclear apprentices:

1. What are the lived experiences portrayed by the graduates of a nuclear apprenticeship program?
2. How does engagement in a nuclear apprenticeship program affect graduates' confidence in their ability to succeed in their nuclear careers?
    2.1. How do graduates depict the impact of variety and utilization of academic resources available throughout the apprenticeship program on their level of confidence in job performance as they transition to their careers in the nuclear field?
    2.2. How do graduates portray the influence of support strategies provided by their employer for the duration of the apprenticeship program on their confidence levels of occupation-related duties as they prepare for their career in the nuclear field?

Using these research questions and sub-questions, a narrative documenting the participants' journeys through work and school with connections to their levels of confidence along the way will be generated.

This literature review covers several topics related to using apprenticeships to solve the labor shortage and skills gap issue in the nuclear field. First, information about the labor and skills gap will be presented. Next, the history of apprenticeships and their role in the workforce over time will be summarized to lay the foundation for understanding the importance of the training format. Then, the components of the apprenticeship model and how it may influence confidence will be discussed. These components include academic and workplace support, collaboration between the HEIs and employers, and work/school/life balance. Lastly, three supporting theories, The Boundary Theory, The Self-Efficacy Theory, and the Skill Theory, will be detailed, including connections to the study and each other. Each theory supports closing the labor and skills gap through apprenticeships in a revitalized format that will potentially increase or maintain high levels of workers' confidence.

Labor Shortage in the United States

Before looking at ways to fix the growing labor shortage in the nuclear industry, researchers must understand the nature of the gaps in each market. In this section, data from multiple industries, including the nuclear field, is presented to highlight identified trends, changes, and predictions in the workforce. These sources list probable causes of the current and continuing labor shortage to aid in deciding how to address the issue.

The labor shortage may stem from numerous triggers. Due to the continuous retirement of the Baby Boomer generation and the challenges of finding skilled workers,

employers struggle to fill rapidly opening positions (Cummins et al., 2019; Levanon et al., 2014). This phenomenon affects various industries, such as the automation sector, where machinery replaces low-skilled jobs, and creates a deficit of trained personnel as new technology moves in (Cummins et al., 2019). In fact, research by Cummins et al. (2019) revealed that 23% of adults do not have sufficient problem-solving technological skills to work with the machines, leaving a hole in their applicant pool. In parallel, a strategy to combat the labor shortage in the construction industry includes an increase in the quality of apprenticeships used to train new workers (Bilginsoy, 2018). Leaders in each industry must be strategic when recruiting and training new workers to fill these workforce gaps.

The labor market has not kept pace with population changes. Levanon et al. (2014) charted the expected labor force growth rate (0.5%) against the number of predicted retirements and aging workers in the workforce. These experts concluded that the labor force would not keep pace with the available workers. This prediction proved true, as Cummins et al. (2019), Bilginsoy (2018), and others have reported. Levanon et al. indicated a gap in skilled labor, noting construction as one of the industries to suffer in multiple ways. Fortwengel et al. (2021) recalled how a medium-level skill gap drew international attention and called for organizations to work together. Other industries comparably impacted included the healthcare sector (due to the rise in the aging population) and science, technology, engineering, and math (STEM) occupations (Levanon et al., 2014).

As early as 2008, industry experts projected a shortage in the nuclear industry (D. P. Krueger & Sather, 2008). D. P. Krueger and Sather (2008) reported that in 2008, about

50% of the workforce was older than 50 years old, and 40% of nuclear positions would experience turnover by 2013. Additionally, the report indicated that the number of higher education institutions in the United States offering Bachelor of Science degrees in nuclear engineering decreased from 38 to 24 from the 1970s to 2006, and the use of apprenticeships was not mentioned (D. P. Krueger & Sather, 2008). This data is relevant today. The Department of Energy's Office of Environmental Management (DOE-EM), which manages environmental waste cleanup from previous nuclear weapon missions and nuclear research, had a 17% vacancy rate at the end of fiscal year 2023 (Radwaste Solutions, 2024). The shortage of workers has coerced the National Nuclear Security Administration (NNSA) administrator, Jill Hruby, to funnel workers from multiple projects to one, more important, project to meet critical deadlines (Parsons, 2023). Likewise, Townsend et al.'s (2022) study echoed the data from 2008 and reported that about half of the workforce in the nuclear field is predicted to retire in the next 5 to 10 years. They also showed that maintenance and radiation protection positions, two careers studied in this dissertation, struggle to keep pace with ongoing retirements (Gillum et al., 2023; Townsend et al., 2022). There are peaks in the 23 to 37 age group and the retirement-eligible age group, but the 38 to 47 age group continues to be the smallest age group (Townsend et al., 2022). This middle-aged group is of utmost importance right now, as it usually consists of first-line managers who can facilitate transferring tacit knowledge when the older age group retires (Gillum et al., 2023; Townsend et al., 2022).

In partnership with commercial energy companies, the United States government has several plans that require a sufficient fleet of skilled workers. At the White House Summit on Domestic Nuclear Deployment on May 29th, 2024, President Biden described

several projects that will comprise the second-largest nuclear rollout in the country's history (Office of Nuclear Energy, 2024c; The White House, 2024). Currently, nuclear energy is the largest source of clean energy in the United States at 19% (The White House, 2024). This statistic will grow as the United States is part of a multi-country agreement to triple the world's nuclear capacity by 2050 (The White House, 2024). In addition to helping the world grow its nuclear base, the government wants to use reactors to power Army sites in the United States to provide consistent energy despite various threats (Office of Nuclear Energy, 2024c; The White House, 2024). The Palisades nuclear plant will be brought back online until 2050, and there was discussion to extend the usage of the Diablo Canyon power plant instead of taking the plant offline (The White House, 2024). High-assay low-enriched uranium (HALEU), a key component in advanced reactors, was produced for the first time in 70 years in 2024; now 900 kilograms of HALEU will be produced every year in Ohio (Office of Nuclear Energy, 2024c; The White House, 2024). There is also the production of at least 80 plutonium pits for the nuclear weapons stockpile at Los Alamos National Laboratory and the Savannah River Site (National Nuclear Security Administration, n.d.). Building a new nuclear plant can create up to 800 permanent jobs (Office of Nuclear Energy, 2024b). Each of these projects will require skilled workers that can be supplied by apprenticeships during and after its completion. One cohort of nuclear apprentices can graduate over 100 students in 7 months. This particular apprenticeship model can serve as a continuous pipeline for large and small endeavors.

The Skills Gap

Identifying the skills desired by employers allows educators to design and plan training programs accordingly. Delving into the existing literature, many sources describe consistent gaps in new employees' skills in entry-level jobs in several industries including, but not limited to, the information technology (IT), construction, and nuclear fields (Bilginsoy, 2018; Hawk et al., 2012; Townsend et al., 2022). The absence of these skills creates difficulties when hiring new personnel to replace lost labor, serving to further widen the labor shortage (Hawk et al., 2012). Apprenticeships have the capability to teach both hard and soft skills (Soto, 2020). Constructing and using apprenticeship programs that target the necessary skills may increase the number of applicants who meet the minimum job requirements. Recognizing the need for specific job skills and then identifying the exact skills required for underemployed positions plays a significant role in preparing to solve the labor shortage.

A look at the research shows two types of skills that employers may need. The first refers to soft skills and assists workers' professionalism (Gauthier, 2020). According to Gauthier (2020), common soft skills employers request include communication and listening, critical thinking for decision-making, workplace functionality, empathy, rationality, and higher order of thought. Likewise, Hawk et al. (2012) corroborated this statement by indicating that colleagues in the Information Technology (IT) field need soft skills such as communication, user relationship, working with teams, and negotiation. Since soft skills are often transferable (Chakraborty, 2021), the previously listed skills may be applicable in the nuclear field. The second type of skill, also described by Hawk et al., pertains to knowledge-based material, otherwise known as hard skills. For

example, hard skills for entry and mid-level workers in IT include systems analysis and database design (Hawk et al., 2012). Gauthier discussed the need for hard skills to advance in a construction firm. Examples of hard skills for a nuclear operator are how and when to open/close valves, dress in a protective suit, and enter and exit confined spaces (Bruce Power Limited Partnership, 2023). Addressing hard and soft skills improves students' employability and curriculum intelligence (Gauthier, 2020).

Taking care to nurture and strengthen both types of skills in individuals begins to tackle the issues contributing to the labor shortage. Higher education institutions (HEIs) and businesses can collaborate to offer students office and technical skills, thereby meeting the needs of the students, HEI, and business (Relly & Laczik, 2022). It is important to focus on the hard and soft skills of students aiming to be nuclear workers. Jill Hruby, the administrator of the National Nuclear Security Administration (NNSA), commented on the quality of recent nuclear workers, indicating that "the productivity of workers is not where it has been historically" (Parsons, 2023, para. 7). In fact, productivity in United States plants is up to 13 times lower than industry expectations (Eash-Gates et al., 2020). Hrubry's statement suggests that training programs may not be as robust as they should be. Low-quality programs may produce workers who have skills and training gaps and do not meet the standards of the employers, which may result in high turnover or low productivity (Eash-Gates et al., 2020). Once the number of people with the necessary skills increases, jobs may be filled, productivity can increase, and the labor gap will likely trend in a positive direction.

Higher education institutions, particularly community colleges, may offer one solution to addressing both the skill and labor shortages. As mentioned previously, the

home healthcare industry's labor force has declined (Kim, 2020; Levanon et al., 2014). In that field, 44% of workers held positions requiring a credential or certificate, and they stayed in their careers longer than those without a credential despite the increase in the labor gap (Kim, 2020). Utilizing colleges and training programs to introduce people to stable careers with required credentials could stand as a first step to addressing the labor shortage (Fortwengel et al., 2021). A skilled credential may put more stake into one's occupation and possibly increase job retention rates.

The History of Apprenticeships

Apprenticeships and comparable training programs have existed for quite some time to influence how trainees learn. In the 1920s, apprenticeships played a central role in providing skilled labor, but their use has ebbed and flowed since then (Fortwengel et al., 2021). Given the current labor and economic environment, employers and educators must familiarize themselves with the various types of apprenticeship models to revive their use successfully and begin to close the skills and labor gap. Fortwengel et al. (2021) reported two recent instances of attempted apprenticeship revivals in the U.S. The first occurred in the 1990s with the School-to-Work Opportunities Act of 1994 and the National Skills Standards Act of 1994, but the initiative proved unsuccessful due to limited support from stakeholders (Fortwengel et al., 2021). The legislation passed in 1994 was not extended, and the idea of increasing youth apprenticeships spread fear among employers (Fortwengel et al., 2021). Many employers thought they would lose control over all apprenticeship programs if the government continued to get involved (Fortwengel et al., 2021). The initiatives pushed down by the national government were not well received by those at the local level (Fortwengel et al., 2021).

The second ongoing attempt followed the 2008 global financial crisis (Fortwengel et al., 2021). President Obama led the initiative by asking the nation to commit to training 2 million Americans with apprentice skills (Fortwengel et al., 2021). The Department of Labor presented $175 million for 46 public-private entities to extend their apprenticeship programs; they also added $90 million to the ApprenticeshipUSA budget in 2016 (Fortwengel et al., 2021). President Trump's administration continued these efforts (Fortwengel et al., 2021). However, slow progress plagued the plans as more legislation was passed to include women, minorities, and other disadvantaged parties (Fortwengel et al., 2021). Fortunately, the second revival following the crisis is projected to be more successful because approaches from the national and local governments are more closely aligned (Fortwengel et al., 2021). Both attempts support the reasoning behind understanding and implementing the multiple apprenticeship formats described in the next section. Doing so increases the chances of matching more workers to a career and learning environment suited for them.

Apprenticeships in Britain

In British history, there have been three significant periods of different apprenticeship styles (Snell, 1996). The first period ranged from the twelfth century to 1563 and is known as the guild apprenticeship period (Snell, 1996). During this period, the state gained control over skilled labor by passing the Statute of Artificers (Snell, 1996). Specifically, regulations were imposed on pilfering workers from other companies, maximum wages, and migrant workers (Snell, 1996). The government also placed limitations on child work and the length of apprenticeships (Snell, 1996). Most apprenticeships during this era lasted 7 years (Britannica, n.d.). The words 'servant' and

‘apprentice’ were often used interchangeably, and many apprentices served a legal indentured servitude before they could practice their skill professionally (Snell, 1996). Still, knowledge and skill transfer made apprenticeships a worthwhile occupation.

After the guild apprenticeship period came the statutory apprenticeship period. The statutory apprenticeship period spanned from 1563 to 1814 (Snell, 1996). The state was still involved with training the youth, but many of the laws from the previous period in the Statute of Artificers had been repealed (Snell, 1996). During this period, the focus moved away from the actual skills of the apprenticeship and more towards its purpose. Many families were using apprenticeships as a means to establish a settlement (Snell, 1996). To avoid this, the state made apprenticeship for settlement illegal, and entire industries, such as knitting and weaving, nearly collapsed (Snell, 1996). To bypass the state’s ban on using apprenticeships to initiate a settlement, an apprentice would live with a family and work to earn an age-based wage (Snell, 1996). Girls were also hired as apprentices, although they were paid less (Snell, 1996). Popular trades that utilized the apprenticeship model during this era included shoemaking, metalwork, leatherwork, watchmaking, button making, silk weaving, and more (Snell, 1996).

The voluntary apprenticeship period started in 1814 and continues today (Snell, 1996). During this period, people sought how to use machines as the world became more modernized (Britannica, n.d.). Initially, the use of apprenticeships was dwindling, and people in the community were becoming concerned about the trades and the lack of training (Snell, 1996). Eventually, institutions dedicated to industrialization were established, such as Birkbeck College (Britannica, n.d.). There was no sweeping revolution, but by 1958, the idea of simultaneous learning and practice became prominent

(Snell, 1996). Leadership under Robert Carr, the Parliamentary Under-Secretary at the Minister of Labor, helped bring that system to life between industries and colleges by merging the two training modalities (Kavanagh, 2012; Snell, 1996).

Despite this practice, apprenticeships have been traditionally reserved for people with a single skill (Snell, 1996). Those deemed more intelligent have been directed away from apprenticeships to other forms of education (Snell, 1996). By the 1980s, 3 to 5 years became the standard length of an apprenticeship. The government is not involved as in past centuries, but some acts have been passed to support funding (Snell, 1996). By 1996, the modern apprenticeship in Britain was looking for a reboot as employers had little buy-in to hire apprentices and pay a high wage (Snell, 1996). Today, apprenticeships are still widespread in Britain and all across Europe.

Apprenticeships in the United States

Apprenticeships had a slightly different start in the United States. They have been around since the establishment of the American colonies, and their format was copied from the English system (Gordon, 2008; Snyder, 2007). Many skilled laborers lived and worked in America during this time, so apprenticeships did not serve a great purpose then (Britannica, n.d.). The establishment of slavery served as labor, and apprenticeships were used as a form of education and were strictly distinguished from servitude (Gordon, 2008). The master apprentice was required to teach their trainees basic education concepts and trade techniques (Snyder, 2007). Then, with the Industrial Revolution, the United States saw an increase in the desire to work with machines (Britannica, n.d.; Gordon, 2008), and employers began sending their employees to school to be trained (Jacoby, 1991). The Cooper Union for the Advancement of Science and Art in New York

City, resemblant to Birbeck College in London, was created in 1859 for those who wanted to study working with machinery (Britannica, n.d.). Around this time, the number of apprenticeships in America decreased (Gordon, 2008). Gordon (2008) listed eight factors that influenced the decline in apprenticeships:

1. Large groups were now being trained to specialize in a specific task.
2. Industries became centralized.
3. There were several subdivisions of industries in which training became extensive, expensive, and impractical.
4. The previous indentured laws became insufficient.
5. Of the apprenticeships that did remain, the trades became saturated with successful workers.
6. Wages remained very low.
7. Young workers were not properly taught techniques; instead, they learned through the "arts of their instructors."
8. Free public education started developing.

Despite the industrial growth in the mid to late 1800s, apprenticeships were not eradicated, and some young workers continued to learn from skilled relatives and on-the-job training (Gordon, 2008).

The passage of the National Apprenticeship Act in 1937 formally created a set of standards for apprentices that became regulated by the U.S. Department of Labor (Voeller, 2023). Regulations included a minimum entry age of 16 and training periods of 2 to 5 years (Britannica, n.d.). Additionally, 11 states passed apprenticeship laws, and 13 others created apprenticeship councils by 1940 (Gordon, 2008). However, like its

counterpart in Britain, apprenticeships were deemed a pathway for low-performing students in the construction industry and other unions (Voeller, 2023). By 1949, 0.37% of the workforce was comprised of apprentices (Lerman, 2022). From 1941 to 1953, registered apprenticeships increased from 760 to 50,220 (Gordon, 2008). The number of apprentices in America increased from 230,000 in 1949 to 290,000 in 1979, but the percentage of apprentices in the workforce decreased to 0.28% during that period (Lerman, 2022). Around the same time as Britain (the 80s and the 90s), the United States also sought a reset for its apprenticeship programs (Voeller, 2023). Youth apprenticeships were introduced but did not garner positive attention from businesses because they feared losing control of registered apprentices (Voeller, 2023). Some businesses thought youth apprentices would push people to start careers at too young of an age (Voeller, 2023).

In the decades after, advocates for apprenticeships fought hard against higher education for participants (Voeller, 2023). A push for a college education for all Americans became an obstacle to apprenticeship programs (Voeller, 2023). This campaign pushed the percentage of apprentices in the workforce towards its lowest at 0.22% (Lerman, 2022). However, community colleges are now critical in bridging the gap between higher education and apprentices with organizations such as Apprenticeship Carolina (Voeller, 2023). Today, many higher education institutions and businesses partner to fill their recruitment and training needs through an apprenticeship program. The number of apprentices in the labor force is beginning to increase, at 0.32% in 2019 (Lerman, 2022). Since 2019, several grants, such as the Expansion Grant and Modernization Fund, have invested in apprenticeships nationwide to bring this helpful teaching method to the forefront of the trades learning landscape (Lerman, 2022).

Apprenticeship Models

As S. Shaw et al. (2020) recounted, a rebranding of apprenticeships that began around 2010 sparked the momentum for creating new apprenticeship models and updating current models, providing even more options for employers and HEIs. In addition to the traditional apprenticeship already defined in this review, youth and pre-apprenticeships also assist in training potential workers (S. Shaw et al., 2020). These types of apprenticeships typically target students in high school or early in their college years since these populations serve as a pool of potential candidates for employers to provide experience before joining a more advanced apprenticeship program (Cantor, 1997; Mindham & Schultz, 2019). Both youth and pre-apprenticeships focus on quality, work-based skills, and transferrable soft skills that will help students in the classroom and workplace (Cantor, 1997; Mindham & Schultz, 2019). Though synonymous in their purpose, there are distinct differences between pre- and youth apprenticeships (Cantor, 1997; Mindham & Schultz, 2019).

A pre-apprenticeship is a program or set of strategies designed to prepare people for entry into Registered Apprenticeship Programs or other job opportunities (Apprenticeship USA, n.d.-c). As of 1997, 18 states offered some form of a pre-apprenticeship model (Cantor, 1997). These programs prepared students to transition from the pre-apprenticeship to a full apprenticeship by connecting school and work-based learning (Cantor, 1997). For example, a study in the UK showed that when participants aged 16 to 18 enrolled in a pre-apprenticeship, there was a strong impact on their ability to secure a full apprenticeship position within 12 months of completing the program (Dorsett & Stokes, 2022). That same study highlighted the opposite results for

participants aged 19 to 23, concluding that the higher-aged group experienced more resistance in participation, which could have led to a decrease in the ability to secure a full apprenticeship (Dorsett & Stokes, 2022). In Oregon, the Highway Construction Workforce Development Program supported several pre-apprenticeships aimed at increasing the number of women and minorities in the construction industry in their state (Kelly et al., 2022). Supporting job supplies, fuel per diems, lodging, meals, childcare, assistance with financial hardships, and other services are just a few of the benefits provided to those enrolled in the program. Through these initiatives, the pre-apprenticeships were able to increase and diversify the number of people who entered a highway construction apprenticeship. From 2008 to 2019, 7,700 new apprentices joined a construction apprenticeship; of those, 278 entered through a pre-apprenticeship program (Kelly et al., 2022). Pre-apprenticeships can make a difference in a worker's confidence and capability to gain skills and experience before securing an apprenticeship to begin or enhance their career (Kelly et al., 2022).

Much like pre-apprenticeships, youth apprenticeships expose people under the age of 18 to potential careers and work opportunities (Mindham & Schultz, 2019). As of 2023, 20 states have some variation of a youth apprenticeship, and 16 gather data on their participants (Kuehn et al., 2023). According to Apprenticeship USA (n.d.-c), a youth apprenticeship is a program for high school students that combines academic and technical class instruction with work experience through a Registered Apprenticeship Program while providing the foundation for students to choose from a variety of career pathways upon graduation. However, despite this definition, the Department of Labor categorizes apprentices between the ages of 16 and 24 as youth apprentices (Kuehn et al.,

2023). Youth apprenticeships can also expose underrepresented groups to new opportunities. Sullivan et al. (n.d.) analyzed data from the Department of Labor's Registered Apprenticeship Partners Information Database System (RAPIDS) and discovered that the number of new youth apprentices grew between 2010 and 2020. This data is supported by Kuehn et al. (2023), who showed that the total number of youth apprentices went from 120,000 to 190,000 in the same time frame. During that time, the Hispanic population of youth apprentices in the U.S. grew, while the Black population of youth apprentices in the U.S. remained steady (Sullivan et al., n.d.). On average, only 7% of the apprentices were women (Sullivan et al., n.d.). Lastly, by 2020, 844 youth apprentices were enrolled in a stem apprenticeship (up from 132 in 2010) (Sullivan et al., n.d.). These changes, albeit small, show that youth apprenticeships provide multiple benefits for youth of various demographics.

A study by Mindham and Schultz (2019) compared two work-based programs embedded in local high schools. The Youth Apprenticeship program emphasized hands-on learning (Mindham & Schultz, 2019), while the Employability Skills Certificate program focused on soft, transferable skills (Mindham & Schultz, 2019). Mindham and Schultz's results showed that 76.1% of the Youth Apprenticeship students and 61.1% of the Employability Skills Certificate program students remained in their field of concentration after high school graduation. Additionally, 75% of students who enrolled in both programs persisted in their field after graduation (Mindham & Schultz, 2019). This data shows that youth apprenticeships have the structure and content to increase the skills and confidence of young people entering their desired career fields (Lerman & Packer, 2015).

A unique type of apprenticeship called a business incubator aids students with beginning their businesses while teaching them fundamental soft and hard skills (Mayorga, 2019). Often, colleges and businesses overlook the support students need to sustain a business, and student businesses are not seriously regarded in the local economy (Bezerra et al., 2017). Business incubators provide students with business support services and train them to manage their companies properly (Bezerra et al., 2017). They also assist with networking and additional funds for start-up costs (Bezerra et al., 2017). Bezerra et al. (2017) conducted a study and interviewed students who participated in a business incubator at their university. Some of the major impacts of the incubator reported by the participants were increased networking opportunities, mentorship, and the ability to ease into learning the bureaucratic rules of businesses (Bezerra et al., 2017). Mayorga (2019) interviewed managers from businesses that assisted with business incubators at five public and private universities. The business incubator model used in Mayorga's research fosters classroom education in a business program through active learning while helping students learn how to launch their own businesses into the economy (Mayorga, 2019). According to the managers, students entering the program did not display strong soft skills but left the program with an increased awareness of transferrable office skills (Mayorga, 2019). Mayorga also reported that the students displayed higher levels of intellectual maturity at the conclusion of the program. Although the business incubator arrangement is not usually considered an apprenticeship, it has the same fundamentals and overall goals for its participants.

Pre-apprenticeships, youth apprenticeships, and business incubators all operate in a parallel format. Students take advantage of the opportunity to learn about future careers

while continuing their education (Cantor, 1997). The skills and knowledge gained from these programs aid in closing the skills and labor gap. Although these apprenticeship models have their benefits, struggles accompany their use. Firstly, not enough employers buy into the idea of utilizing apprenticeships (Cantor, 1997; Fortwengel et al., 2021). The lack of buy-in from employers frequently results in little to no advertisement, and the program remains relatively unknown (Cantor, 1997). Cantor (1997) also listed other potential issues with pre and youth apprenticeships. Due to the lack of advertisements, recruiting the younger population requires more work. Supervision and liability also make initiating these two programs difficult (Cantor, 1997). S. Shaw et al. (2020) and Cantor factor in the need for government and financial support as another hindrance. Cantor suggested ensuring the company's investment yields a significant gain to remedy these worries. Compromise and progress can happen when entities work together, as discussed in the next section.

Higher Education Institution and Employer Collaboration

One aspect of the apprenticeship models mentioned in the previous sections pertains to the balance of the project's stakeholders. This section reviews the implications of a strong partnership, or lack thereof, on the apprenticeship's outcomes. The relevant studies detailed the effects on the apprentices, their instructors, the relationship between each entity, and the program's future from multiple schools and companies. To close the skills gap, training programs must prove successful by multiple measures. Relly and Laczik (2022) determined that a school and employer with a close relationship sets a solid foundation for accomplishments and change in their apprenticeship and the local labor force.

During various apprenticeship models' development, collaboration between the higher education institution (HEI) and the employer plays a critical role because the characteristics of the partnership can determine the program's trajectory and outcomes. The communication level becomes established at the beginning and sets the tone for the duration of the joint venture. For example, employers in the UK prefer to designate a single point of contact at the HEI to streamline communication (Bravenboer, 2016). Each HEI and employer have their own needs and goals for the apprentices; maintaining each organization's balance allows for a smooth transition through hiring, training, graduating, and other internal processes. Minimizing issues in those areas allows the apprentices to focus on their success instead of procedural complications. Collaboration within and with other HEIs encourages smoother governance and management from leaders where morale is higher, trust is stronger, and better decisions are made (Kezar & Lester, 2009). This is critical as an apprenticeship program with a fragile relationship may not handle concerns well (Cumberland & Ellinger, 2023; Relly & Laczik, 2022); criticism and feedback will improve the program after resolving any problems (Kwok, 2022; Relly & Laczik, 2022).

A strong connection between the HEI and the employer engenders higher achievements and confidence for those in training programs, due to the fact that the apprentice's academic and workforce success remains the top goal for both HEIs and employers (Relly & Laczik, 2022). Voeller (2022) validated this statement by indicating that the apprenticeship program in his study included academic success as a requirement of employment. When employers and educators have an open and consistent communication method, reporting grades can occur regularly and on time. Voeller mentioned that institutions will alert employers of at-risk students so they can start

attending to issues together. Universities in the UK struggled to teach the skills needed by local employers until their collaboration efforts were strengthened (Bravenboer, 2016).

The collaboration benefits more than the two organizations; students in the apprenticeship program will notice the efforts made by both parties to boost their success, potentially increasing their work ethic and confidence in their ability to persist in the field. Other constituents that benefit from regular and substantiative collaboration include foundation directors and government funders, leaders of disciplinary organizations, national and professional organizations, accreditors, government officials, and alumni (Kezar & Lester, 2009). The advantages of collaborating with other HEIs and the various entities that engage with HEIs range from more significant amounts of funding, increased innovation, teaching, and student learning, the ability to solve problems from a complex perspective, and better service throughout an organization (Kezar & Lester, 2009). There is also a decrease in overall costs and an increase in efficiency, which contributes to greater job satisfaction among workers in the organization (Kezar & Lester, 2009). Kezar and Lester (2009) also highlighted how collaboration between multiple associations can foster a stronger research arena, generating growth and knowledge in several disciplines and providing opportunities for research in traditionally underserved areas.

Collaboration between the institution providing the training and the employer has a vital place in the apprenticeship program due to the ever-changing nature of industries (Dolasinski & Reynolds, 2023; Plawgo & Ertman, 2021; S., 2024). Much like the business world, higher education adjusts to the students' and clients' needs to better serve them (Carver, 2020; Dolasinski & Reynolds, 2023; S., 2024; Voeller, 2022). Both organizations must display flexibility and provide the same accommodation for the

opposite organization when the time comes (Martin et al., 2020). Schedules alter, the number of hires may increase, instructors can back out at the last minute, and more. Each scenario requires cooperation and creativity from both sides to keep the program running despite the sudden modifications. Additionally, the HEI may need to periodically revise a program's curriculum to meet the employer's needs (Relly & Laczik, 2022; Voeller, 2022). A close partnership gives each company a chance to meet and agree on the content and assessment of each course in the program (Martin et al., 2020). When feedback indicates the content does not meet the needs of the business or industry, the partners should come together to decide on the next steps.

An essential part of developing an apprenticeship program involves understanding the new tasks in delivering the courses for the client. Understanding each unique role and what equipment to purchase can become daunting assignments for a new manager working alone. Martin et al. (2020) reported that educators felt stressed and pressured due to attempting to make things work in a small amount of time when beginning a new program. Those same educators also felt required to participate rather than internally motivated. Relly and Laczik (2022) suggested that teamwork with the employer can alleviate these issues on both sides. Delegation of the roles should occur after each party meets, allowing various areas to have differing control. For example, the employer can take the lead on deciding which skills to focus on while the college handles the training delivery method (Relly & Laczik, 2022). When implemented correctly, a strong collaboration can benefit the HEI, the employer, and, most importantly, the apprentices.

School and Employer Support for the Apprentice

This section of the literature review focuses on support systems for apprentices. These systems extend from the collaboration efforts described previously, creating a holistic approach to apprenticeships that benefit the higher education institution (HEI), employer, and apprentice. The importance of these support systems lies in the environments created for students. For example, Fabian et al. (2022) acknowledged that apprentices' self-confidence developed as they excelled academically and were offered opportunities to apply their skills outside of the workplace. Knowing how to generate this occurrence consists of a large part of supporting apprentices.

Mentorship programs commonly seen in various organizations play a role in apprenticeships (Quew-Jones & Rowe, 2022). Research has shown that mentors show contentment with supporting their apprentices throughout their programs (Howe et al., 2023; Quew-Jones & Rowe, 2022). This satisfaction may result from the ability to influence registration, which also eases the hiring process and increases retention (Howe et al., 2023). Mentorship also positively affects student outcomes. Both Quew-Jones and Rowe (2022) and Fabian et al. (2022) observed that apprentices with active mentors showed better signs of academic and workplace success. Students without a dedicated support system, as told by Fabian et al., struggled in class and decided their development at work was their responsibility. Additionally, this group of apprentices from their study reported not having a healthy work/school/life balance (Fabian et al., 2022). Mentorship includes advantages for the HEI and employer as well. The close relationship between all three parties (HEI, employer, and apprentice) opens the door for communication about progress and improvements (Quew-Jones & Rowe, 2022). Continuous conversations

allow evaluation and corrections to occur, followed by the program's continuation (Fabian et al., 2022; Howe et al., 2023). The support provided by mentorships transcends the student's needs and increases buy-in for the HEI and employer. Support for apprentices can happen in other ways. Marginalized groups, such as English Language Learners (ELLs), can receive individualized instruction or specially trained mentors to aid with classes or navigating the workplace. Mollica (2020) suggested creating partnerships to show employers how ELLs prove themselves valuable. These individuals may also benefit from a pre-apprenticeship program to give them extra time to acclimate to the work and school balance (Mollica, 2020). Employer support can positively or negatively impact an apprentice's experience. A study by Smyth and Zimba (2019) showed that positive employer support encouraged apprentices to finish their apprenticeship in Northern Ireland. In this instance, the employer provided dedicated company time for apprentices to complete mandatory work. On the other hand, conflicts at this same place of employment, such as not being recognized for achievements or disputes between managers and tutors over content, made some apprentices consider resigning (Smyth & Zimba, 2019).

Fabian et al. (2022) favored academic support from tutors and coaches. As enrolled students at the college, apprentices should have access to the support services available to traditional students, such as the computer lab, library, life coaches, academic tutors, and other forms of support. For example, UK social work degree apprentices listed mentors, managers, family members, and professors as resources when they initially began their program (Stone & Worsley, 2022). When the COVID-19 pandemic forced classes online, sufficient digital technology and peer groups became another source of

support (Stone & Worsley, 2022). The more support available, the more positive and aligned the apprentice experience (Fabian et al., 2022). Finally, support can materialize through campus events such as games and clubs. Implanting a sensation of belonging increases the sense of pride and effort in apprentices (Fabian et al., 2022). With copious amounts of support from both stakeholders, apprentices should have the tools to get the skills needed to become gainfully employed in several fields. Doing so launches the first step in closing the skills and labor gap.

Theoretical Framework

A critical component of this study is the theoretical framework. Theoretical frameworks, also known as conceptual frameworks, are defined as the system of concepts, assumptions, expectations, beliefs, and theories that support and inform your research and are a major influence on the study's design and direction (Maxwell, 2005). In this study, three theories shaped the research questions and methodology. The Boundary Theory by Nippert-Eng (1996) and Ashforth et al. (2000) discusses the demarcation between work, school, and life. Bandura (1977) developed the Self-Efficacy Theory in 1977 to support the concept of motivation and personal accomplishments. Lastly, the Skill Theory focuses on the ability to learn new skills and the experiences needed to do so (Fischer, 1980). In Chapter I, a concept map visualizes how the theories' key principles interconnect and overlap while relating to the core of the research questions. Together, these theories justify the research and will support the methods and findings with prior knowledge (Maxwell, 2005).

Boundary Theory

Research question one investigates the lived experiences of the apprentices in this study. Based on the structured interview questions, those lived experiences will include time during and after work. Because of this, the Boundary Theory is an appropriate theory to use for developing this question and analyzing its data. As discussed in Chapter I, the main principles of Boundary Theory are:

- Keeping work and family separate makes it easier to manage work-family borders,
- Integrating work and family facilitates transitions between these domains,
- Both strategies can improve the well-being of employees, the meanings they attach to work and family, their preferences for integration versus segmentation, contextual factors, and the fit between their preferences and the boundaries allowed by their social context (Desrochers & Sargent, 2003).

According to the Boundary Theory, the division between work, home, and other domains exists in the physical, temporal, and psychological realms (Y. Park et al., 2020). Additionally, these relationships, known as integration or segmentation, can have varying strengths (Y. Park et al., 2020; Piszczek & Yestrepsky, 2024). Integration is described as having fewer or no distinct boundaries between domains (Rybnikova & Krüger, 2015). For example, a supervisor may be required to answer work phone calls after hours, indicating a weak transition between domains (Y. Park et al., 2020; Piszczek & Yestrepsky, 2024). However, employees who are not required to check emails outside of work hours and do not have a business phone can completely disconnect from their work duties and show strong signs of segmentation or drawing clear lines or boundaries

between domains (Rybnikova & Krüger, 2015). This represents a strong transition or demarcation between domains (Y. Park et al., 2020; Piszczek & Yestrepsky, 2024). People who implement boundary strengths that align with their lifestyle report higher job satisfaction, lower stress, and lower role conflict (Piszczek & Yestrepsky, 2024).

Work and home life requirements have changed drastically and continue to do so (Piszczek & Yestrepsky, 2024). For example, many people now have the ability to work from home, especially since the COVID-19 pandemic (Darouei et al., 2024; Mirbahaeddin & Chreim, 2023). Working from home influences the temporal, physical, and task-related fields (Mirbahaeddin & Chreim, 2023). An employee may now work and live in the same space, work around family members, or multi-task by switching between work and home duties (Mirbahaeddin & Chreim, 2023). These changes and activities may have small or significant impacts on a person and their family (Piszczek & Yestrepsky, 2024). To display proper boundary management, swift adaptation to these changes must occur (Piszczek & Yestrepsky, 2024).

There is also the aspect of socially constructed borders. In some industries, managers or supervisors have the power to protect or impede employees' non-work time (Y. Park et al., 2020). They may work hard to ensure that their direct reports do not work outside of their scheduled time. On the other hand, clients expect expanded access to personnel in some industries, such as real estate or education, which may cross over the worker’s boundaries (Y. Park et al., 2020). For this reason, it is important for employees to have restrictions on information communication technologies in place. Boundary management tactics are strategies used to facilitate segmentation or integration between boundary preferences (Piszczek & Yestrepsky, 2024). Examples include turning off work

emails on a personal phone after a certain time or purposely using separate work and personal computers in different spaces (Nsair & Piszczek, 2021). These tactics should be used to reduce unwanted disturbances and potential boundary crossings (Y. Park et al., 2020; Piszczek & Yestrepsky, 2024).

The Boundary Theory relates to an employee's satisfaction through the attributes of the transitions between domains and the strength of the barrier between the domains themselves (Darouei et al., 2024). Smith et al. (2016) conducted a study and found that workers who had some form of integration between work and other areas of life showed fewer effects of mental exhaustion on the job. Those who chose complete segmentation had to exert more energy to transition between domains and experienced higher mental exhaustion and lower job performance (Smith et al., 2016). The lower job performance due to exhaustion may contribute to lower confidence in a worker's capabilities to complete their tasks. Similarly, F. Wang and Shi (2023) reported that those with strong boundary control tend to better meet their personal and work needs. Research question one will look deeper into the experiences of nuclear apprentices to analyze their work/home/life transitions and their effect on their confidence to remain employed in the nuclear industry.

Self-Efficacy Theory

The Self-Efficacy Theory by Albert Bandura (1977) will be used as the supporting theory for research question two and sub-questions 2.1 and 2.2. These questions involve the use of multiple resources to build knowledge in various learning environments, such as schools and the workplace, where self-efficacy is of optimal use (Shengyao et al., 2024; Ye et al., 2024). According to Shengyao et al. (2024), self-efficacy directly

correlates to a person's self-confidence and belief that they can accomplish a task and make it through specific situations. Individuals with a stronger sense of self-efficacy are more likely to persevere in difficult scenarios, think clearly when frustrated, and set higher goals and objectives (Shengyao et al., 2024). As noted by Lopez-Garrido (2025), the four factors that influence the development of self-efficacy are:

- Performance outcomes. Practicing allows a person to show themselves that they can learn new skills.
- Vicarious experiences. When one associates with a positive role model, one is more likely to mentally ingrain positive beliefs about oneself.
- Physiological feedback. Properly managing moods and mental changes during difficult experiences can lead to higher success for individuals.
- Verbal persuasion. Positive feedback during a complex task tells people they have the skills and ability to succeed.

Like self-efficacy, confidence is an internal motivator that encourages people to pursue their goals (M. Wang & Liu, 2023). People with higher levels of confidence usually participate in more group activities and challenge themselves longer before giving up on a task (M. Wang & Liu, 2023). Several studies, such as Pandya's (2021) research on mothers with children diagnosed with Autism Spectrum Disorder (ASD), reported high levels of self-efficacy corresponded with high levels of confidence (Hamamcioğlu & Ferit, 2024; Pandya, 2021; M. Wang & Liu, 2023). A separate study showed that providing specific training first (in this case, CPR) increased self-efficacy and self-confidence (Ko et al., 2023). After the training session in Ko et al.'s study (2023), students were 43.6% more likely to assist family members and strangers in need

by performing CPR. Connections in studies like these support the idea of researching ways to increase self-efficacy, self-confidence, perseverance, and more to close the labor and skills gap through nuclear apprentices. This study will look for the components of self-efficacy to make connections to the participants' confidence as their data is analyzed.

Self-efficacy plays an important role in academics and workforce development (Honicke & Broadbent, 2016). A person's confidence and determination to persist in a particular field are not only determined by their academic success and interest in that career (Honicke & Broadbent, 2016) but also by their understanding of their occupational growth and opportunity for work-life balance (Ye et al., 2024). Self-efficacy impacts the strength and satisfaction of work/life balance, which is described in the previous section (Darouei et al., 2024; F. Wang & Shi, 2024). The desire for a better work/home/life balance is often the motivation for someone to improve their self-efficacy to manage the transitions (Darouei et al., 2024). Badri and Panatik's (2020) study revealed that those with higher self-efficacy had more positive work and life encounters. This occurrence is most likely due to the ability of those with high self-efficacy to better control their ideas, emotions, and performance (Badri & Panatik, 2020). With this knowledge, it is important to consider self-efficacy and work/school/balance as nuclear apprentices are preparing for their careers.

Skill Theory

The Skill Theory by Kurt Fischer (1980) is a complex theory that underscores the main issue in this study: the shortage of skilled workers in the nuclear field. The premise of the Skill Theory is that skills develop in a step-by-step fashion organized into ten levels spread across reflex, sensory/motor, representation, and abstract skills tiers

(Fischer, 1980). The levels correspond to complexity; higher-level skills are formed by combining skills from multiple lower levels. Further research described skill building as a web with multiple strands; people have distinct webs where they learn a skill in one context and transfer it to another for application (Fischer & Farrar, 1987; Fischer & Rose, 2001). Fischer described the three main principles of the Skill Theory:

- Concept of Cognitive Control. A person controls the various ways they do things or think.
- Nature of Skills: Several classes or sets of skills vary based on the level and tier.
- Concepts for Defining Levels and Transformations: There are several ways to define levels, but it is important to note that higher levels include all the skills of the lower level, and the level describes the skills of a person, not the person. The five transformation rules also determine how a skill can be changed during development.

Fischer and Farrar (1987) describe another way to view learning and transferring skills within the Skill Theory. Generalization, which is the transfer of specific skills to other contexts or skills, is the opposite of specificity and can be predicted based on the conditions where generalization is maximized (Fischer & Farrar, 1987; van Slageren & Herrmann, 2024). These conditions include having tasks that are comparable and recognizable, providing an encouraging environment that allows practice and support, allowing the opportunity to consolidate the skills at the appropriate developmental level, and ensuring the person has the proper intellectual and emotional states to carry out the skill (Fischer & Farrar, 1987). Under these conditions, a person is more likely to transfer a skill to another task or setting and do so with ease (Fischer & Farrar, 1987). On the

other hand, skill specificity refers to the limited ability to transfer skills from one context to another (van Slageren & Herrmann, 2024). Skills that fall in the specific range may lose their relevance when presented in a new setting (van Slageren & Herrmann, 2024). There is a subset of specific skills called industry-specific skills (van Slageren & Herrmann, 2024). Industry-specific skills can be used across businesses in the same industry but not in businesses in other industries (van Slageren & Herrmann, 2024). While gathering and analyzing data, skills that fall under general, specific, and industry-specific should be considered as they may uncover several ways to enhance skill development in nuclear apprenticeship programs.

Connecting the Theoretical Framework to Apprenticeships

The Boundary, Self-Efficacy, and Skill Theories support the purpose of this study and its research questions by providing insights into how and why people learn and develop in their unique ways and the effects of those developments on their self-confidence. Separately, each researched theory increases the knowledge needed to write appropriate research questions. Together, the three theories allow for the creation of a methodology based on prior research and data analysis grounded on the principles from multiple theories.

To gauge the effectiveness of nuclear apprenticeships in increasing apprentices' confidence, three main areas will be the focus of the research and interview questions. The ability to pivot between work and school duties while still having time for other life commitments plays a large role in apprenticeship design. Howe et al. (2023) reported that apprentices have dropped out of training programs due to the program's length or inability to earn a living wage while finishing the program. Fabian et al. (2022) described

how an imbalanced work/school environment changed the experiences of individuals in the same apprenticeship program. The Boundary Theory addresses these concerns, and the study will highlight the nuclear apprentices' experiences regarding the work/school/life balance. Two other core areas are the need for and actual use of academic and support systems and strategies. These additional supports, which should be provided by the employer and learning institution, are critical to building the necessary skills and self-efficacy of the apprentices. The Self-Efficacy and Skill Theory discusses how repetition, modeling, verbal praise, and more strengthen one's confidence and learning capability (Bandura, 1977; Fischer, 1980).

Using the Boundary Theory, Self-Efficacy Theory, and Skill Theory to analyze and improve how confidence is fostered in apprenticeships will supply research-grounded interview and research questions that can generate answers for those looking to close the labor and skills gap. The academic and workplace learning environments will benefit from the feedback on support strategies and the ability to manage their responsibilities to reach their goals. From there, business leaders, higher education institutions, government entities, and others can wisely make changes and new developments to nuclear apprenticeship programs and other high-need industries with soundly supported research findings. In time, these changes will begin to positively impact the labor and skills gap in the nuclear industry.

Chapter Summary

This literature review assessed factors contributing to the labor gap that currently presents a problem in several areas of the U.S. A large percentage of retirements from the current workforce and a continuation of those retirements due to an aging labor force

over the next few decades serve as a cause of the labor gap (A. B. Krueger, 2017; Oakes, 2016). A second issue, a deficit in necessary soft and hard skills in the adult population, makes it difficult to replace the lost knowledge accumulated from the mass exodus of workers (Christo-Baker et al., 2017; Oakes, 2016). Other countries use apprenticeships to foster economic growth successfully, therefore researchers recommended using them to solve the labor problem (Fortwengel et al., 2021; Harris, 2015; Wiemann & Fuchs, 2018).

The research identified four focus areas for apprenticeships when attempting to reduce the labor gap. These critical areas are the hard and soft skills desired by employers needed for success in the nuclear industry, multiple apprenticeship models that can be utilized to train future workers, meaningful collaboration between higher education institutions (HEIs) and employers to develop effective programs, and support systems for apprentices both in school and at work. Understanding the necessary skills for employment allowed HEIs and employers to refine the programs based on the students', HEIs', and employers' needs. The various apprenticeship models gave industry partners and HEIs options on how to reach untapped potential in the surrounding area best. Collaboration between the HEIs and companies provided opportunities for each entity to define their respective goals as well as the goals for the students. Finally, support for the apprentices from HEIs and the employer displayed ways to engage the apprentice and boost achievement.

Apprenticeships can effectively teach the soft and hard skills desired by employers, such as the ability to think critically, rationalize, listen, and remain organized (Soto, 2020). Hard skills include job-specific tasks like networking in the Information Technology (IT) field or performing valve work and donning suits in the nuclear industry

(Bruce Power Limited Partnership, 2023; Hawk et al., 2012). Both skill sets create a dependable employee that can maintain long-term employment. To learn these skills, people have the option of attending different apprenticeship models. Pre and youth apprenticeships target the younger population, giving them a head start to a stable career. Traditional apprenticeships allow adults to earn and learn simultaneously (Cantor, 1997; Voeller, 2022), and business incubators expose entrepreneurs to the financial industry (Mayorga, 2019). Despite the benefits of apprenticeships, a lack of employer buy-in and promotion makes it hard to recruit potential candidates.

HEIs and employers can collaborate when implementing apprenticeships to find the best method of delivery to reach their goals. The effects of collaboration on funding sources, research, innovation, learning, governance, and more are exemplified when HEIs reach out to one another and other supporting entities that back student success and learning (Kezar & Lester, 2009). These collaboration efforts also extend to student support strategies to maximize the success of the apprentices. Tutors, campus engagement, mentors, and access to student facilities all reinforce academic assistance. Additionally, on-the-job mentors, engaging or interactive employee onboarding, meaningful and actionable feedback, and job shadowing are examples of workplace support. These proactive systems are meant to encourage apprentices and build their academic and job knowledge and workplace confidence. Overall, partnering together to foster these supports allows each partner to provide feedback about the program, carry out changes, and move forward with educating the next cohort of apprentices (Kwok, 2022; Relly & Laczik, 2022).

Tackling the labor and skill gap will take hard work from multiple groups. Utilizing the suggestions above can start the process, but more research must determine what other resources should be applied to garner the best results. A new apprenticeship model could suffice for many industries that have not succeeded with the current measures in place. This study aims to uncover information about confidence building and the intentions of apprentices to persist in the nuclear field once the training program is over. The results from the individual and focus group interviews will yield insights for all entities involved in developing and delivering training experiences for nuclear apprentices to allow for long-term careers in the nuclear industry.

Chapter III

Method

This chapter will describe the methodology for this study, including the theoretical framework, research design, anticipated sampling techniques, the data collection, and data analysis procedures. Additionally, the study's purpose and research questions will be further reviewed. Lastly, the study's subjectivity, trustworthiness, and considerations are detailed and connected to the methodology to explain the researcher's involvement and potential impact on the outcomes. The study employed a qualitative research method, so the actual design and analysis evolved as the study continued. However, the details outlined here were followed as closely as possible. The information presented in this chapter set the stage to begin the research and data collection.

This study aimed to gather information about strengthening nuclear apprentices' confidence as they prepare to enter their careers in the nuclear field. This information may also yield other beneficial data on retention factors from nuclear apprenticeship graduates, leading to adequate training programs. With better training programs and higher confidence levels, the labor and skills gap in the nuclear field may begin to close.

Three key factors were explored while collecting this data. The first was the use of academic resources provided by educational institutions, such as tutors or life coaches. The next factor is workplace support that the employers may provide, such as a mentoring program or embedded orientation. The final factor is the ability to balance the

workload, school requirements, and other aspects of life that each apprentice will encounter. The results of this study will be supplied to higher education institutions, businesses, and others involved in developing nuclear apprenticeship programs.

Data from those who have participated in a nuclear apprenticeship as students in the last 5 years was collected through individual and focus group interviews. The individual interviews covered each of the four research questions, and the focus group interviews allowed for deeper questioning and comparison across three companies. To assist in collecting the data, two main research questions and two sub-questions were created:

1. What are the lived experiences portrayed by the graduates of a nuclear apprenticeship program?
2. How does engagement in a nuclear apprenticeship program affect graduates' confidence in their ability to succeed in their nuclear careers?
    - 2.1. How do graduates depict the impact of variety and utilization of academic resources available throughout the apprenticeship program on their level of confidence in job performance as they transition to their careers in the nuclear field?
    - 2.2. How do graduates portray the influence of support strategies provided by their employer for the duration of the apprenticeship program on their confidence levels of occupation-related duties as they prepare for their career in the nuclear field?

Research question one explores the effects of the nuclear apprenticeship's constraints on participants' confidence levels during and after the program, such as

program length, cost, and work/school/life schedule. Connections between those factors and the intention to persist in the nuclear field may also be discovered. Data collected from this research question may identify potential areas in apprenticeship programs that need strengthening. In contrast, research question two looks at a different topic. This question aims to gather data on the various tools supplied throughout the program to increase apprentice success. The technical colleges and employers who collaborated on this training endeavor made different resources available to aid in the learning process. Sub-questions 2.1 and 2.2 further explore these areas.

Research sub-question 2.1 intends to have participants identify the academic resources that were most beneficial to their new career in the nuclear field while describing how and why these factors contributed to their confidence levels and intentions to remain in their career. Again, understanding the most important academic resources for nuclear apprentices will guide higher education leaders as they create and modify apprenticeship programs to train individuals to close the labor and skills gap quickly. Research sub-question 2.2 aims to reveal the most advantageous support strategies provided by the employers throughout the program. Knowing what supports to put in place to achieve higher success and, hopefully, retention rates will aid companies in hiring and maintaining new employees to close the labor and skills gap. Like sub-question 2.1, the data collected from this sub-question will also provide information about the participants' confidence levels in their careers.

Theoretical Framework

The theoretical framework sets the tone and direction of a study for readers in the same way a blueprint provides instructions to a contractor when attempting to build a

home (Grant & Osanloo, 2014). Ideally, a theoretical framework has three parts: the theoretical, epistemological, and methodological premises (Saldaña, 2022). According to Saldaña (2022), the theoretical premise focuses on the theories that drive the search for new knowledge within the study. The epistemological premise is about how knowledge is perceived and understood (Saldaña, 2022). This is especially important in a qualitative study as the researcher is the main instrument in the study. Lastly, the methodological premise centers on the approach used to gather data in the study (Saldaña, 2022). Each part plays an important role in providing readers with the full context of the study, including its methods and analysis (Grant & Osanloo, 2014).

Theoretical Premise

The theoretical premise of this study includes three theories. These theories, as Grant and Osanloo (2014) noted, create the structure of the study to build upon. One theory used in this study is the Boundary Theory by Nippert-Eng (1996) and Ashforth et al. (2000). The Boundary Theory, which drives research question one, encompasses the various contexts that may affect the total experiences of participants as they completed a nuclear apprenticeship program. Specifically, the Boundary Theory explores the connections and divisions between society's work, home, school, and additional domains that pertain to an individual's life (Desrochers & Morgan, 2021). Using this theory lets readers know that multiple areas of life will be considered as data is collected to understand participants' confidence levels better.

The next theory used in this study, the Skill Theory, also relates to the experiences of participants in several parts of their lives. Developed by Kurt Fischer in 1980, the Skill Theory pertains to how people develop new skills, which is critical to understanding how

training programs can be used to close the labor and skills gap in the nuclear field (Fischer, 1980). Sensory/motor, representation, and abstract skills are developed over multiple tiers that grow as people interact in different manners over time (Fischer, 1980; Fischer & Rose, 2001). Research questions one and two both involve the Skill Theory, as the participants' actions and encounters are elaborated for readers and researchers to see if the principles of the theory are present in current training programs.

The final theory discussed in this study is the Self-Efficacy Theory by Albert Bandura (1977). With the belief that self-efficacy is the footing and underlying support for a person's sense of personal accomplishment, well-being, and motivation, the Self-Efficacy theory is directly connected to research sub-questions 2.1 and 2.2 (Lopez-Garrido, 2025). The core principles of the Self-Efficacy Theory, such as monitoring *Performance Outcomes* through practicing and appropriately managing emotions during challenging times, assist in developing higher levels of confidence (Lopez-Garrido, 2025). Therefore, the Self-Efficacy Theory is a suitable theory for exploring the workplace and school-supplied support systems for former apprentices. The Self-Efficacy theory pushes the study in the direction of gathering data to discover if the training programs supported confidence-building efforts through the main principles of the theory.

Epistemological Premise

The epistemological premise, which describes the philosophical worldview, for this study and many other qualitative studies is constructivist (Saldaña, 2022). Researchers who adopt this mindset believe that humans construct meanings as they engage with the world (Creswell & Creswell, 2018). In this worldview, the researcher aims to describe the meaning of the phenomenon from the viewpoint of the participants

(Creswell & Creswell, 2018). The philosophical worldview heavily influences the research design and methods. Case studies that utilize open-ended questions are common for constructivist studies (Creswell & Creswell, 2018). The researcher also often validates the accuracy of the findings through triangulation, studies the settings of the participants, and positions themselves in the research (Creswell & Creswell, 2018). Constructivism is designed to generate a theory about the phenomenon or social interactions of the participants, which can be done through the various forms of collected data (Creswell & Creswell, 2018).

Methodological Premise

The methodology used in this study is a Comparative Case Study (CCS). A CCS was chosen due to the multiple institutions and contractors chosen for participants and data collection, in addition to the richness of the information desired by the theories selected for the research. Detailed information about the CCS, including recruitment, data collection, analysis, and study considerations, are described later in this chapter.

Research Design

The chosen research methodology for this investigation is a comparative case study (CCS). According to Goodrick (2014), a CCS is a detailed inquiry of two or more cases in an effort to reveal more knowledge about trends or causes and effects in a common phenomenon or program. There are many definitions of cases, but Yazan (2015) provides one originally articulated by Yin that defines a case as an occurrence within its natural setting where the researcher has little control over the occurrence and its setting (Yin, 2002). The occurrence in this study is the use of nuclear apprenticeships. Each site, which will be explained in detail in the next section, used a nuclear apprenticeship to

train and supply more workers for the nuclear field quickly. Although Goodrick did not provide a definition of a case, he noted that cases should be chosen based on the objectives of the study. Additionally, cases can represent the micro, meso, or macro levels of an organization, be used to evaluate an intervention at a site, or monitor the progress of a process (Goodrick, 2014). A CCS can be used to collect both qualitative and quantitative data (Goodrick, 2014), but this study will only generate qualitative data through both individual and focus group interviews.

Ideally, a CCS is used to gather information when an intervention has been employed across multiple sites (Goodrick, 2014). For instance, a CCS can answer "how" or "why" questions about the intervention, especially if manipulation or controlling variables is impossible (Goodrick, 2014). Furthermore, Goodrick (2014) also stated that a CCS should be used if a traditional experiment cannot be completed for the various sites. Lastly, a CCS should be used if there is time for repetitive data collection and analysis of that data (Goodrick, 2014).

Goodrick (2014) outlined six general steps to carry out a CCS. In the first step, the researcher should identify their key evaluation questions (KEQs) or research questions to ensure a CCS is the right design for the study. Step two involves the Theory of Change. The Theory of Change is a detailed narrative of what is expected to happen from the interventions or phenomena at the selected sites (Goodrick, 2014). This theory will be tested or explored in the study. In step three, the cases are selected. Purposeful and stratified sampling are sampling techniques used to choose a smaller number of cases, such as in this study (Goodrick, 2014). Fewer cases allow for a more in-depth analysis of the intervention or phenomenon over time (Goodrick, 2014).

After the cases are identified, the data must be collected and analyzed from each case. Data collection and analysis occur in step four (Goodrick, 2014). As Yazan (2015) reported, Yin (2002) proposed six major data collection tools: documentation, archival records, interviews, direct observations, participant observation, and physical artifacts. Other researchers, such as Stake (1995) and Merriam (1998), offer alternative variations of data collection methods (Yazan, 2015). Yin also suggested five data analysis strategies: pattern matching, explanation building, time-series analysis, program logic models, and cross-case synthesis (Yazan, 2015). The method of analysis will depend on the cases and data collected.

In step five, once the data has been analyzed, it should be triangulated with other data sources from the same study or another similar study (Goodrick, 2014). Other triangulation methods include member checking and theory triangulation (Yazan, 2015). Triangulation can be used to confirm responses to descriptive research questions, support answers to causal questions, and further explain observed patterns (Goodrick, 2014). While triangulation has many benefits, it does have a few cons. It can require a lot of time and resources, which can become costly (Patton, 2015). Additionally, the audience who will review the findings may not agree with the sources used (Patton, 2015). However, the benefits of reviewing the data and confirming the findings usually outweigh the cons (Patton, 2015).

The final step in CCS is reporting the findings. Goodrick (2014) encouraged using narratives that include tables and charts to display the information. Additionally, researchers should take care when generalizing the data. The general population may not

mirror the setting of the cases, so the trends and patterns of the study cannot be broadly extrapolated to other sites and locations (Goodrick, 2014).

Goodrick (2014) described a frequent downfall in the use of CCS. Although researchers can successfully identify similarities and differences between the interventions or phenomena at the various sites, they often neglect to specify the causal relationships. These relationships should be identified and tested. The process of selecting cases can be another weak point in CCS. Again, the cases and sites may be rich and diverse, but they are not selected with regard to how well they will provide data for the causal relationship (Goodrick, 2014). Researchers must be diligent in keeping the causes of the similarities and differences at the forefront of the study while conducting research using CCS.

Site and Participant Selection

For the comparative case study, one physical location was chosen. The nuclear site is home to five contractors; however, data was only collected and compared from three of these five contractors. The paragraphs below provide concise and pertinent information about the site, including the contractors used in this study.

Site 1

Site 1 is a 310-square-mile Department of Energy (DOE) complex located in the Southeast United States. The site was created in the 1950s to produce nuclear materials for weapons, but its missions have changed slightly over the years. Site 1 and its occupants cover several areas, including national security, nuclear materials disposal, environmental cleanup, and waste management. New missions, such as repurposing the

Mixed Oxide Fuel Fabrication Facility for plutonium pit production, will keep Site 1 in need of qualified workers (National Nuclear Security Administration, n.d.).

Contractor 1

Contractor 1 is charged with the overall management and operations of the complex. Its parent companies are Fluor and Newport News Nuclear of Huntington Ingalls Industries. This contractor employs over 6,000 workers, including its apprentices. Contractor 1 began the apprenticeship program with the first cohort of production operators in 2020, which had 10 apprentices.

Contractor 2

Contractor 2 is also housed at Site 1. Composed of parent companies Amentum, BWX Technologies, and Fluor, this contractor secured a 10-year, $21 billion contract that spans several missions. Examples of these missions include storing liquid radioactive waste, decontaminating nuclear facilities and equipment, remediating/treating contaminated water and soils, and treating/disposing of spent nuclear fuel. In fiscal year 2023, Contractor 2 co-hosted the first joint cohort of production operator apprentices. Over 100 apprentices graduated from this single cohort.

Contractor 3

Battelle Savannah River Alliance (BSRA) manages Contractor 3 and has six higher education institutions on its governing board. As the only Office of Environmental Management-sponsored national lab. Contractor 3 has three main mission areas: environmental and legacy management, national security, and science and energy security. Contractor 3 also houses the nation's sole radiological crime investigation lab. Over 1400 people currently work at Contractor 3.

Technical Schools

Each of the aforementioned contractors in the previous section utilized a technical school to deliver the academic portion of the apprenticeship. The contractor enrolled students in programs from at least one school, but some used multiple colleges during each cohort. The programs at each school differed as well, but each college offered the Production Operator apprenticeship. Cohort cycles varied at the schools based on employers' needs and the schools' resources. Each of the three technical colleges that assist in the training of the apprentices for this CCS are detailed below.

Institution A

Institution A is a two-year technical school and is accredited by the Southern Association of Colleges and Schools Commission on Colleges (SACSCOC). Founded in 1972, Institution A has grown to serve 2,923 students in the 2022-2023 academic year, with the majority of those students (65.3%) being female. Additionally, the average student age is 27, and the population is 50.5% White. It was also reported that Institution A employed 58 full-time and 131 part-time faculty members.

Institution B

Institution B was founded in 1947 and opened in 1948. Its primary purpose was to educate the Black citizens of a local city, establishing its legacy as a Historically Black College or University (Surles, n.d.). Institution B has grown considerably since being accredited by SACSCOC and assuming its current name in 1979. There were 895 students enrolled at Institution B in Fall 2022, most of whom were Black or African American (Institute of Education Sciences, 2023).

Institution C

Founded in 1961, Institution C is a two-year college with multiple sites and is accredited by SACSCOC. As of Fall 2022, the student population was 3,970, and the number of faculty members was 126 full-time and 88 part-time. Data showed that most of their students are Black or African American and female.

Sampling Technique

Although current and former nuclear apprentices are affected by workplace and academic support and work/school/life balance during a nuclear apprenticeship, former nuclear apprentices are the overall population for the sample selection. The size of this group is currently unknown. Former nuclear apprentices, including those who were released from the program by their employer, those who chose to quit on their own, and successful graduates, potentially relied on support from the school and employer and may still need to figure out how to balance the various areas of their day. They may be able to offer insight into what contributed to their success in their nuclear career or what prompted them to change career paths.

The accessible population is individuals who participated in a nuclear apprenticeship at certain schools in the states of Georgia and South Carolina within the last 5 years. Individuals in this group must also have been hired as a limited-service employee (LSE) or full-service employee (FSE) (part-time or full-time employee) for one of three select contractors at Site 1. This population includes non-completers. Eligible apprenticeship programs include radiation protection (RadCon), production operators (nuclear operators), electricity and instrumentation, maintenance mechanics, and laboratory technicians. The apprenticeship must have been registered with the

Department of Labor to track the academic and work hours of the apprentices. These individuals do not have to be currently employed in the nuclear field to participate in the study. Their decision to find employment elsewhere may have been influenced by the apprenticeship, which is one area this study hopes to cover.

Before sampling and data collection began, approval from Valdosta State University's Institutional Review Board (IRB) was secured. To gain approval, I completed a training series through the Collaborative Institutional Training Initiative (CITI) program. There were eight modules to complete, which included topics such as ethical principles, informed consent, and research with human subjects. The CITI completion certificates are located in Appendix A. IRB approval also required a Letter of Cooperation from all data gathering sites used in this study. A letter from Site 1 and the three institutions were collected; the letters can be viewed in Appendix B. An additional requirement for IRB approval was masking the names of all sites, contractors, and participants in the study to protect the participants' identities as much as possible. Lastly, the IRB reviewed consent statements, which are available in Appendix C, for individual and focus group interviews and the study's interview protocol. Once IRB approval was achieved, recruitment and data collection began. The IRB approval letter/Exemption Report is located in Appendix D.

Two sampling procedures were used to recruit participants for this study. First, a targeted, purposeful recruitment strategy was employed. Flyers were distributed to colleges and businesses identified as nuclear apprenticeship partners so that information about this study could be shared with recent graduates. The identified colleges are masked to protect the identity of the participants, but they are institutions in the states of

Georgia and South Carolina. The businesses will be one of three select contractors at Site 1. Purposeful sampling in the form of snowball sampling was used to expand the pool of eligible participants. Individuals who knew of qualified individuals were asked to refer them to the study to see if they qualify to participate in the study.

After the Institutional Review Board (IRB) approved the study, a flyer was posted indicating the purpose, needs, and other major study details. This flyer, which is housed in Appendix E, was distributed physically and electronically via e-mail to the three identified businesses and three educational institutions. Additionally, the flyer was posted on social media. When contacted by potential participants, the following screening questions were asked to determine if they qualified for the study:

- Did you participate in a Department of Labor registered nuclear apprenticeship within the last 5 years?
- Were the apprenticeship classes held at Institution A, Institution B, or Institution C?
- Were you an LSE or FSE at Contractor 1, Contractor 2, or Contractor 3?

Details about confidentiality and the interview process were also discussed. Participants were invited to ask any questions they may have regarding potential participation in the study.

Next, the participants were interviewed to gather much of the desired qualitative data. The study initially planned for three to five participants from each contractor and three to five non-completers, for a targeted total of 12 to 20 participants. This range was selected as it would likely provide enough data to reach saturation through individual interviews as well as two to three rounds of focus group interviews. Focus groups of four

to six participants are a typical range for smaller focus groups and work better for some topics (Kvale, 1996; Roulston, 2022). Redistribution of the flyers and other sampling techniques, as mentioned earlier, occurred due to a low response rate. Recruitment continued until data saturation was reached.

Data Collection

Interviews are a common data collection method for qualitative research (Roulston, 2022). This comparative case study collected data through individual and focus group interviews. As mentioned earlier, participants came from one of three contractors at Site 1 and represented completers and non-completers of the program. The richness of the data from individual and focus group interviews allowed for data triangulation once the collection was completed.

Before beginning the interviews, each participant was asked to create a pseudonym to maintain their anonymity during the individual interviews. Additionally, two interview guides (one for the individual interviews and one for the focus group interviews) were created to assist in keeping the interviews on track. The interview guides had a semi-structured format where open-ended questions were initially asked, and follow-up questions were generated based on the interviewee's responses (Roulston, 2022). The interview guides can be reviewed in Appendix F. An hour was the estimated time frame for each interview, but additional time was scheduled for sessions that surpassed 60 minutes. All interview sessions were audio-recorded to facilitate transcription of the interviews.

Individual interviews were conducted with each participant by the researcher. The interviews occurred in a virtual format. Each interview session used the same structure

and set of interview questions. However, follow-up questions tailored to the participant's response differed from session to session depending on participant responses, as indicated in the interview guide. This portion of data collection continued until data saturation was completed.

After each participant had their personal interview, they had the option to share their experience in a focus group interview with participants from other contractors and non-completers. They were contacted by email or phone to confirm their participation. According to Roulston (2022), participants are purposely brought together, and interactions between the various participants are encouraged in focus groups. The focus group interview was virtual and scheduled during a common meeting time for the participants to maximize participation. The interview guide drove the conversation. One focus group interview took place with three contributors.

After all the individual and focus group interviews concluded, participants were encouraged to share additional thoughts. These thoughts were included in the field notes section of the data. Field notes are descriptions of observations that allow researchers to recall details of the observation during analysis and empower readers to visualize the observation themselves (Patton, 2015). They often include information such as the date, settings, environment, and other specific notes that may impact responses from the participants (Patton, 2015). Other field notes included information from the interviews that was not captured by the audio recording, such as body language (Kvale, 1996; Patton, 2015). When field notes are used in interviews, they contribute to documenting how things were said, which assists in coding and creating themes during analysis (Phillippi & Lauderdale, 2017). Field notes serve a great purpose as the data is impacted

by the researcher's subjectivity and limited memory (Kvale, 1996). Notes taken before, during, and immediately after the interviews capture information that may otherwise be forgotten or unintentionally altered.

Data Analysis

After all of the data was collected from the individual and focus group interviews, data analysis began. The first step in the analysis procedures was to transcribe the interviews from audio recordings into transcripts to be referenced. Instead of manually transcribing the interviews, computer software was used. Otter.ai was used to transcribe the interviews in this study. Since this software uses artificial intelligence (AI) to create the transcript, a comparison of the audio and transcript was completed for accuracy. Once all of the interviews were transcribed, coding was conducted. Coding is using a word or phrase to capture a language-based or visual piece of data that elicits a meaning or significant thought (Saldaña, 2021). Two rounds of coding occurred. During the first round, the codes represented more of an analysis, while the codes became more of a synthesizing technique during the second round (Saldaña, 2021). Additionally, memoing occurred while coding was taking place. Memos differ from field notes; Field notes are significant pieces of data about the participants, and memos, which can be classified as data, are thoughts from the researcher during the analysis process (Saldaña, 2021).

After all of the individual and focus group interviews were transcribed, coded, and memoed, thematic analysis began. Themes were identified based on the similarities of the codes from the previous step. Themes capture the patterns seen in the codes and memos from the interview data (Qualtrics, n.d.). As themes were created, they were

related to theoretical frameworks and research questions. At this point, each theme was given a specific name and definition (Dawadi, 2020).

The last step in the analysis procedure was to write up the study findings (Dawadi, 2020; Qualtrics, n.d.) This was done as a narrative that includes diagrams, charts, and tables to explain numerical data and other pertinent findings (Goodrick, 2014). Examples and references from the data will be included in the narrative to strengthen the findings and arguments (Dawadi, 2020). The final write-up included areas for further research or suggestions for implementation for the higher education institutions and employers involved in the study.

Trustworthiness

Trustworthiness in qualitative research differs from that of quantitative research (Merriam & Grenier, 2019). The results of qualitative research are not meant to be replicated or repeatable, especially in the social sciences, as human behavior changes constantly, and several influences can affect a study's outcomes (Merriam & Grenier, 2019). Regarding reliability, qualitative research is more focused on dependability; the study's results must be reasonable with the gathered data, and other researchers should be able to come to the same conclusion (Merriam & Grenier, 2019). Merriam and Grenier (2019) suggested using triangulation, the investigator's position, an audit trail, and peer examination to check the reliability of the research. Triangulation, which is discussed in the section below, and peer examination were used to establish reliability in this study.

Triangulation and peer examination can also be used to determine the validity of a study (Merriam & Grenier, 2019). A study is valid when it measures what it is supposed to measure (Merriam & Grenier, 2019). Validity starts with the research questions; proper

research questions set the stage for collecting data needed to answer what needs to be known. Appropriate data collection methods also affect if the correct information is gathered. An experienced researcher will know how to structure the study to suit their needs. Lastly, Merriam and Grenier (2019), Roulston (2022), and Goodrick (2014) all recommended collecting data until saturation occurs. Data saturation is the point where the data collected will begin to sound redundant, and no new data will appear (Merriam & Grenier, 2019). In this study, peer examinations were executed at various points. A peer examination, also known as a peer review, is a process where a committee member or colleague reviews the study's data and provides feedback about its credibility (Merriam & Grenier, 2019). Also, the focus group interviews continued until saturation was reached, assisting in establishing validity for the data.

Peer Examinations

Peer examinations, as previously defined, differ from formal journal peer review processes (Booton, 2024). This process typically involves a researcher's peers and dissertation committee (Booton, 2024; Chappell & Voykhansky, 2022). Usually, up to three reviewers participate, but as many as five can offer feedback to the manuscript (Chappell & Voykhansky, 2022). The purpose of a peer examination or peer review is to provide objective feedback to the researcher about their work (Chappell & Voykhansky, 2022). Peer reviews also teach novice researchers how to explain their study's research questions, data, and findings (Booton, 2024). The critiques from professors, peers, and committee members will improve the researcher's skills and strengthen the study's narrative (Chappell & Voykhansky, 2022).

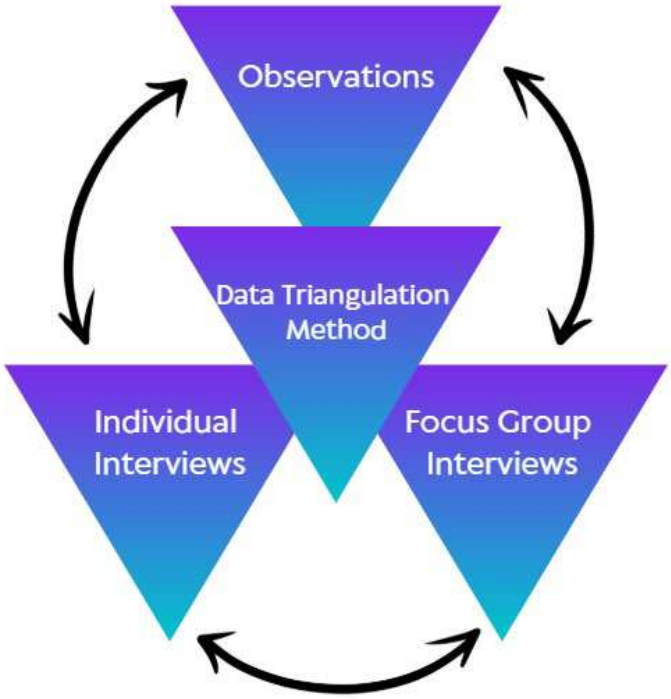
In this study, peer examinations occurred before, during, and after data was collected and analyzed. A methodologist, as well as two other committee members with terminal degrees, frequently checked the data and findings before the final submission of the paper to assess the plausibility of the results. Additionally, a reader reviewed the narrative to check for cohesiveness and a synthesis of the information through each chapter of the study. These checks increased the quality of the narrative, ensured the study follows all outlined protocols, and helped develop my research skills.

Triangulation

A very important part of the analysis process for both qualitative and quantitative research is the triangulation of data. Data triangulation was first defined and used in research by Foreman in 1948 (Merriam & Grenier, 2019). Over time, the methods of data triangulation have grown. Denzin (1970) proposed four ways to triangulate data: through multiple investigators, multiple theories, multiple sources of data, and multiple data collection methods (Merriam & Grenier, 2019). In this study, multiple data collection methods, as shown in Figure 2, were used. As previously detailed, participants were interviewed in a private setting to gather their initial thoughts and feelings on the topic. Then, those same participants returned to engage with others from varying companies in the case study and share more information. Observations from both interviews served as data to be used in triangulation.

Figure 2

Data Triangulation Methods



Other methods of triangulation occurred as well. Similar to having multiple investigators, member checks and peer examinations are common practices. Member checking involves taking the data and its interpretations back to the source for confirmation of its understanding (Merriam & Grenier, 2019). In other words, the participants validated that their thoughts and feelings were appropriately captured during the interviews. Through peer examinations, a subject matter expert reviewed the data before it is published and provided feedback, validating that the data is at least possible based on the given scenario. To further enhance data triangulation, a methodologist and researcher assessed the methodology, data, and findings to ensure the study is well-written and captures the essence of the participant's experiences. Frequent inspections from multiple researchers through member checks and peer examinations strengthen the study's reliability and validity.

Subjectivity

Every researcher carries some bias towards their study. This bias, known as subjectivity, can hinder the researcher's understanding of the participants' experiences (Ratner, 2002). It is critical that researchers address their biases before undertaking the study and throughout the data collection and analysis process. A potential source of bias I present in this study is being connected to the nuclear apprenticeships as a former program coordinator and department chair at one of the participating institutions. I was employed there from August 2018 until December 2023. I began serving as the coordinator of the Production Operator apprenticeship program in January 2020, and I became the advisor of the Radiation Protection apprenticeship program in August 2021. I fulfilled these roles until my departure.

My affiliation with those programs means some participants may recognize me, theoretically limiting those who want to participate. It may also cause participants to speak less openly since I had a working relationship with their employer. On the other hand, this established relationship may encourage participants to engage and speak truthfully. Most importantly, I need to make sure I am hearing what the participants are saying and not what I expect/want to hear. I realize there may be comments that reflect negative experiences of a program I helped to create. The purpose of this study is to hear the range of experiences (good and bad) to improve the program for future cohorts. I will be mindful of my emotions and thoughts as I collect, analyze, and present the information in this study.

Ethical Considerations

There are potential issues and limitations to consider when employing a comparative case study. One of the biggest ethical matters is the ability for participants to possibly identify each other (Goodrick, 2014). This may occur through in-depth descriptors or by recognizing one another at a focus group interview (Goodrick, 2014; Roulston, 2022). To combat this, participants were informed upfront about the possibility of being identified (Goodrick, 2014). Each participant chose a pseudonym to conceal their identity in presentations and publications, further protecting their identity after the study has concluded. Choosing their own pseudonym increased the participants' buy-in and personal connection to the study (Itzik & Walsh, 2023). Itzik and Walsh (2023) believed that a name is connected to a person's identity, and allowing the participants to choose their pseudonym gave them the power to maintain the part of themselves they wish to represent in the study. The name was recorded at the beginning of the interview and used during the transcription of the interview. If a participant declined to choose a name or could not think of one, the researcher developed one. The applied pseudonym will have no relation to their government name or employer. Additionally, participants were given the option to back out of the study at any point, even after the interviews began. Recruitment efforts continued to gather more participants when participants backed out at the last minute. The contractors of Site 1 and the technical schools were masked to further protect the participants' identities.

Roulston (2022) wrote about the benefits and challenges of when participants recognize each other. One, if the participants know each other, the researcher may not have to spend as much time creating a comfortable environment where the participants

can speak freely, depending on their relationship outside of the focus group. On the other hand, Roulston noted the participants may present themselves in a particular manner since they are in the company of other influential people. Either situation can help or hinder the study's results.

Comparative case studies also have the potential to be rigorous and laborious, especially if a large number of cases and sites are chosen (Goodrick, 2014). Should there be a large number of cases, this likely will negatively impact the researcher's budget for this study. Lastly, should a significant period of time pass between the initial data collection period and the presentation of the results, the study's findings may not be as accurate as other influences may present themselves (Goodrick, 2014). To minimize all of this, as the researcher, I have chosen a smaller, more manageable number of sites for this comparative case study.

Chapter Summary

With a constructivist worldview as a guide, a qualitative comparative case study was employed between three contractors at Site 1 to collect data and answer the study's research questions. The study's participants, which included graduates and non-completers of nuclear apprenticeship programs, were recruited through purposeful and snowball sampling. Semi-structured individual and focus group interviews took place until data saturation occurred.

The data was analyzed in several steps. First, the interviews were transcribed through Otterai. Next, coding and memoing took place simultaneously; there was an analysis and a synthesis round of coding. Then, the codes were combined into emerging themes that were named and defined. The last step was to write up the findings. The

findings were presented in a narrative with charts, tables, and diagrams in Chapter IV. Limitations and potential issues of comparative case studies were considered during each phase of the study, especially the risk of identifying participants to each other and readers of the study.

Chapter IV

The Participants' Experiences

Chapter IV focuses on the study's participants and their responses to the interview questions. An overview of their experiences and supporting quotes from the individual and focus group interviews will paint a picture of their lives during their apprenticeship program. Six participants were interviewed for this study. They all reside in South Carolina or Georgia and attended a higher education institution in one of those states. The ages of the participants range from the mid-20s to the mid-40s, with an average age of 34, which is slightly below the 2021 Site 1 average of 48.6 years old.

The former apprentices share many demographics. Everyone but Kay is African American; she is Caucasian, and James is mixed with African American and German. Jacob, Mel, James, and Victor are male, and Kay and Mary are female. Jacob and James are the only graduates who attended Institution C, and Mel is the only employee of Contractor 3. Everyone else attended Institution A and worked for Contractor 1. They all have obtained at least a technical school certificate, while two have moved beyond that level. Jacob is pursuing a bachelor's degree, while Mary has already completed a master's degree.

Each participant worked in the nuclear field at some point, but only five of the six participants are still employed in that industry. Most participants have experience in at least two careers, including the switch to their nuclear career, but Mary led the group with

five career industries. Former careers across all participants included: retail, brokerage, parks and recreation, healthcare, clerical work, food and beverage, and sales. Victor was the only graduate whose first career was in the nuclear industry. However, he is no longer working for a nuclear contractor due to legal issues, but he wishes to return later.

The characteristics described shaped the experiences of each person's apprenticeship program and impacted the journey that led them to the nuclear field. The following table summarizes each participant's demographics, while also highlighting the similarities and differences among the graduates.

Table 1

Participants' Demographics

Name	Age	Race	Gender	Pronouns	Education Level	Number of Careers
Mel	Late 30s	African American	Male	He/Him	Technical School Certificate	Three
Mary	Mid-40s	African American	Female	N/A	Master's Degree	Five
Kay	Late 20s	Caucasian	Female	She/Her	Technical School Certificate	Three
Victor	Mid-20s	African American	Male	He/Him	Technical School Certificate	Two
Jacob	Mid-30s	African American	Male	He/Him	Technical School Certificate	Two
James	Early 40s	Mixed, German and African American	Male	He/Him	Technical School Certificate	Two

To maintain the authentic voice of the participants, direct quotes will be used throughout this chapter. These quotes may include, but are not limited to, grammatical errors and improper sentence structure. Quotations that are written verbatim can exemplify an experience and illustrate the connections between individuals in a focus group interview (Eldh et al., 2020). Preserving the original language ensures the richness of each participant's perspective is fully represented.

Mel's Experience

Mel is an African American male in his late 30s who has experienced three career changes before landing in the nuclear field. He is a July 2021 graduate of the Nuclear Fundamentals Apprenticeship program at Institution A. At that time, Institution A was the only school offering this program in the region. During the apprenticeship, Mel was employed by Contractor 3 and still works for them. Due to the opportunities for financial growth, Mel has decided to remain in the nuclear field for at least 10 more years, but he does not see himself working in this industry until retirement age.

In general, Mel believed the apprenticeship program was "very beneficial" and effectively prepared him for his career in the nuclear field. His cohort used a model where apprentices would go to class for 20 hours per week (two 10-hour days) and then go to work at the site for 20 hours per week (two 10-hour days). The class days were not back-to-back, but the work days were consecutive. This model suited Mel well, and he described the program's pacing as "okay" and right for him, even as someone who "reviled school."

Mel defined work/life balance as being able to get off work for various reasons, such as spending time with your family, traveling, or navigating natural disasters, while

still being compensated for those days. However, when asked about work/life balance as an apprentice, he replied there were times when he felt the program was "modern-day slavery," and he cried occasionally. Mel stated, "You got up, went to class, slept, go [*sic*] to each area, sleep [*sic*], go [*sic*] back to class, test [*sic*], and repeat [*sic*] every seven weeks." After the program ended, Mel excelled at work and enjoyed life after his shifts.

The next topic explored support systems available to the apprentices during their program. For Mel's cohort, Institution A provided "knowledgeable teachers and actual study material." One support he took advantage of the most was his colleagues. Due to everyone being "spirited" and eager to succeed, Mel felt he had everything he needed to complete the program and did not express the need for additional systems to be implemented. He had similar feelings regarding Contractor 3's support systems. Two supports were available to him. One was that his class material and work duties closely mirrored each other, making it easy to transfer the knowledge from one setting to another. The second was his colleagues. Like in school, each apprentice led one another to progress through the program. He did not believe more support systems were needed at work either.

Overall, Mel felt his confidence in his ability to perform his job at the nuclear site increased as a result of the apprenticeship program. Not only did his confidence increase, but his aptitude did as well. The apprenticeship helped him to retain important and pertinent information related to safety and procedures. Because of this, he does not believe anything else was needed to enhance the program. He had access to "good instructors," which was enough to help him when the school and employer expressed their high expectations. The only negative experience was his struggle to maintain a

desirable work/life balance. Despite this, Mel valued the apprenticeship program and does not regret pursuing a career in the nuclear field.

Mary's Experience

Mary is a former apprentice whose journey to the nuclear industry spanned several disciplines and educational institutions. She is an African American female in her mid-40s with work experience as a custodian, customer service representative, delivery service broker, warehouse worker, and a public park facility assistant. After struggling to find employment with her master's degree, Mary was encouraged to seek a position as a Radiation Control (RadCon) Inspector at Site 1. To increase her chances of getting hired, she applied to the RadCon degree program at Institution A. Mary was accepted, and she graduated with her Associate of Science Degree in Radiation Protection in May of 2023.

While working on her degree, Mary began the RadCon apprenticeship program with Contractor 1. She is still employed with this company and is thriving in her role as a RadCon inspector. Mary has even progressed to the next pay grade. Due to her success in the field and the opportunity to earn a salary that suits her lifestyle, Mary plans to persist in this industry. However, she would like to expand to other positions, such as a health physicist, dosimetry technician, trainer, procedure writer, industrial hygienist, or health and safety manager. There are enough options in the nuclear field for Mary to explore until she retires.

When Mary was an apprentice, she did not follow a cohort model. Instead, apprentices took classes at their own pace while working on site. Although the apprentices were enrolled in different courses, they all worked the same schedule. Luckily, she had an apprentice and coworker in her courses who helped her navigate the

various assignments and projects, so she never felt alone. Every apprentice started on the day shift to work four 10s (four ten-hour days each week) and took classes in the evening from 6 to 9 PM. This structure and pace were "suitable" for Mary, and she stated that other models sounded like they required too much "shifting around." Her response to the nature of the program tied directly into her perspective on work/life balance. She described it as:

> You need balance first. You need to understand, know when to work. You have to, how can I spend it? You have to do a little bit. You probably have to half it up to balance it out. You have to. You can't. If you don't have a balance, it'll never work. So, I feel like you have to balance both of them.

For clarity, her definition was summarized as "being able to do some work and some things outside of work, but make sure one is not overshadowing the other." The RadCon apprenticeship provided the flexibility that Mary needed to achieve her view of work/life balance. Working four 10s gave Mary the time she needed to focus on work and school for designated time periods during the week, while offering three days off each week to relax and recuperate.

Mary attributed her accomplishments in the nuclear field to her participation in the apprenticeship, where she felt supported by her institution and employer. She took advantage of the Student Services Center at her academic institution and its tutors to get help with her general education courses, such as science or math. Mary also utilized support from her employer, indicating that she had an instructor at Institution A who also worked for Contractor 1 and served as an unofficial mentor for her. There was also another instructor at Institution A who greatly impacted Mary's experience. Mary relied

heavily on them for guidance about the nuclear industry and assistance in her core classes. However, she believes their aid could have been even more fruitful if her employer had spent more time communicating with her professors about expectations in the workplace. Comprehensively, Mary felt supported by her employer and supervisors. She expressed:

> I did because they understood, and they knew that we were in class, [*sic*] and they understood, you know, not to put me on a shift yet, until I was finished with the program, because normally, if I wasn't [*sic*] enrolled in school, they would have sent me straight to a shift, but once, but they did understand, and they did know that I was currently in school, and that's why they pretty much waited until I was finished with it, when I finished the course work.

Even after completing the program and transitioning to shift work, Mary still uses her support systems by connecting with those mentors. They advise on career goals and other challenges Mary may face on site.

When asked about the difference in her confidence levels pertaining to her ability to perform her nuclear job duties, Mary responded with:

> I want to say yes, because what I saw, or what was brought to me, the information that was brought to me, I was able to use it at work, especially when it's time for me to take my mock-up…So, I would say that even though they didn't teach us how to use the instruments in the beginning, I can say that when I got hired out there, I was a little bit familiar of what they were and how to use them.

This statement aligns with Mary's success in her career; she's already progressed from a Limited-Service Employee (LSE) to a Full-Service Employee (FSE) and the next pay

grade. Mary also mentioned how she successfully maintains her qualifications through the recall procedures at Site 1, which is another testimony to how the program continues to help her flourish in this field. She saw a vast distinction between those who entered the job through the apprenticeship and those hired through other means. Many of them struggled with the math and RadCon concepts, where Mary was well versed in them due to learning the content in her classes.

Even though Mary felt the program was effective in preparing her for the nuclear field and her participation resulted in a confidence boost, she suggested two changes for the program. One recommendation was to rearrange the order of the classes. She would have liked to take the classes about maintaining and operating instruments and dressing out first. Mary added:

> Tell them this is what you do, instead of waiting until like, the end of the program to do it, because I feel that if you see it early on and also do it throughout the program, they'll be ready for it. The inspect, the potential inspectors, will be ready for it. And when they say, "Oh, I've seen this at school, now I know what to do on my job…It'll show you how to respond to contamination and radiation and show you what it looks like. But that's the only thing. I just wish they would at least get the students prepared. Let them start learning about the instrument, let them read them and show them and start knowing what to do instead of waiting until the end.

Her suggestions align with research by Ko et al. (2023). Ko et al. (2023) showed that providing specific training first often increases self-efficacy and confidence. Spending extended periods of time with the instruments used in RadCon settings while teaching the

techniques frequently used in the field may have piqued the interest of the apprentices early on. This approach coincides with Ko et al.'s (2023) method of demonstrating cardiopulmonary resuscitation (CPR) procedures while providing textbook education on administering CPR, rather than presenting the lesson before the hands-on portion. Combining the two learning strategies, which Mary desired in her program, had a direct impact on confidence, knowledge, attitude, and self-efficacy, with confidence showing the highest growth (Ko et al., 2023). Each of those four variables can hinder or enhance someone's preparedness for a task, and Mary longed for earlier preparation for RadCon procedures while in her program.

Mary's next idea was to recruit instructors from the nuclear field to teach the core RadCon classes. When Mary was in the program, instructors had to have experience in RadCon or a related field to teach the course. Some instructors were retired or had been out of the industry for years. Mary believes:

> If you had instructors that [*sic*] were also RadCon, come to Institution A and teach, I think that would be helpful. I don't know if you can recruit someone to do that, but that might be helpful because it's someone who's been in the field who knows what to expect and can show you exactly how it's done and show you and tell you, "Well, this is how you do it. But as a perspective [*sic*] inspector, develop your own technique."

Although these key components were missing from Mary's experience, she still felt "comfortable" in the program because the knowledge and skills she gained at school brought a sense of familiarity to her in the workplace, aiding in her success. The apprenticeship helped develop her confidence, enabling her to adapt once she entered the

field. Although some practical elements, such as hands-on learning, came later than she would have liked, Mary established a solid foundation of skills that allowed her to continue growing professionally. Her current financial stability and exposure to other potential nuclear positions are a testament to the benefits she has gained from the apprenticeship program.

Kay's Experience

Kay brings a unique angle to this research study. She is a Caucasian woman in her late 20s with a certificate in pre-nursing from a technical school. With that certificate, Kay worked as a caregiver and then a scheduler in the healthcare industry before finding the nuclear field. She sought a position as a RadCon technician with Contractor 1, but did not get hired right away. This rejection led Kay to apply for the RadCon degree at Institution A to boost her chances of being selected. Her plan worked, and after one semester of classes, Kay joined the apprenticeship program with Contractor 1. The ability to earn more money while adventuring to other areas of the nuclear field, such as procedure writing, has kept Kay in this industry. She is still employed with Contractor 1 as a RadCon technician and has been promoted from an LSE to grade 18, which is a mid-level Full-Service Employee. However, she does not see herself working for a nuclear company after five years.

> I don't see myself working in [*sic*] retirement age. I don't see it in 10 years either. I do possibly see the next 5 years. But also possibly doing RadCon, doing procedure writing for RadCon, which I guess is still in the nuclear field. They do like for people who have had prior experience in RadCon to write procedures and

edit procedures in that field, so I probably see myself at least for the next five years doing that. But I do plan to find a work-from-home job for my family.

Kay's current work schedule does not give her as much time as she would like to spend with her family. A career change is almost inevitable for her as she plans to have more children.

The model of Kay's RadCon apprenticeship was the same as Mary's. Apprentices were required to work 10-hour shifts Monday through Thursday. Then, after the shift, the apprentices would drive to their technical college to take classes from 6 to 9 PM. She found the program's pace to be "suitable," but it "could have been a little faster." Kay then gave more details about what made the apprenticeship right for her:

> I feel like there are some classes that they could have combined together. But for the math, I think it was a suitable pace for me. They gave us a whole semester to really focus on the math, the DOE [Department of Energy] policies, and Rad Worker I and II. I feel like that was a suitable pace, just to focus on that and get a very good grasp at it, because Contractor 1, they kind of rush you through it. You have like four months to get everything, where we had four months to just focus on math, Rad Worker II, and DOE policies and stuff. And I feel like it was a suitable pace.

Alas, Kay's praises for the model stopped there. The work and school schedule was too much for Kay, and she was not getting paid for her time in school. She felt:

> It was very hard to have the home/life balance of going to work for 10 hours and then going to school at night. It was, they didn't have the option of like, 20 hours at Contractor 1 and then 20 hours at school, getting paid. At that time, it was 10

> hours all day at Contractor 1 and then still having to go to night school, not getting paid for the night school. So, at that time, the home life balance was not good. I was planning on having a baby…"

Kay defined work/life balance as "being able to go to work, but it not completely control your life, still having time at home." She then goes on to say:

> There was no way I was doing enough work, working 40 hours a week and then going to school for 5 to 10 hours a week. That was not possible. It was not very healthy. It did not let me finish the program…I think if they, Institution A, would offer more online classes, or if they would have started this program sooner, it wouldn't have been difficult.

Unfortunately, Kay did not finish her apprenticeship program due to the lack of a proper work/life balance. She stopped-out after two semesters at Institution A and one semester in the apprenticeship in May 2022. Kay was not able to maintain a work/life balance that fit her lifestyle during her program; she "would get off at 4, 4:30, rush to Institution A by six, be in class to like nine. It just was not good." She still struggled with work/life balance after stopping the apprenticeship. Kay wishes the program had emphasized work/life balance to give apprentices a mixture of 40% work and 60% life. Instead, classes and work-based training took precedence. Kay strongly believes she would have finished her program if the apprenticeship had used a different model. Her preferred model was the two 10-hour school days and two 10-hour work days each week.

Even with having a negative experience with the program's work/life balance, Kay had positive remarks about the available support systems. Her institution offered tutoring for the general education courses, and the RadCon instructors would set aside

time to review core concepts with students. The most helpful resource did not come directly from the school; it was her classmates and colleagues. They created a study group and "if anyone needed help with something, we all made Quizlets and test sheets, and we all sent it [*sic*] to each other." Kay was also appreciative of how fast Institution A got her signed up and ready for classes. The school played a major role in getting her into the program. There was also support from Kay's employer. During the on-site training, supervisors would tutor the apprentices, especially if they failed an exam. There was also a supervisor who created pages of study material for RadCon workers to view, that was posted to the contractor's website. Kay collaborated with her coworkers to study for the training exams.

There was an increase in Kay's confidence about her ability to perform well in her nuclear career as a result of her participation in the apprenticeship. Kay "already knew what the job was about" compared to people who just "walked in." Her participation set her apart from the others in more ways than one:

> Yes, especially with the math, Rad Worker I and II, and just DOE policies. It really did increase my confidence. There were people who got hired off the street in the LSE program at Contractor 1, and they were all stressed out about the math and worried about it, and I'm not. I wasn't. I was like, I've already done this before. I know how to do it…so I was confident going in. I made a 97 on my final without even really trying. So, I was very confident.

Kay gave the program and her instructors at Institution A credit for building her confidence. She believes the practice she got in class was rigorous enough to prepare her for the challenging DOE exam.

In total, Kay had mixed, but mostly constructive feelings about the apprenticeship. She felt like the program prepared her for her career in regards to math concepts and the comprehensive final that is required of all workers. Since Kay did not finish the program, she could only realistically reflect on the portion she was exposed to. She remarked:

> I think it [the program] effectively prepared me for the math and the comp final. I did not finish it, so I wouldn't be able to say. I know they do more mock-up stuff towards the end. I didn't finish it, but I think it prepared me for the math. A lot of people who came in off the street were not prepared to do the math…or the amount of studying for the comp final. I think it effectively prepared me for that. But I don't think the Institution A program…effectively prepares you for being in the actual field. They do a lot of math, a lot of definitions…it prepares you for the book work and the math that you need.

To increase the program's value, Kay suggested transitioning some of the classes from in-person to online and combining some classes to get them done faster. Completing the courses more quickly could have increased Kay's confidence earlier in the program and supported her self-efficacy, increasing her chances of finishing the program. M. Wang and Liu (2023) reported that individuals with greater confidence tend to push themselves longer before deciding to give up on a project. Kay also stressed the importance of improving the work/life balance for apprentices by stating, "If they would have been paying you for both [school and work]…it would have been a lot better, and I would have finished my degree." Still, Kay is thankful for the jumpstart the program gave her into her RadCon career, especially the math courses.

Victor's Experience

Victor is another participant who brings a different experience to the study. Victor, a mid-20s African American male, achieved his Nuclear Fundamentals Certificate from Institution A. He graduated from the program in July of 2021 and launched his nuclear career with Contractor 1. Unfortunately, Victor is no longer employed in the nuclear industry. Factors unrelated to the field resulted in him taking a step back to focus on himself. Currently, Victor is employed in the food and beverage industry, but he hopes to return to the nuclear industry when things settle down.

Institution A supplied many support tools for the nuclear apprentices. Victor's cohort received a tour of the facilities to view the available study aids. The college's Success Team "made them feel like regular college students" as they showed them the library and tutoring center. Because of the tour, Victor and his colleagues readily knew how to access appropriate resources. Another source of support at the institution was the accessibility of the professors. They were "extremely kind" and offered to answer any questions the apprentices may have had. Victor did not take advantage of the supports, but he appreciated that they were available to him. He would have liked to have the option of intramural sports during his time at Institution A. Clubs and games can facilitate a sense of belonging, resulting in elevated efforts in apprentices (Fabian et al., 2022). Victor's response suggests that he may have utilized that type of support if it had been offered.

Contractor 1 had a few resources for Victor and his cohort to explore. The most notable support was small group help sessions after each class for apprentices who failed the course or wanted to reinforce specific objectives from the content. These sessions

gave the apprentices a second chance to meet their required academic goals. Victor did not attend any of the help sessions but was grateful that the option was presented. He felt the employer's support methods were generally sufficient throughout the program. However, there was one addition Victor wanted for his entire cohort:

> Everybody's going through different things in life, and I feel like the cohort always varies in age, like there is no specific set age range that they're hiring people at. So, we're all going through different things and different stages of life. So, I guess, if anything, probably a more stationary counselor to help you throughout your everyday life and transitioning from, I guess you could say, regular civilian work to nuclear work, because there is a big transition in that.

Fabian et al. (2022) and Quew-Jones and Rowe (2022) concluded that committed mentors in academic and employer spaces created stronger indicators of success in those areas. Students who lacked a devoted mentor often struggled in class and at work (Fabian et al., 2022). Victor's request for a mentor to aid in the shift to a nuclear career could have made a powerful impact on the apprentice's skills and confidence.

Victor's cohort participated in the only model available for his program at that time; apprentices went to class two non-consecutive days per week and went to work with their contractor for two consecutive days each week. Every day was 10 hours long, totaling 40 hours for the entire week. However, Victor and the apprentices were only paid for their work hours as Limited-Service Employees and did not receive compensation for their school days. This model was not bad academically for Victor, but was "challenging from a monetary aspect." He wished the program had provided higher pay or more financial support in general, stating, "outside of money…it was a good program. But you

know, beggars can't be choosers, because we already got paid a pretty decent amount." In spite of the financial concerns, the pacing and content of the program worked well for Victor. While referencing the apprenticeship and nuclear field, he shared that:

> It's not bad. It really isn't. A lot of people are, I guess you could say, like, scared of nuclear work altogether, just due to lack of knowledge. But once you understand the different parameters and precautions they take to prevent, you know, I guess you would say, whatever threatening or dangerous aspect of work you think you're going to be a part of, it's not bad at all. It's really a cake walk.

These comments support Victor's desire to return to the nuclear field. Victor was able to complete his program requirements without utilizing the school's or employer's support systems, demonstrating his strong connection between theoretical and practical concepts and the ability to apply them as a nuclear operator. Additionally, the apprenticeship program deepened his understanding of potential dangers and how to mitigate them, further reassuring his beliefs that the nuclear field "isn't bad" and is a great field to work in. Lastly, Victor spoke highly of the program and viewed it as an investment, even with the financial barriers. Since his departure from the field was not related to the apprenticeship requirements or his job performance, Victor is likely to retain the skills and knowledge gained through the program, allowing him to find employment in the nuclear industry again.

This apprenticeship model also allowed Victor to maintain his work/life balance after an adjustment period. His definition of work/life balance is:

> Having a definitive aspect of what you are to do outside of working, and you are at peace with whatever your actual life is outside of work, and you have a

> schedule for whatever you do, whatever you enjoy doing, and you're able to effectively get those tasks done, and it doesn't affect your professionalism at work and your ability or efficiency to do your job at work as well.

Finally, Victor praised the program and its contributions to increasing his confidence in working in the nuclear field and his capacity to perform well in other areas. When questioned about whether his confidence had increased, he replied:

> It really increased my ability to perform jobs on site, or just in general, just because of [*sic*] the level they hold you to. So you kind of build like leadership skills through the program by working with the people that you're working with. So definitely says it increased my confidence…that's one of the key factors, really just makes you a lot more punctual, makes you a lot more accountable. I feel like it just really throws you into a leadership thought process.

Although Victor no longer works in the nuclear industry, his success in the program has amplified his life in several ways. Through his experience, he gained numerous hard skills, such as physics and chemistry, and learned to perform on-the-job tasks. He also developed soft skills, like being on time and working to high standards. Victor did not apply any workplace or academic supports during his time; fortunately, he prospered without them. However, research shows that implementing different resources can positively influence an apprentice's development (Fabian et al., 2022; Quew-Jones & Rowe, 2022; Smyth & Zimba, 2019).

Jacob's Experience

Jacob, an African American male in his mid-30s, is an April 2025 graduate of the Nuclear Fundamentals Certificate program at Institution C. Although he has completed

the apprenticeship program and remains employed in the nuclear industry with Contractor 1, Jacob is currently pursuing a Bachelor's Degree in Business Management. He is planning to advance and work in the nuclear field until retirement age and believes this industry gives him "purpose and meaning." He added, "It's a very meaningful job. It's a great opportunity to grow, no matter if you're looking to grow personally, financially, it offers a lot of benefits to stay with the company and grow." His first career was in sales, so this change to working for Contractor 1 has been an overall optimistic experience for him.

Jacob's cohort used a model where apprentices alternated between school and work for 6 weeks each, over 7 months. During school days, apprentices began class at 6 in the morning, had a lunch break around 11 A.M., and then attended a different class in the afternoon. The day ended around 4 P.M. This approach mainly suited Jacob's needs because it allowed him "to focus solely on the classes…and provides the best opportunity for students to learn being that they're continuously engaged in the content throughout the entire course", but he did state that "it was a bit fast." However, Jacob understood that this program was meant to be introductory, providing the fundamentals of the nuclear operator position before delving deeper into the subject. This understanding made his desire for classes to "go a little bit slower" less pressing.

Even with the fast pace, Jacob had the ability to maintain control over his responsibilities. He defined work/life balance as:

> Whenever you're off from work, you're not necessarily stressing or allowing the things that go on at work to interfere with life itself. So, I feel like once you come home, you're able to digress the day and focus on, you know, your family and not

> necessarily have to jump on emails or additional calls to make sure things are going good at work, but you want to make sure you are prioritizing all of your duties when you're at work. That way, those duties don't necessarily come home with you when you leave for the day, so just making sure that you're prioritizing your tasks that need to be done that day, and making sure that also you're handling things at home. That way, you're not bringing additional stress from home into your workplace as well.

Jacob was sustained through actions from both Institution C and Contractor 1. He and his peers were given ample time to study during class and other periods of downtime, despite the recommendation to study at home. However, since his school and employer understood the importance of balancing studying, working, and recuperating at home, Jacob's cohort was able to apply the content from school to work without spending many unpaid hours to prepare.

When taking classes at Institution C, Jacob was exposed to many academic support options. Online and in-person tutoring in the library and online sources such as Khan Academy and Pearson Learning were available to the apprentices. Jacob took advantage of the in-person and online tutoring from the school's library, and he created study guides using tools like Google Drive. He also found Pearson Learning to be helpful in his chemistry and physics courses. Other aspects, like the campus environment and Student Life, made Jacob feel fully supported by the institution. Jacob stated that the campus was "very welcoming and friendly," and the school "had a lot of amenities as well." He would not add any additional resources to the list of available options.

Jacob had similar feelings towards the support offered to him through his employer. He recalled that individuals in the Human Resources (HR) office were available to answer questions he may have had. Also, there was a team lead who took on a mentorship-like role with the apprentices. Jacob depicted the experience like this:

> So, we had a facilitator, and he would regularly check up on us. We would do monthly one-on-ones, where he would kind of come in and check up on us, make sure everything's good, and then we would normally meet with our management team that would also kind of look into everything and ask us questions [*sic*] how we're doing, if there's anything that they could offer to assist us. So we were regularly checking in with management and our facilitator through the apprenticeship program.

With no requests or wishes for additional support options, Jacob felt empowered and championed through Contractor 1's endeavors. The consistent communication and feedback made him feel valued as an apprentice and employee. The support from his manager and facilitator helped him strengthen his certainty in his actions and fostered a sense of belonging within the organization. These efforts contributed to his success in the program and may have influenced his decision to commit to the nuclear industry long term.

The positive feedback and encounters from Jacob's tenure with the program led him to feel very prepared for his nuclear career. A combination of efforts from Institution C and Contractor A contributed to his well-equipped mentality. Jacob added that the program:

> Taught us a lot of skills…how to really navigate as far as like work/life balance. It helped us prepare ourselves for the recognition of tools and things that we'll see regularly on our jobs. For example, our chemistry class and fluid flow class, it taught us how to identify particular instruments and things that we'll normally see on a job that I feel like we normally, you know, would have taken us a couple of extra days or weeks to learn on the job itself, versus learning in the classroom first. So, it kind of gave us those foundational tools in order to help us identify and kind of hit the ground running…at our job.

Jacob also reported a boost in his confidence level due to his participation in the apprenticeship. He gives credit to being able to "take his time to progress through the classes and learn the material through the classes first." Additionally, Jacob said:

> Just our first couple of days when we were in our facility, I was able to identify instruments and understand kind of the foundation of what they do, just from some of the classes we took. So, I was able to directly apply the knowledge from my classes into my workplace just from taking these classes. And it's definitely things that I wouldn't have known or understood, had I not taken these classes prior.

There was one piece of advice that Jacob offered to enhance his classroom experience. Consistency between teachers and having instructors who were knowledgeable about not only the nuclear field but also nuclear operations at Site 1 would have made the apprenticeship even more effective, especially when transferring classroom lessons to on-the-job workspaces. Jacob adds:

> I feel like having a set of teachers already knowledgeable on the content, because I felt like sometimes, whenever we would get a course, the teachers were also kind of learning the material in a way that we had to learn it as well. So, I feel like maybe if we had teachers that already were knowledgeable in the subject, possibly facilitators from the site themselves teaching the content, that it would have helped to flow a little bit better. I think that would be one of the main things I felt like the program was missing was teachers that sometimes knew the content in a way to make it applicable to us.

In sum, Jacob felt that the supplied resources, interaction with his colleagues, and support from his employer made the program feasible and worthwhile for his career goals.

James's Experience

The last participant in this study is James. James is of African American and German descent, and is in his early 40s. Before joining the Production Operator Apprenticeship at Institution C, James worked in the food and beverage industry. The Nuclear Fundamentals Certificate, earned at the culmination of the apprenticeship, marks James's highest level of education. He obtained this certificate in April of 2025 and transitioned into shift work with Contractor 1. He is pleased with how things are going so far, stating, "I just completed my first month, and it just gives you more of an introduction to what we'll be doing. Everybody seems to be real [*sic*] nice. The job gets me to learn more and new things. I like it, so I'm still here." As of now, James envisions himself working in the nuclear industry until retirement, but he would also like to transition into a management position or transfer to another area at Site 1.

James's cohort followed a model where apprentices went to school Monday through Thursday, from 6:30 A.M. to 5:00 P.M. Each day, the apprentices took two classes. There was a morning session, then lunch, and then the afternoon session. This schedule continued for about 6 weeks. At that point, the cohort began working on site for 4 days a week for 6 weeks. Then, they would switch back to class to repeat the process until all of the classes were done. This model fitted James's wants. After hearing about other models that apprentices have experienced, he believed this model served the purpose of "doing your job" the best. Although he was mostly satisfied, James believed there were still areas for improvement in the program. He thought the pacing of the classroom portion was just right, but there was excessive downtime during the six weeks on site. It was too slow for him, and coming from the fast-paced food and beverage industry required a major adjustment in time management. James also sensed that classes became "hard" at the end of the day, after being in school for 6 hours. At one point, James had the same instructor for both the morning and afternoon sessions. He recalled being able to tell that she was "over teaching for the day." James goes on to say, "It's kind of hard to have somebody study and listen to somebody teach for…8 hours a day straight." Even with some moments of vagueness in the program, James deemed it a great way to start his nuclear career.

The long days did not detract from James's work/life balance. He did not define what work/life balance is, but he described it using examples from the apprenticeship. For instance, James was thankful that this program paid him for 40 hours of work each week. He does not believe it would have been as easy to succeed if he had to work a part-

time job in addition to his school, apprenticeship, and family responsibilities. When queried about his work/life balance during the program, James expressed:

> I think my work/life balance was great. It gave you enough time to study. It gave you enough time to learn what you needed to learn, and have time to kind of mostly separate it once you get home, and then spend time with your family during that time.

This balance permitted James to remain focused and motivated throughout the program. His experience highlights the importance of structured support in achieving both professional and personal success.

Institution C and Contractor 1 had distinct methods to assist apprentices during their journey. On the academic side, James reported having access to the library, school-based tutors, his instructors, and his classmates. He also mentioned support from the school's vice president and a liaison from Site 1. The vice president and liaison would drop in each morning to ensure apprentices had what they needed. James took advantage of his classmates to make studying more productive. He joined a group of apprentices, and they quizzed each other during the class breaks. They would also call each other on the weekends and complete quizzes simultaneously online. James found his instructors to be especially helpful. He booked time with them to confirm he had mastered the content and understood their teaching approach. James was more direct with his employer's resources. He reached out to three administrators who were familiar with the nuclear field and tritium (an isotope of hydrogen that is extracted from existing warheads) facilities whenever he had questions. They were all able to give him insights about the courses and exams, and even offered him study tips and tricks. However, the administrators were not

always available since they oversaw the entire apprenticeship program and had many people to manage. At times, James's concerns were "swept under the rug." These instances did not deter James, as he realized that he was there to do a job and things had to be done no matter what. Throughout everything, James felt supported by Institution C and Contractor 1 and would not add anything to their list of resources.

In general, James agreed that the apprenticeship program provided a strong foundation, though some aspects lacked clarity. He noted that instructors, particularly those without firsthand experience, sometimes struggled to convey complex topics like nuclear physics effectively. While the basics were manageable, more advanced concepts were harder to grasp, especially without hands-on experience. Much of the learning relied on diagrams and verbal explanations, which made it difficult for a hands-on learner to fully understand how things worked. James explained what he would have liked to have by saying:

> I think more hands-on. We did a lot of stuff off of pictures and diagrams, which it was kind of hard to relate, or kind of hard to see what it actually meant or how it worked. We saw, like some diagrams of some valves, which most of those were alright, but how they actually work. And when we did classes, you know, they would describe stuff, but actually seeing it or having your hands on it, I think that will be a lot better for me. Personally, I'm more of a hands-on person than just somebody trying to tell you stuff, and you're trying to visualize in your head, make it connect.

James appreciated the gradual progression of coursework from easier classes to more challenging ones, but he wished the tests would focus more on practical application rather

than definitions. Unfortunately, James did not undergo an increase in confidence by the program's conclusion. He claimed that each test was stressful for him. He “felt like he failed every one of them,” but he made a high score each time. The lack of an increase was primarily because “there was a lot of stuff they couldn’t say or really tell us.” James was not prepared for the hands-on part of his career, but the apprenticeship successfully gave him a good start to what the nuclear industry and being a production operator might be like.

Overall, James enjoyed the program and found it enriching. Although some improvements could be made, particularly in increasing hands-on learning and making assessments more application-based, the experience sparked a genuine interest in subjects like nuclear science for him. This curiosity extended beyond the classroom, leading to independent research and a deeper appreciation for the field. Despite the challenges, James felt the program’s scheduling was well-executed and was grateful for the opportunity to grow and learn in a new and engaging way.

The Focus Group’s Experience

In addition to the individual interviews with each participant, a focus group interview was conducted with Kay, James, and Jacob. The participants discussed their motivations for joining the nuclear field, experiences with academic and workplace supports, perceived advantages of the apprenticeship program, and opportunities for program improvement. All participants were former apprentices at Site 1 and represented various job positions, technical schools, and contractors.

The interview began with a discussion about connections to Site 1 prior to employment. James, Kay, and Jacob all shared that they had some kind of influence from

family, friends, or the community that influenced their decision to explore the nuclear field. Kay said, “Most of my family worked out there. My husband worked out there when I applied, and I just had a lot of people telling me to apply for the site, and people talking about RadCon over and over.” Similarly, Jacob had friends and family who worked at Site 1. He was able to learn a bit about what they did and saw how it affected their daily lives. He added, “A lot of them tell me they bring the culture from the site home. It helps them not only at work but in life in general.” Lastly, James chimed in. He remarked, “I had a couple of friends out there, and they really enjoyed their work.” Having friends or family at Site 1 is a common experience among the participants. This familiarity with the site and its impact on loved ones created a sense of trust and motivation to pursue similar career paths.

Follow-up responses to the first interview question shed light on personal reasons for seeking employment at Site 1. Jacob “wanted to have a bigger purpose in life” and sought out a career in the nuclear industry to launch that change. James desired a break from the food and beverage business, which was fast-paced and tiresome at times. He had never thought about joining the nuclear industry, so this transition was the start of a new adventure for him. Kay took action and applied for her position once she saw that Institution A was looking for RadCon students to complete their degree while working on-site. This opportunity, coupled with encouragement from her family, pushed her to make a decision about her profession. Collectively, these responses demonstrate that interpersonal relationships and a desire for meaningful and stable work may influence career decisions in the nuclear field. The reputation of Site 1 and its cultural impact on

employees' lives were compelling motivators for each participant, guiding them toward a field they may not have considered otherwise.

One of the core areas explored during the interview was how academic support at the participating technical colleges shaped the experiences and outcomes of former apprentices. When asked to reflect on the types of support available and how they varied across institutions, all three participants emphasized the critical role these services played in building confidence and ensuring academic success, especially in math-intensive areas such as RadCon. Kay highlighted that tutoring was especially important for students struggling with math, a key component of the RadCon curriculum. She remarked that access to this type of academic help allowed apprentices to better manage the rigors of the program. This sentiment was echoed by Jacob, who identified academic supports like tutoring, faculty assistance, and peer guidance as confidence boosters. He stated that even when students lacked prior knowledge or strong study habits, the presence of knowledgeable support staff and students offered helpful strategies to navigate the coursework more effectively. James agreed, reinforcing the psychological benefit of simply knowing support was available. For him, the awareness that help was within reach contributed to a more manageable academic experience. There was consensus that academic supports served as both a practical and emotional anchor for apprentices, aiding them through challenges and strengthening their academic foundation.

A secondary question explored whether inconsistencies between the tech schools created any disparities in apprentice outcomes. James, Jacob, and Kay unanimously agreed that consistency across institutions would benefit not only the apprentices but also Site 1. Kay specifically highlighted how a lack of uniformity complicates Site 1's training

processes, stating that apprentices come in with varying levels of preparation, depending on their school's resources and instructional quality. She asserted:

> Consistency is key, especially if you're working in different areas. If you're going to a tech school like Institution C or Institution A, you know…you're going to Site 1. So, it makes it difficult for Site 1's training when there's not consistency across the board from the schools.

Jacob expanded on this idea by identifying instructor quality as a critical factor in consistency. He recounted experiences where facilitators appeared to be learning the material alongside the students, which undermined instructional effectiveness. To address this, he recommended hiring instructors through long-term contracts to ensure consistency, content expertise, and smoother course delivery over time. These shared concerns underscore the need for a standardized curriculum and instructor qualifications across institutions. Implementing such measures could help ensure all apprentices enter the workforce with comparable knowledge and skills, ultimately enhancing the effectiveness of site-specific training.

The next topic encompassed workplace support during the apprenticeship. The group was asked about the consistency of employer support between programs and contractors, as well as its potential effects on apprentices. The list of tools included mentorship, study materials, and informal peer-led study groups. However, the participants focused on the peer-led study groups and study materials. Kay and Jacob agreed that each group of apprentices should have consistent reference material between contractors that is job-specific. On a broader scale, Jacob suggested that each body at the site tailor its study resources to the operational focus of the contractor, stating that

"different organizations require different material." Kay hopes that future RadCon apprentices are provided with relevant study material since "you can't just find a CCP question online very easily. There should be stuff that they give you to study." When discussing study groups, everyone noted that the groups were encouraged by employers, but each group was initiated by apprentices. James noted that the groups were not "provided by the training." Kay chimed in and added:

> The study groups wasn't [*sic*] necessarily something employers provided. That was more so something that us apprentices in training did on our own. I feel like it would be really hard for employers to be like, "You have to have a study group, or you have to get in a group." Everyone was not part of one.

Instead, the employer set aside time for apprentices to work together if they requested. This approach afforded apprentices the flexibility to form groups based on their individual needs and learning styles, fostering a sense of ownership over their learning. While not mandated, the option to collaborate proved beneficial, especially when paired with accessible and relevant study materials.

Lastly, the participants were asked about how they perceived their preparedness for the nuclear field compared to those who did not participate in a nuclear apprenticeship. James believes he did have an advantage because the program "gave a good idea of what the expectations are. The work ethic you do in school goes further into the job itself." Kay had strong feelings about being well prepared in some areas and not others when conversing with those who did not attend an apprentice program. She went into detail and communicated:

> Yes. For the math part, yes. I felt like we got more hands on, more time to study for it. I'm more prepared to know what the job actually is. There were people who were like, “I got hired for this job. I don't know what it is. I don't know anything about it. I just know it makes this amount of money.” So, for the job scope and knowing what it is, yes. For the math, yes. For the actual working in the field process, I'd say it was about the same, at least for my group. Our apprenticeship…did great on teaching us math, teaching us the basics, teaching us for that big test, but in the actual field, we were kind of the same level as everyone else, just doing field work. For the tests and for what the job scope was, it prepared us more.

Jacob shared those sentiments, adding:

> Yeah, I do agree with that. And some of the more senior guys that are out there, operators, they've mentioned that, “You guys kind of come in at an advantage because you've gone through the school and done the apprenticeship program.” And it does help you with the basics and the fundamentals. It helps me personally, which is kind of the critical thinking, as it helped me understand how to grasp things, how to tackle, you know, things at a job. But as far as, like she was saying, as far as the actual work itself is something that you can't really get on you get your hands on until you get out there, because of what we do and how unique it is. So, I think it's still pushing at the same level once you start actual work.

These responses stress a communal belief that the apprenticeship program offered a solid academic and conceptual foundation when evaluated against those who did not participate in the program. To give apprentices an advantage in all areas, Kay

recommended including hands-on time at the site through job shadowing instead of just focusing on academic requirements. She believed this would bridge the gap between classroom learning and real-world application, thereby better preparing apprentices for fieldwork. Altogether, comments from the study's participants imply that proficiency is developed through hands-on, on-the-job training.

Jacob mentioned the word "advantage" in one of his responses, and that triggered a new point in the conversation. He thinks a significant advantage of his participation in the apprenticeship program is being able to adapt to the job more easily due to gaining skills before being placed in the field. He indicated:

> I just think adaptability to the job is easier for us because…we still had that foundation. And so, you know, going into my job now, instead of just kind of throwing into something and not knowing and not having a skill set on how to navigate the job, I now have that skill set to do the job and or navigate it appropriately, whereas some of these guys just came in…not knowing what they were going to be doing and just having to kind of learn the skills as they were actually learning the job at the same time, and not already having those skills to do the job or try to navigate the job.

Continuing along the same vein, Jacob noted that:

> Some of the courses that we took, like instruments and controls, I was able to already understand and identify some of the instruments that we use at work. I was already kind of familiar with some of the terminology, the little bit of math that we do use, I was already knowledgeable on the formulas. Whereas, you know, if you're coming into the program without the apprenticeship program,

> you're having to learn all of this, you know, as you're doing the job itself. So, that was kind of some of the detailed examples of how we have that advantage over and not going through apprenticeship program.

This perspective reinforces the idea that apprenticeship programs equip participants with foundational knowledge that eases their transition into the workforce. His experience highlights how early exposure to job-specific skills can reduce overwhelm and promote greater confidence on the job. James felt like he had an edge on others because he was able to "get his feet wet," unlike others who had to jump right in. He imagines it would be "overwhelming to come straight in and start to learn your job plus the culture of Site 1." By building both skill and familiarity beforehand, apprentices feel better positioned to succeed from the outset of their careers.

Kay had a different idea of her advantage. She did not finish her apprenticeship program, but she feels that those who did complete a RadCon degree will "have an advantage, because they're looked at more favorably for management positions. We've been told that, and they get to go up to the next grade level… sooner." Kay then compares herself to other apprentices and their apprenticeship format. Kay was not paid for her time in class, and she wishes that:

> It was something that was offered to me. I think I would have actually finished my program if that was it, because I was going through the apprenticeship, going to school unpaid, and then they were getting paid. So I feel like that would help better with my work/life balance, and would have just been better all around.

Jacob concurred and conveyed his experience regarding his cohort's model compared to others:

> I agree, yeah. And I've met, a couple of the students that came through, and they were having to like work, second and third job. You know, not only go to school, but do the program, but also have another job. So, you know, with us being able to just do everything and get paid for that is a huge advantage and a lot of stress that we don't have to deal with. So, keeping that a part of the program, because that allows them to focus solely on their job and not have to worry about additional things going on to meet their needs in life.

In agreement, James included, "I think it was great that we got paid for it. I definitely couldn't have done it without getting paid." Their reflections accentuate the importance of financial support in apprenticeship programs, especially for adult learners balancing multiple responsibilities. Without paid training, participants like Kay faced challenges that impacted their ability to complete the program. Ensuring apprentices are compensated not only reduces stress but may promote equity and increase program completion rates.

The focus group interview with Kay, James, and Jacob offered rich insights into their motivations, experiences, and reflections as former apprentices at Site 1. Influenced heavily by family, friends, and community connections, each participant described how interpersonal relationships played a significant role in their decision to pursue careers in the nuclear field. Their stories highlighted the cultural impact of Site 1 on their lives and how that familiarity created a sense of trust and purpose in joining the workforce. Beyond personal motivation, each participant emphasized the value of academic supports, such as tutoring, mentoring, and access to knowledgeable faculty, as critical factors that boosted

their confidence and prepared them for the program's rigorous content, especially in math.

Throughout the discussion, the participants also voiced concerns about inconsistencies between technical schools, especially related to the quality of instruction and access to resources. They advocated for greater alignment and standardization to ensure all apprentices enter the workforce equally prepared. Similarly, when reflecting on workplace supports, the group highlighted the benefit of peer-led study groups and access to job-specific study materials. While these supports were not always structured or provided by employers, they played a vital role in preparing apprentices for on-site assessments and real-world responsibilities. A key consensus that emerged was the value of early exposure to job-specific skills, which allowed apprentices to adapt more easily than their non-apprentice counterparts and navigate the job with greater confidence.

Additionally, financial support emerged as a critical factor influencing program completion and success. Kay reflected on her challenges completing the program due to unpaid schooling, while Jacob and James emphasized how paid apprenticeships reduced stress and allowed them to focus solely on their development. Their comments suggest that compensation is not just a financial benefit but a structural support that promotes retention and a better work/life balance for adult learners. Altogether, the interview participants fortified the belief that well-structured, consistent, and financially supported apprenticeship programs provide meaningful advantages in preparing workers for the nuclear field.

Conclusion

Conducting interviews with six individuals who attended a nuclear apprenticeship program offered valuable insights into their personal experiences, challenges, and successes. Each participant brought a unique perspective shaped by their background, motivations, and journey through the program. The individual interviews allowed for in-depth exploration of how participants navigated academic demands, workplace expectations, and personal circumstances. Their responses highlighted the importance of structured support systems, relevant training, and financial stability in boosting confidence and sustaining commitment to the apprenticeship.

Three of the six participants also took part in a focus group interview, which provided an opportunity to observe how shared experiences and group dynamics influenced their reflections. During the focus group, participants expanded on topics introduced in the individual interviews and validated one another's experiences, which strengthened the credibility of the findings. The group setting revealed how interpersonal relationships and peer support play a critical role in motivation and success, especially in high-stakes, technical training environments like those found in nuclear industries.

The combination of individual and group interviews enriched the data, leading to a more nuanced understanding of what makes nuclear apprenticeship programs effective. The interviews bring attention to the potential of well-designed apprenticeship programs to transform lives and build a competent, confident nuclear workforce. Phrases and thoughts from the interviews will be analyzed to identify patterns and implications for program improvement.

Chapter Summary

This qualitative study explored the experiences of six former apprentices who completed nuclear industry training programs in partnership with educational institutions and contractors at Site 1. Each participant had a unique journey, shaped by their background, the apprenticeship model they followed, and their perception of support systems, work/life balance, and career preparation.

Participants like Mel and Jacob found the apprenticeship to be highly beneficial, crediting their success to strong foundational coursework and supportive learning environments that helped ease their transition into the workforce. Both praised the connection between classroom instruction and job responsibilities, which enabled them to adapt more easily to nuclear work. Jacob especially appreciated the program's structure and support from both school and employer, which allowed him to grow personally and professionally.

Others, like Mary and James, also reported positive outcomes, noting how the apprenticeship strengthened their confidence and skills. Mary emphasized the importance of flexible scheduling and continued support from mentors, while James valued the structured pace and accessibility of academic and employer resources. However, James also highlighted the need for more hands-on learning and application-based assessments to better prepare for real-world responsibilities.

Conversely, Kay and Victor shared more mixed experiences. Kay ultimately left the program due to a lack of work/life balance and financial strain from unpaid class time. Despite this, she acknowledged the academic benefits, particularly in building confidence in math and technical knowledge. Victor appreciated the program’s

foundational training and its ability to build leadership skills, but he suggested that stronger personal mentorship and life-transition support could have improved his experience.

A consistent theme across the interviews was the impact of work/life balance and compensation on retention. Participants who received pay for both work and class time reported greater satisfaction and reduced stress, while those who did not, like Kay and Victor, struggled more to juggle responsibilities. Additionally, peer collaboration, supportive instructors, and mentor relationships played vital roles in fostering confidence and skill development.

The focus group interview with Kay, James, and Jacob revealed that personal relationships, community ties, and familiarity with Site 1 strongly influenced their decisions to pursue nuclear careers. Academic support systems such as tutoring, mentoring, and knowledgeable instructors were crucial in building their confidence, particularly in math. Participants expressed concern over irregularities between technical schools and called for greater standardization to ensure equal preparation. They underlined the importance of peer-led study groups, early job-skill exposure, and financial compensation, with Kay citing unpaid schooling as a barrier to completion. In general, the discussion highlighted the importance of structured, supportive, and financially backed apprenticeship programs in fostering success and retention in the nuclear field.

Ultimately, the responses suggest that well-structured nuclear apprenticeship programs that integrate academic rigor, workplace relevance, supportive environments, and financial stability can significantly boost apprentices' confidence, competence, and

career satisfaction. Improvements in instructional consistency, hands-on training, and holistic support, especially for nontraditional or at-risk learners, may further strengthen these programs and reduce attrition. These responses provide a foundation for deeper exploration of the recurring patterns in participant experiences. The following chapter presents the central themes that emerged from the interviews, offering insight into the shared challenges and supports encountered during the apprenticeship journey. By examining these themes, stakeholders can better understand the elements that contribute to both successes and struggles in nuclear workforce preparation.

Chapter V

Data Analysis

Chapter V presents the study's findings. Data were collected from six individuals who identified as nuclear apprenticeship participants in the states of Georgia or South Carolina. While most participants were graduates of their program, non-completers were also included to create a richer pool of data. Additionally, participants were required to be employed at a specific nuclear site during their apprenticeship. Through six individual interviews and one focus group interview, qualitative information was gathered and analyzed using coding and thematic analysis. The goal of the analysis is to relate the resulting themes to at least one of the four research questions. Doing so will facilitate the study's purpose, which is to understand the factors that influence the confidence of nuclear apprenticeship graduates as employees in the nuclear field and share these findings with higher education institutions and employers affiliated with the nuclear industry. Confidence levels may impact the length of nuclear workers' employment in the field, which is currently suffering from a labor and skills gap and needs skilled workers to keep up with nuclear demand (O'Sullivan, 2023; Today in Energy, 2017; Trum, 2021; Volpe, 2015). Apprenticeships are already being used to train these new workers, but improvements to the existing programs may accelerate the school-to-work pipeline (Christo-Baker et al., 2017).

As described in Chapter III, the interviews were transcribed for accuracy and analyzed through two rounds of coding to reveal the thoughts and perceptions of the participants regarding their experiences during the program. The first cycle of coding was completed using an elemental coding method called In Vivo coding. In Vivo coding uses the actual words from the participants and may be more action-driven than other types of coding (Saldaña, 2021). Through this method, codes that "told a story" and directed my attention to the participants' perspectives were derived. Before the second round of coding began, code mapping was used to organize the initial codes into categories (Saldaña, 2021). This technique required the initial codes to be compared and grouped according to their relationship with one another. Once code mapping was complete, the second round of coding began. Pattern coding, which arranges the resulting code mapping categories based on their similarities to develop a theme (Saldaña, 2021), was implemented. Finally, thematic analysis through a categorical approach, as described by Saldaña (2021), occurred, allowing the creation of sentence-like phrases that served as themes. Although many codes were identified and mapped, not all of them were used to create themes. Only the most repetitive and meaningful codes that remained after two rounds of coding were used. Each of the developed themes and subthemes corresponds to one of the four research questions presented earlier in the study. The questions and their related themes and subthemes are listed below:

1. What are the lived experiences portrayed by the graduates of a nuclear apprenticeship program?
    - Theme: The Impact of Financial Support on Work/Life Balance
        - Financial Stability

- Financially Challenging

2. How does engagement in a nuclear apprenticeship program affect graduates' confidence in their ability to succeed in their nuclear careers?
    - Theme: Many Factors Influence Workplace Confidence
        - Familiarity With Site 1
        - Increase in Aptitude
        - Developing Work Ethics

    2.1. How do graduates depict the impact of variety and utilization of academic resources available throughout the apprenticeship program on their level of confidence in job performance as they transition to their careers in the nuclear field?
    - Theme: Improving Academic Experiences
        - Need for Consistent Instruction
        - The Desire for Hands-On Learning

    2.2. How do graduates portray the influence of support strategies provided by their employer for the duration of the apprenticeship program on their confidence levels of occupation-related duties as they prepare for their career in the nuclear field?
    - Theme: Mentorship in the Workplace

In the following sections, direct and indirect quotes from the individual and focus group interviews are used to expand the themes and subthemes. Then, each theme and subtheme are connected to a theoretical framework to demonstrate its significance in the study further. Earlier in this study, three theories were explored and related to how they

potentially affect nuclear workers' confidence levels. The first theory was the Boundary Theory by Nippert-Eng (1996) and Ashforth et al. (2000). The next theory was the Self-Efficacy Theory, which was introduced by Bandura (1977). The final theory discussed in this study was the Skill Theory by Kurt Fischer (1980). After linking each theme, subtheme, and participant experience to a theory, the overall findings for each of the research questions and subquestions are summarized and reviewed.

The Impact of Financial Support on Work/Life Balance

When interviewing the participants, the topic of work/life balance often appeared organically before the interview question had been asked, suggesting that it played a large role in the participants' success in the program and ability to build their confidence. Many participants expressed satisfaction with the pacing and model of their program, as well as the overall work/life balance, indicating that it was effectively maintained, particularly when ample study time was provided both at work and at school. This feature contributed to a more manageable routine, helping the former apprentices navigate personal responsibilities, academic requirements, and job expectations. For example, James reported, "I think with an apprenticeship, they did overall a really good job…It really gave me time and a chance to do the schoolwork at school, you know. I did have to study at home, but it wasn't as much." Victor felt like his work/life balance was upheld after an initial timeframe. He said, "It wasn't bad. It was an adjustment period." However, other participants struggled to juggle all of the responsibilities during the apprenticeship. For instance, Kay did not complete her apprenticeship program due to the demands of work and school. She stated that "it was very hard to have the home/life balance of going to work for 10 hours and then going to school at night," and that it was not healthy for her.

Mel echoed similar sentiments, describing the program as “modern-day slavery” that made him “pray and cry” due to the constant requirements of school and work. This struggle often led to stress, fatigue, and the need to sacrifice personal or family time to meet the program obligations. As the interviews continued, the words "finances" or "financial" continued to appear. A strong influence on the ability to have a suitable work/life balance centered around the need to be financially stable. From this, two subthemes emerged: Financial Stability and Financially Challenging.

Financial Stability

Financial growth and stability have a direct impact on one’s quality of life and potentially their future. This study’s participants were seeking employment within the nuclear sector of the Department of Energy (DOE), which increases job security and the potential to earn a higher salary. For reference, the median pay for nuclear technicians with an associate’s degree is $50.11 per hour (U.S. Bureau of Labor Statistics, 2025a), and the median pay for a powerplant operator with a high school diploma is $49.81 per hour (U.S. Bureau of Labor Statistics, 2025b). These figures align with participants’ responses regarding what attracted them to the nuclear field and their apprenticeship. Four of the six participants gave a financial reason for persisting in their nuclear career, and three of the six want to retire from the nuclear industry. Two of the participants, Mel and Kay, do not plan to work in the nuclear industry until retirement. Mel sees himself working in this sector for 10 more years, while Kay only wants to work in the nuclear field for 5 more years.

Responses from the participants were very similar throughout this portion of the interview. When asked about his reason to remain employed in the nuclear field for the

next 10 years, Mel simply replied, “My financial growth.” Kay’s response was short and succinct as well, stating, “Honestly, money and benefits,” as her reasons to stay in the nuclear field for about 5 years. During that time, she hopes to increase her salary and skills by transitioning to procedure writing for Radiation Control (RadCon) technicians before leaving the field. Kay’s reasons for leaving the field are personal. She articulated, “I do plan to find a work-from-home job for my family. I do plan on having another baby, so that’s kind of more precedent.” Victor is not currently working in the nuclear field due to reasons unrelated to finances or industry-specific factors. In his interview, he mentioned that he and his cohort “got paid a pretty decent amount at the time” after completing the apprenticeship. He aims to return to the nuclear industry as soon as possible to regain access to those Full-Service Employee (FSE) financial benefits. Even though Mel, Kay, and Victor currently do not have long-term plans for their nuclear career, it is evident that financial stability and the potential for economic growth are key motivators for them to enter the nuclear field.

On the other hand, James, Jacob, and Mary have future-oriented career plans. Aside from enjoying the workplace atmosphere and having the opportunity to learn new things, James wants to continue growing and obtaining new positions throughout the industry, such as management, before retiring from the nuclear field. He mentioned that “The job gets me to learn more and new things,” and, when probed about retirement, he explained that he wants to retire “not from the one position he is currently doing, but something definitely in that area.” In the same manner, Jacob stayed in the nuclear field for various reasons. He declared that his position with Contractor 1 is a “very meaningful job. It’s a great opportunity to grow, no matter if you’re looking to grow personally or

financially. It offers a lot of benefits to stay with the company and grow." Jacob confidently stated that he would like to stay employed in this nuclear industry until retirement age as well. Both he and James are aware of the financial incentives, professional development, and personal fulfillment that come with their roles. Their statements and beliefs suggest that long-term careers in the nuclear field are influenced not only by financial stability but also by meaningful work, opportunities for advancement, and overall job satisfaction.

Mary expressed a comparable outlook, emphasizing that the nuclear field offers stability and room for advancement, which are important qualities for her future career. She proudly stated, "I hate to say it, but the money. Money. Money and benefits. And it's a leg up because the money that I'm making currently it's tripled from when I first started working. It's tripled." That increase is quite impressive since Mary only graduated from her program 2 years ago in May of 2023. Like James and Jacob, Mary views the nuclear industry as a pathway to professional growth, which can also stimulate financial growth and stability. She goes on to say:

> I will still be in this industry, but I do see myself venturing out into other sectors. There are at least four other sectors I would like to do, but one of them is health physics. They have a department where they fix and calibrate the instruments…Another area is dosimetry, where they see how much [radiation] dose an individual got [*sic*] in a quarter. So that's one area I was looking to pursue. Another area is training in the training department…If I choose to stay in RadCon, I could see myself training new inspectors or others who need Rad Worker II, plastic suits, or any other classes. Another one would be procedure

> writer, where you review procedures and make sure they are up to date…Two recent ones that I'm looking into are industrial hygiene and health and safety. They check to see if working conditions are safe enough for a person or group of individuals to go in. So those are some options that I'm looking at.

Finally, Mary expresses that her goal is to "retire from Contractor 1 and have a comfortable retirement to stand on." James, Mary, and Jacob appreciate the financial stability and growth opportunities provided by their employer. Their personal ambition reflects a strong commitment to long-term career development in the nuclear industry, which is needed to close the labor and skills gap. Collectively, their perspectives highlight how diverse career pathways can motivate apprenticeship graduates to remain in the field well into retirement.

Financially Challenging

Participants in this study include former apprentices from 2020 to 2025, who have experienced several types of apprenticeship models. Earlier models, such as the ones Kay, Mel, Victor, and Mary enrolled in, started apprentices as Limited-Services Employees (LSE) instead of FSEs. This means that all apprentices under the LSE title were part-time and were only paid for 20 hours of work each week, despite spending 40 hours a week between school and work. This concept proved to be very difficult for them. Victor, who was drawn to the nuclear field due to the financial opportunities, recalled his time in the program as "challenging from a financial perspective." When asked about changes he would make to the apprenticeship, he replied, "Just more money in general." This statement, along with his ability to gain financial stability after graduating from the

apprenticeship, highlights a significant gap between the program's expectations and the financial support provided to its participants.

Others shared similar sentiments, expressing that the financial strain made it harder for them to focus on their training and academic responsibilities. Kay was the most vocal about her struggles. One of the major factors contributing to her lack of work/life balance in the program was the need for financial assistance. Working 10-hour shifts and attending school at night did not leave Kay enough time to pursue a second job, making it difficult for her to support her family. "Not getting paid for the night school" was a pain point for her. Specifically, she stated:

> People nowadays can't afford to only work part-time and then go to school the other time. That's why I was struggling to work those 40 hours and then also still go to school for 10 hours a week, or even 5 hours a week.

She goes into more detail, sharing that:

> I was going through the apprenticeship, going to school unpaid, and then they [future apprentices] were getting paid. So, I feel like that helps better, or would help better with my work/life balance, and would have just been better all around.

Her suggestion to improve the program was to focus on work/life balance through streamlined classes and offering compensation for taking those classes. Her experience highlights the importance of equitable and timely pay and scheduling flexibility in enabling apprentices to successfully balance their personal and professional responsibilities.

Apprentices who did not suffer from financial burdens chimed in on the subject. Mary, who was enrolled in the Radiation Protection apprenticeship program shortly

before Kay, mentioned a colleague of hers who did not complete his program. She remembered that "he would have completed his degree, but he had some financial issues, and he couldn't finish." Jacob and James were fortunate enough to enroll in the apprenticeship program after the transition from starting as LSEs to FSEs was made. They received 40 hours of pay each week, which covered time in school and at work. After learning in the focus group interview that past apprentices did not receive payment for 40 hours a week, they reflected on how their experience would have been different if they had to go through the same process. James initially conveyed, "If it wasn't paid, I think it would have been a lot harder," but then he went further to say, "I definitely couldn't have done it without getting paid," but he still would have tried to complete the program. Jacob agreed, saying:

> I've met a couple of the students who came through, and they were saying they were having to work like second or third jobs, you know. Not only go to school, but do the program and also have another job. So, you know, with us being able to just do everything and get paid for that is a huge advantage and a lot less stress; that's something we don't have to deal with. So, keeping that a part of the program because that allows them to focus solely on their job and not have to worry about additional things going on to meet their needs in life.

Their reflections feature how crucial financial support was to their success, reinforcing the need for adequate pay across all apprenticeship cohorts. Their stories and experiences also showcase how the financial support gave apprentices the chance to be fully immersed in their work and school obligations. Those impacted with financial challenges may have been more successful if the support had been readily available. This means that

financial support is not just a benefit, but it is a critical component to apprentice retention and success in the program. Ensuring consistent financial support could help reduce stop-out rates and create a more sustainable training experience for future cohorts.

Boundary Theory

The Boundary Theory by Nippert-Eng (1996) and Ashforth et al. (2000) examines how individuals shift from work to school and other areas of life. The principles of this theory, which focus on separation, integration, and the quality of workers' lives, can be used to explain some of the participants' experiences (Desrochers & Sargent, 2003). More specifically, Desrochers and Sargent's (2003) research shows that managing work and family borders can be simplified through separation; the greater the separation, the easier it is to flex between one setting and another. On the other hand, those who choose to mix the family and work domains must define their level of integration. Transitions between work and family settings flow more smoothly when the level of integration is clearly established and kept to a minimum (Desrochers & Sargent, 2003). Both separation and integration can influence employees' well-being, their feelings about their employer and family, and the boundaries they maintain in their social life (Desrochers & Sargent, 2003). Additionally, an individual's preferences between separation and integration and the way they move between those domains may change over time (Desrochers & Sargent, 2003). Participant responses about finances and work/life balance in general can be used as examples to support this theory.

In 2023, Aura and Desiana published a study using the Boundary Theory with women who worked in Information and Communication Technology (ICT) service companies. Using an online survey with 6-point Likert scale questions, they concluded

that flexible working arrangements had a positive impact on work/family conflict and job satisfaction (Aura & Desiana, 2023). Additionally, Aura and Desiana (2023) found that work/family conflict negatively affected job satisfaction. Lastly, these researchers discovered that work/family culture had a negative consequence on work/family conflict but a positive effect on job satisfaction (Aura & Desiana, 2023). Examples of this can be seen through Kay's experience. She was unable to maintain her work/life balance due to the financial and time constraints of her program. The lack of flexible schedule arrangements for her job and schooling decreased her approval with the program, leading her to say that the situation was "not healthy." In the focus group interview, Kay added specifics about how her work/life balance was affected by her lack of pay.

> I think I would have actually finished my program if that was it because I was going through the apprenticeship, going to school unpaid, and then they [future apprentices] were getting paid. So, I feel like that would help better with my work/life balance and would have just been better all around.

Kay set a personal boundary by completely separating from the apprenticeship program and unenrolling from school. At that point, she was able to establish a better work/life balance through spending time with her family after work, which resulted in an increase in job satisfaction with Contractor 1.

Another example of applying the foundations of Boundary Theory to develop a balanced distinction between work and home life is that of James. Throughout his individual and group interviews, James makes several comments about the program being harder if he did not get paid for the whole 40-hour work week. He offers more details, saying:

> I think my work/life balance was great. I don't know how to explain it. It gave you enough time to study. It gave you enough time to learn what you really needed to learn, and have time to kind of mostly separate it once you get [*sic*] home and then spend time with your family during that time.

The limited integration of his work responsibilities with his home life was a result of James occasionally studying with his cohort on weekends. James reflects further on his experience in the program and recalls that "I still had time to go to my son's football and basketball games. In fact, I saw for the first time, probably in my whole life, every single game that he went to. So that was really nice." This flexibility, along with the cohesive work environment, is one of the reasons James has decided to stay in the nuclear field with his current employer. Retention in this field is a national concern (D. P. Krueger & Sather, 2008; Radwaste Solutions, 2024; Townsend et al., 2022), and the Boundary Theory has been used to explore this area (Unsworth & Seivwright, 2023). Unsworth and Seivwright's (2023) study revealed that the greater a person's ability to identify who they are both at work and home while staying true to those identities, the higher the chance of workplace retention. This concept is especially true in James' story, as he plans to remain in the nuclear field until retirement age. He can see himself as both a worker and a father, actively achieving success in both domains.

Findings Overview: Research Question 1

Participants provided many reasons for why they were or were not able to maintain their work/life balance during the apprenticeship, and all of them stated that maintaining the balance was important to them. While the opportunity for financial growth played a significant role in their decision to pursue and remain in the nuclear

field, some participants reported experiencing financial challenges throughout their program, which hindered their ability to establish and maintain a suitable work/life balance. Previous studies show that the Boundary Theory can play a role in job satisfaction, work/conflict situations, and work/family culture. The separation or integration of work and home domains, which also influences work/life balance, is explained through the Boundary Theory. The financial and workload struggles of some participants are further examples of how important the Boundary Theory is for them, their careers, and their families. This data contributes to the research and highlights how the Boundary Theory and its principles should be taken into consideration when structuring apprenticeships. Most importantly, the results within this theme demonstrate that financial support plays a significant role in an apprentice's ability to persist through a program, particularly in the nuclear field.

Many Factors Influence Workplace Confidence

Levels of workplace confidence can serve as strong indicators of an individual's intentions to remain at their current employer. To answer the research question about how confidence can affect someone's ability to succeed in a career, qualitative data about confidence levels and their effects for each participant were collected through interview questions. As participants shared insights about their time in the apprenticeship program, additional connections emerged, confirming that confidence is not only shaped by internal motivation but also by external supports and experiences, as described in the Self-Efficacy Theory (Bandura, 1977; Lopez-Garrido, 2025). For example, Mel took advantage of studying with his colleagues. Kay, Mary, James, and Jacob formed study groups within their cohorts, both at work and at school, which aided in their skill building

and helped them become more familiar with the job and material. Jacob shared, "There was someone, whether it was another student or, you know, a faculty member or tutor, that was able to help guide you and give you tips." Likewise, James jumped in and stated, "To have the knowledge that there is somebody that is able to help you is always great." Outside of the classroom, confidence was built through comfort and ease. James elaborated on his perspective of first working at the site.

> I think the advantage is…just the start of the culture of going over there to Site 1 and get [*sic*] your feet wet, than somebody just coming straight in to do the job. It might be a little overwhelming, you know. Somebody guides you and then you start doing the classes and stuff like that. But yeah, I think it'd be a little bit overwhelming to come straight in and start to learn your job, plus the culture of Site 1.

Having familiarity with not only the job duties but also the other workers in the area and the environment they create made some respondents feel more prepared to begin the job. Overall, it was revealed that several factors influenced the participants' confidence levels. Former apprentices credited an increase in self-confidence to having prior connections to the nuclear field, increasing their overall knowledge about the position, and advancing their work ethic. This growing sense of self-confidence not only helped them succeed in the apprenticeship but also motivated them to envision long-term careers within the field.

Familiarity With Site 1

The nuclear site where the apprentices worked during and after their program has a long-standing history and leaves a monumental impression on its community. Generations after its completion, Site 1 continues to draw interest from diverse crowds,

including recent high school graduates and older citizens seeking a new career. Many people's first introduction to Site 1 comes through friends and family members. However, community exposure, such as job fairs and educational outreach events, piques the attention of both adults and children. The area's nuclear apprenticeship programs add on to this initial level of curiosity. Through carefully curated courses and on-the-job training, apprentices gain immediate access to a side of Site 1 that others are not privy to until they have been working for a few weeks. These bits of information served as an advantage for graduates of nuclear apprenticeship programs, increasing their workplace confidence.

Mary's relationship with the site began long before she knew about RadCon. In high school, she secured her very first job as a custodian alongside her mother. She also had a temporary job out there but was laid off after a few months. As she was looking for ways to regain employment at the site, her brother and his coworker suggested she try for a job as a radiological inspector. She recalled:

> I came across my current position through my brother and someone who works at the site with him…He was a radiological inspector, but he was under, I believe, soil and groundwater. And my brother mentioned to him that, "Hey, my sister is looking for a job out at the site." So he said, "Well, let me get your sister's information and I'll talk to her."

With their guidance, Mary was able to quickly take the appropriate steps to complete her pre-hire requirements and join the apprenticeship program at Institution A. Since then, Mary has been employed with Contractor 1 and continues to stay in touch with those who assisted her in finding this career. Her journey is a testament to how personal connections

can open doors to career opportunities, even in the highly competitive field of nuclear energy.

The interactions of some of the other participants prior to the start of their apprenticeship were much like Mary's. Kay had several friends who kept telling her, "Try for RadCon. Try for Radcon." Additionally, she had family ties to the site; her husband was employed at Site 1. Kay gave more insight by commenting:

> Most of my family worked out there. My husband currently worked out there when I applied, and I just had a lot of people telling me to apply for the site, and people talking about RadCon over and over. I saw a posting for it, saw that they wanted Institution A students, and that's kind of how it got started for me.

Jacob chimed in by adding:

> Yeah, similar story. I have friends and family that worked out there. Just kind of knowing, not necessarily what they do, but how it affects them in their daily life. A lot of them, you know, they tell me that the culture that's out there, they bring it home. It helps them to see not only, you know, at work, but just in life in general. And I wanted to just have a bigger purpose in life and look into it.

Lastly, James contributed to the conversation, noting, "I had a couple of friends out there, and they really enjoyed their work." Mary, Jacob, Kay, and James all benefited from knowing people who were employed at Site 1. Without these connections, they may not have been exposed to the nuclear field, missing a great opportunity to secure a stable career. These personal relationships served as informal bridges to the nuclear industry, offering firsthand accounts of what life would be like as a site employee. The trusted voices of family and friends gave them the confidence to pursue positions that initially

felt out of reach. The interviewees' stories revealed that social and professional networks play a bigger part in increasing confidence than before.

While familiarity with Site 1 relates to personal relationships and connections, there is another side that pertains to the job itself. Many of the participants felt prepared for their new role simply because of what they were exposed to during their classes at the technical school. When Mary thought about her confidence levels, she believed they increased due to what she saw in her program, remembering, "Whatever I learned at school, I could say that I'm familiar with it when I got to work." She later indicated:

> What I saw or what was brought to me, the information that was brought to me, I was able to use it at work, especially when it's time for me to take my mock-up…So I would say that even though they didn't teach us how to use the instruments in the beginning, I can say that when I got hired out there, I was a little bit familiar of [*sic*] what they were and how to use them.

Like Mary, Kay also appreciated being able to recognize certain things upon her arrival at work. She heavily believes the program prepared her for the on-site comprehensive exams. In her interview, Kay was asked if she felt an increase in confidence, even though she did not finish her program. Her response was a resounding "yes", with these factors to support her claim:

> I will say yes, yes, especially with the math, Rad Worker I and II, and DOE policies. It really did increase my confidence. There were people who got hired off the street in the LSE program at Contractor 1, and they were stressed about the math and worried about it, and I'm not. I wasn't. I was like, "I've already done

> this before." I know how to do it…So I was confident going in. I made a 97 on my final without even really trying. So I was very confident, right?

Before the end of her individual interview, she remarked about how she "already knew what this job was about" and she "had prior knowledge and not [*sic*] going in blind sided" thanks to the apprenticeship program. In the focus group interview, Kay said she felt more equipped than someone who did not attend an apprenticeship. Hearing about the "job scope and knowing what it is" gave her an advantage over others. This sense of preparedness set Kay apart from those who did not participate in an apprenticeship program. Her experience reinforces the importance of collaboration between employers and higher education institutions to ensure apprentices are exposed to relevant topics and items in their coursework.

The last two participants to discuss job readiness and confidence were James and Jacob. Their views did not differ significantly from those of Kay and Mary. Jacob felt prepared for his new career with Contractor 1, stating, "It helped us prepare ourselves for recognition of tools and things that we'll see regularly on our jobs." At the end of his interview, he emphasized that the program's pacing and dedication to laying the groundwork for the Production Operator position had a substantial impact on his confidence, which he noted increased as a result. He remarked:

> It was definitely taking the time to progress through these classes and learn the material through the classes first. Just our first couple of days when we were in our facility, I was able to identify instruments and understand kind of the foundation of what they do just from the classes that we took. So I was able to directly apply the knowledge from my classes into my workplace just from taking

> these classes. And it's definitely things that I wouldn't have known or understood had I not taken those classes prior.

In the focus group interview, Jacob shared more of his perspective:

> I just think adaptability to the job is easier for us because, you know, it's even though we didn't know we weren't going to be doing hands-on, we still had that foundation, and, like I said, critical thinking was one of the big things that helped me navigate it.

In another question, Jacob expressed that he was already familiar with the technology and the math due to the program. James gave a few statements that echoed his sentiment, revealing that the program gave a "good starter" to the job requirements, and that it was good for "getting an introduction and setting the pace of what we need to be doing or how we look at stuff." His viewpoint adds to the notion that apprenticeships with a strong structure can enhance confidence and improve preparedness through familiarity. Overall, the participants agreed through the statements that being prepared and confident can ease the transition to nuclear work, setting the stage for a long career. Adaptability, familiarity, and workplace awareness are the hallmarks of a successful shift to the nuclear field.

Increase in Aptitude

Along the lines of site familiarity is an increase in aptitude, where the study's subjects explained what they learned and how it shaped their experiences on the job. The difference between heightened familiarity and a rise in aptitude is that familiarity pertains more to the culture of Site 1 and overall job duties, while aptitude refers to the content knowledge and hard skills required for the job. Most of the participants left the program feeling more educated than when they began. For example, Mel mentioned that his

"knowledgeable teachers" worked well with the site, and the material he needed to know directly reflected what was presented at work. He credited his growth in confidence to a substantial "increase in aptitude" and closed by saying, "The actual apprenticeship program did help [me] retain important and pertinent information." Mary had a parallel outlook that also tied closely with her previous comments about site familiarity. She was able to quickly advance from an LSE to an FSE, resulting in a corresponding pay bump. She recollected:

> When I first got started, I was an LSE, a Limited-Service Employee, and when you get hired out there, they put you through a training process as well. So the training that I got from Institution A pretty much prepared me for the training that I got as an LSE apprentice. So, anytime they would give us tests or quizzes, I could say, "Okay, well, we did this at Institution A." I still have all my notes from Institution A and all my work that I can use to help me study, so it pretty much went hand in hand.

Mary's journey in the program illustrates how apprentices benefit from a mutualistic relationship between the technical school and the employer. When these entities partner together, the training transcends one setting and flows seamlessly into another, allowing participants to easily transition from school to work, taking their technical knowledge with them. This occurrence supports previous research by Relly and Laczik (2022) and Kezar and Lester (2009). Their studies showed that combined efforts between all parties involved led to a decrease in overall costs and an increase in efficiency, resulting in higher job satisfaction from the apprentices and workers. Most importantly, a strong partnership between schools and employers lays a solid foundation for success and

positive change in both apprenticeship programs and the local workforce (Relly & Laczik, 2022).

Kay and Victor both felt as if the technical schools gave them a jump start into the content needed for their positions. Although Kay did not complete her apprenticeship, she still learned about the math skills needed for RadCon and the format of the site's exams, sharing, "I think it [the program] effectively prepared me for the math and the comp final." She added, "They do a lot of math, a lot of definitions, a lot of that…So it prepares you for the book work and the math that you need." Lastly, Kay gave a major nod to her school, saying. "Institution A prepares you better for the math than Contractor 1 itself." These statements exemplify the impression that the technical college had on her learning. Victor, who believes the nuclear industry is a "great field" to work in, summed up his learning experience in one answer. He declared:

> A lot of people are, I guess you could say, like, scared of nuclear work altogether just due to a lack of knowledge. But once you understand the different parameters and precautions that they take to prevent, you know, I guess you would say, whatever life-threatening or dangerous aspect of work you think you're going to be a part of, it's not bad at all. It's really a cakewalk. It really is. Knowledge is power.

Victor's statement was similar to a comment made by Mel, indicating that "We do have a lot of procedures, and not following them could lead to other things, not so pleasant." These reflections represent a different aspect of learning that helps apprentices maintain safety standards, a core component at Site 1. The apprenticeship not only teaches about nuclear fundamentals, but it also works to break down barriers and misconceptions about

the nuclear field. With this information, both Mel and Victor were able to confidently step into their roles as nuclear employees.

Jacob noted that his apprenticeship model "allowed him to focus solely on the classes" he was taking, aiding in understanding the content before arriving at the site. He emphasized his experience by pointing out:

> It [the program] taught us a lot of skills…For example, our chemistry class and fluid flow classes, it taught us how to identify particular instruments and things that we'll normally see on a job that I feel like we normally, you know, would have taken us a couple of extra days or weeks to learn on the job itself versus learning in the classroom first. So, it kind of gave us those foundational tools in order to help us identify and kind of hit the ground running at our job.

To underscore the mark the apprenticeship had on his cognitive gains, he continued to shine a light on how his involvement in the technical school training gave him an advantage over other new hires who did not enroll in an apprenticeship program.

> I now have that skillset to do the job and or navigate it appropriately, whereas some of these guys just came in like you said, not knowing what they were going to be doing and just having to kind of learn the skills as they were actually learning the job at the same time, and not already having those skills to do the job or try to navigate the job.

The contrast of being an apprentice as opposed to not enrolling as one appears to be evident based on Jacob's comments. He came across as being steps ahead of those who did not have the opportunity to be trained at the technical college. Jacob also reinforced the idea of a layered approach to learning by seeing the content in a classroom setting and

then handling it on the job site. This tactic eases the learning process for apprentices, giving them a chance to be fully immersed in the educational journey. James concurred with these findings. In the focus interview, he highlighted his encounter, which was similar to Jacob's and his thoughts on layered learning.

> I think they did a good job with not overwhelming you with all the big information all at once. It kind of trickles down. You did the easy classes first to kind of get you introduced, and then the harder classes later on.

James appreciated how the program gradually built upon prior knowledge, allowing him to develop confidence and increase his aptitude throughout the apprenticeship steadily. This structure made the content easier to grasp, supporting long-term retention in the field and both James's and Jacob's success thus far. After listening to each participant's explanation of how they developed hard skills related to their position, it is clear that a set curriculum, a structured partnership, and ample chances to apply the knowledge in a work-based setting are imperative to establishing job readiness, reinforcing technical competence, and ensuring a smooth transition into the nuclear workforce.

The ability to transfer knowledge from one setting to another made the adjustment to Site 1 easier and more comfortable for these apprentices, forming a solid level of confidence from the early days of their career. When institutions and training programs mirror their theoretical matter to the expectations of the job site, apprentices can apply their learning in more meaningful ways. The learning curve and workplace errors can also be minimized through the program's teaching styles. Lastly, the overall framework is strengthened by ensuring consistency and relevancy across the learning and work environments. These testimonies reiterate the importance of aligning the classroom

content and on-the-job expectations, requiring institutions and employers to collaborate during planning.

Developing Work Ethics

The last subtheme related to workplace confidence reflects the participants' growth in their work ethics. As an important soft skill, work ethic shapes how an employee views their position and responsibilities (Pantelakis, 2023). Additionally, it can affect job satisfaction, productivity, and the employer's reputation (Pantelakis, 2023). In this study, the data revealed that some respondents had to reevaluate and adjust their work ethics to keep pace with the school's demands and the severity of their position. In doing so, they also built their preparedness and confidence regarding their new profession, making the transition to the nuclear field a more pleasant experience.

While some interview responses mentioned the phrase "work ethics" verbatim, most did not. Mel alluded to his work ethic needed to pass his classes and maintain his momentum at work through other expressions. At one point, he cited, "Yes, well, during the actual apprenticeship program, our main focus was to learn as much as we can within those 7 weeks." He later goes on to say, "We had good instructors, and the rest was put on us as the student to succeed." This reflection shows that Mel understood what was required of him by his instructors and employer. He applied the traits needed to pass his studies to his career as well, helping him survive the moments that he recalled feeling like "modern-day slavery." Jacob did not use a term like slavery to describe his reaction to his program's pace, but his expression was one of shock. He commented:

> I felt like it was, it was too fast. But I understand that this program was meant to kind of give you the fundamentals, so it introduced you to a lot of different subjects that you will then see and be able to deep dive.

However, he quickly realized that he needed to adjust his thoughts towards the program's speed, enabling him to keep up with the classroom instruction and on-the-job training. Like Mel, Jacob comprehended that his employer expected a certain level of workplace discipline. The apprenticeship program helped him with that adjustment, making him better equipped for the work environment.

Mary briefly touched on work ethics during her interview, speaking about her work experience and remembering specific traits that her managers were looking for, such as "checking to see if you were understanding the material." She indicated:

> If they like what they see, they will offer you a job. They pretty much go by your attendance, and if you're willing to learn, if you're willing to do all three of those things, more than likely you will get a job out there. It's just up to that individual.

Her statement indicates that her employer had established clear work ethic expectations, and she discovered what to exemplify during her time as an apprentice. Given that Mary is still employed with Contractor 1, it is evident that her attention to learning the material, understanding the culture, and simply showing up were effective strategies. The rise in her work ethic contributed significantly to her retention in her career.

Victor spoke with conviction about how his time in the apprenticeship changed his perspective of what was expected on site. He began with:

> It really increased my ability to perform jobs on site, or just in general, just because of the level that they hold you to. So, you kind of build like leadership

skills through the program by working with the people that you're working with. So definitely say it increased my confidence.

His response touches on how he felt more confident in his work ethic and hard skills after taking advantage of being around his peers and members of the leadership team. He continues by adding, "That's one of the key factors. It really just makes you a lot more punctual, makes you a lot more accountable. I feel like it just really throws you into a leadership process." Like Mary, Victor grasped that he needed to match his employer's standards, especially if he wanted to continue working in the nuclear industry. Unfortunately, Victor is not currently employed in the nuclear field, but his goal is to use these skills to return to the industry. Taking accountability, maintaining good attendance, and displaying the willingness to advance intellectually are the hallmarks of a strong professional work ethic and the ability to achieve long-term success in a highly structured field.

James had a positive outlook on recognizing the program's impression on work ethics. Coming from the fast-paced food and beverage industry, he knew how to jump in and get acclimated to his employer's demands. He started his remarks by saying, "It [the program] gave me a good idea of a lot of people's work ethics." James may not have been aware that not everyone valued workplace etiquette and culture as he did. As a result, he applied himself even harder, taking the habits he acquired in school to the job site. He proclaimed, "That work ethic that you do in school, kind of, you know, goes further into the job itself." Other participants, such as Victor and Mary, had a similar mindset and stepped up in their classroom and workplace settings. Having the structure and guidelines of the technical school match the employer's demands is a constructive method that

prepares apprentices to meet real-world job requirements with confidence and proficiency. Looking back, James also remembered moments of supporting himself when his employer was not available. Without a strong work ethic or a high level of confidence, this could have been challenging for James. One example of this was when the program's managers became busy with other tasks. He recollected:

> Sometimes, I know they have, like, a lot of people to take care of, so sometimes, it seemed like you would say something, and they kind of, I guess, get brushed under the rug, maybe. But I think overall, they did a good job, too. And again, you know, it's a job. You can't really cater to everyone's feelings and wants at one time. You still have to do what you got to do to make stuff happen.

Again, his ability to understand what employers expect, both cognitively and emotionally, helped him navigate this situation and ultimately the program. This independence enabled James to strengthen his decision-making skills and problem-solving abilities, which are useful in multiple settings. Collectively, the participants' encounters bring attention to how the development of a solid work ethic was not only essential for completing the program but also for laying the foundation for long-term professional growth. The apprenticeship model of having the institution and employer require high standards catalyzed personal and professional transformation, reinforcing the behaviors and mindset needed to thrive in the nuclear industry. As shown through their reflections, cultivating a strong work ethic is a critical step toward building confidence, gaining credibility, and sustaining career success.

Self-Efficacy Theory

Albert Bandura (1977) developed the Self-Efficacy Theory to explain the factors that may contribute to increases in confidence across different areas of life. Like confidence, self-efficacy can be strengthened or improved through various methods (Lopez-Garrido, 2025). *Performance Outcomes*, *Vicarious Experiences*, *Physiological Feedback*, and *Verbal Persuasion* are four principles of the Self-Efficacy Theory that participants could have tapped into to enhance their growth in the program (Bandura, 1977; Lopez-Garrido, 2025). *Physiological Feedback* and *Performance Outcomes* closely mirror the experiences described under the theme and subthemes covered in this section. Additionally, the participants who displayed a substantial amount of grit during their training can be included in this theory. Grit, defined as the determined effort to achieve an overarching goal, even in the face of obstacles, plays a role in one's desire to continue learning to reach their professional objectives (Duckworth & Gross, 2014), a major component of this study. Tying the responses and stories revealed in the interviews to the Self-Efficacy Theory can bring me, higher education institutions, and employers in the nuclear industry one step closer to understanding what steps can be taken to close the labor and skills gap.

Physiological Feedback

Lopez-Garrido (2025) stated that *Physiological Feedback* presents itself as properly managing moods and mental changes during difficult experiences. When this occurs, higher success rates of increasing self-efficacy are possible for individuals. The most prominent examples of this phenomenon are from Victor and James. Both graduates discussed adjusting to the fast pace of their programs and learning about the demands of

their institutions and employers. Victor reflected on how his confidence increased after he was exposed to the high standards of Institution A and Contractor 1. There was an adjustment period for him, but he was able to cope and alter his work ethic. From that point, Victor felt more prepared to thrive in the nuclear industry, as well as other areas of life, citing that he was prepared "to perform jobs on site or in general." Victor's outlook on his soft skills evolved, too, making him more aware of the growth he had made during the training. He describes the development of his mental understanding by sharing, "That's one of the key factors. It really just makes you a lot more punctual, makes you a lot more accountable. I feel like it just really throws you into a leadership process." Shengyao et al. (2024) conducted a study that uncovered that students with higher self-efficacy set higher goals and are more likely to reach them. Students with high self-efficacy are also more likely to have effective stress management and coping skills, which is a key component of *Physiological Feedback* (Shengyao et al., 2024). Victor's capability to maintain high academic achievements while adjusting to the standards of the field shows how his self-efficacy positively influenced his outcomes. The same could be said for other participants in this study, including Mary and Jacob. Victor's reflection shows how managing internal responses to external pressures can foster personal and professional growth. Although Victor is not currently employed in the nuclear sector, his capacity to quickly adapt to high expectations reinforced his confidence and self-efficacy, allowing him to shine in his current career path.

James had a comparable revelation. Coming from a high-intensity industry, he was accustomed to the hustle and bustle of the workplace and completing tasks in a timely manner. However, he still had to learn the culture of his job with Contractor 1 and

mentally adjust to his new reality. James especially displayed grit when he realized that there would be occasions where he could not rely on his instructors or managers and would have to help himself. He quickly discovered:

> Sometimes, I know they have, like, a lot of people to take care of, so sometimes, it seemed like you would say something, and they kind of, I guess, get brushed under the rug, maybe…You still have to do what you got to do to make stuff happen.

James's ability to navigate those moments maturely and professionally shows that his self-efficacy, which started strong, grew throughout the apprenticeship and will support his continued progress and heightened confidence in his career. This advancement mirrors his readiness to meet future challenges with independence and resilience.

Duckworth and Gross (2014) reported that grit pertains to lifelong learning. New teachers with higher levels of grit stay in their profession longer and are generally more effective in their profession (Duckworth & Gross, 2014). Their research also reported that high school juniors in Chicago public schools who displayed more grit were more likely to graduate on time the following year. Mel used the phrase "modern-day slavery" to sum up how his apprenticeship made him feel between going to school and work each week. Like the students and teachers from Duckworth and Gross's (2014) study, he used grit to persist and graduate from his program. Mel is still flourishing in his position with Contractor 3 to this day. The examples from previous research lead me to believe that James, Victor, Mel, and others in this study who persevered during their program also have high levels of grit and will likely have a track record of success throughout their long, nuclear careers.

Performance Outcomes

Another characteristic of the Self-Efficacy Theory is *Performance Outcomes*. According to Lopez-Garrido (2025) and Bandura (1977), *Performance Outcomes* can be witnessed when a person practices a new task to reinforce the idea that they can learn new skills. Apprenticeships are built around this notion. Unlike an internship, which does not focus on skill mastery or credentialing, apprenticeships require a minimum number of on-the-job training hours, providing the apprentice with several opportunities to engage in and master activities typically required of that position (Apprenticeship USA, n.d.-d). The participants in this study had numerous occasions to demonstrate the skills they learned during the training. For example, Mary and Kay, who both attended the RadCon apprenticeship program, spoke of having access to tutors at the academic institution, with Mary stressing that the "tutors were willing and ready to help me." This resource served as a means of practicing the classwork needed for the program in an environment that was low-stakes and non-intimidating. Additionally, extra support for preparation and mastery was provided on site. Kay recalled specific moments where her employer, Contractor 1, supplied study materials to aid in her learning. She recollected, "There's a training instructor…he has a little website area on the Contractor 1 page that has just pages or study material, pages of practice tests and stuff." She continued:

> If you were to by some way fail the Comp, they would let you try again, but they would go over a lot of stuff with you before. So, it wasn't like, "Okay, you failed, you're done." It was, "You failed, let's try again." So they were very supportive.

Moments like this showcase how beneficial practicing was to the apprentices and emphasize how the employer focused on mastery of a task or subject. Consistent practice

and repeated attempts to demonstrate skills can reduce some of the anxiety that may surround examinations or program completion, contributing to increased growth in self-efficacy and, therefore, confidence (Bandura, 1977; Pandya, 2021). These experiences with the technical school and employer reinforce the idea that success is attainable through hard work and repetition. As a result of these interactions, participants developed their hard skills and strengthened their belief in their own capabilities.

Victor, James, and Jacob, who were working to obtain a Production Operator certificate, also commented on the opportunities to frequently practice and demonstrate their skills through tutors, study sessions, and additional resources. Their perspective and involvement with *Performance Outcomes* were similar to Mary's and Kay's. Victor detailed his experience at the institution and Site 1:

> Depending on what actual classes we were learning, let's say we were struggling with it, or we failed it once and we had to retake a class, they would have, I guess you could say, little sessions after the learning session that they would be willing to go back and help you if you did struggle with whatever aspect of the lesson you struggled with.

Knowing that his instructors and managers supported him, Victor strived to do his best on the assessments and took advantage of study sessions when he needed assistance. Jacob reflected on getting help from others, sharing, "If you felt like you weren't knowledgeable on something, there was someone, whether it was another student or a faculty member or tutor, that was able to help guide you and give you tips." James concurred with that sentiment and said, "To have the knowledge that there is somebody that is able to help you, I think is always great." He went further to share his interaction

with an administrator on site, exclaiming, “If you ask her questions or needed [*sic*] help, she was a good support and actually helped me out on one of the classes, too. When I had a little bit of difficulties [*sic*], she showed me some tricks to help.” This mindset is another feature of self-efficacy and confidence; individuals with higher levels of self-efficacy tend to persist longer on a task before giving up (M. Wang & Liu, 2023).

Regarding the use of tutors at school, Victor said the Tutoring Center was available to him, but he did not take advantage of it. Both James and Jacob utilized the tutors on their campus and praised the quality of their work. Jacob started by saying that he “took advantage of the tutoring in the library,” but then he went into more detail, explaining:

> The main thing that they offered to us was tutoring, which was offered in the library. They also offered additional sources, online sources, that we could use in some of our courses as well, such as Pearson Learning. We relied on that a lot. There was another one we would use. It was Khan Academy. We also had online and then in-person academic support.

Likewise, James expressed:

> They were very supportive. They did have a tutor. I did use the tutor a couple of times just to make sure I got to [*sic*] the information that I needed to make sure, you know, I get a good grade and stuff like that.

The tutors provided a method for apprentices to focus on practicing and mastering the standards in their courses. Again, these opportunities built their self-efficacy and confidence by allowing the participants to prove to themselves that they are capable of learning. A supportive learning environment at higher education institutions and the

workplace is essential for facilitating this growth. The more they engage in that positive experience, the further their confidence can flourish over time.

Lastly, James brought his connections full circle when reflecting on his ability to seek help throughout the program. As discussed earlier in this paper, James felt as if he maintained his work/life balance. He recalled, “They did offer ample opportunities to study and make sure that we understood the content at work and while we were at school.” His statements about enjoying his work/life balance and feeling supported through ample chances to study and practice his work corroborate a study by Ye et al. (2024). Their study linked elevated confidence and persistence to understanding and sustaining a healthy work/life balance. Another study found that individuals who know how to maintain a suitable work-life balance often exhibit higher self-efficacy (Darouei et al., 2024). Using the findings from these studies and this one, one can conclude that apprenticeships and other training programs should strive to provide a positive work/life balance while implementing several opportunities to study and practice the program’s desired objectives.

Skill Theory

Kurt Fischer’s (1980) Skill Theory posits that skill development occurs in a step-by-step sequence across ten levels, organized within three hierarchical tiers: sensory/motor**,** representational**,** and abstract. Each level reflects increasing complexity, with higher-level skills built by combining skills from multiple lower levels. Later research expanded on this model, describing skill acquisition as a web of interconnected strands, where each individual forms a unique path to mastering the same skill (Fischer & Rose, 2001). Two of the three main principles of the Skill Theory can be related to the

theme of Influencing Workplace Confidence. They are *Concept of Cognitive Control*, where individuals regulate how they think and act through various strategies, and *Concepts for Defining Levels and Transformations***,** where skill levels reflect the complexity of actions, not the person themselves (Fischer, 1980). There are additional ways to assess how the Skill Theory can affect learning. Fischer and Farrar (1987) demarcated generalization versus specificity, which determines how transferable a skill is from one situation to another. A skill that falls along the lines of generalization can easily be transferred to other settings (van Slageren & Herrmann, 2024). On the contrary, specificity means a skill is unique to a particular career or task (van Slageren & Herrmann, 2024). Industry-specific skills fall into this category and include hard skills that participants had to master to be proficient in their positions (van Slageren & Herrmann, 2024). The participants learned many industry-specific skills, such as how to dress out, read equipment, and monitor valves. Understanding how skills emerge and influence self-confidence throughout one's life is crucial for designing effective programs and learning materials for industries facing urgent workforce needs.

Concept of Cognitive Control

The *Concept of Cognitive Control* insinuates that a person is in control of the way they operate or think, meaning they play an active role in their learning (Fischer, 1980). Instances of this concept can be observed in the interviewees' experiences and responses, as explained in their interviews. Increasing their aptitude and developing work ethics both rely on the former apprentices' ability to assess their situation and quickly decide how to react to different triggers. For example, James recalled a time when he needed

assistance, but his managers were unable to help because their workload had become heavy. He said:

> Sometimes, I know they have, like, a lot of people to take care of, so sometimes, it seemed like you would say something, and they kind of, I guess, get brushed under the rug, maybe…You still have to do what you got to do to make stuff happen.

Being able to understand that his managers' reaction was not personal towards him and choosing not to be upset at the circumstances shows that James cognitively controlled his actions and thought process, leading to a satisfactory outcome over time. Another example can be witnessed through Mel's periodic feelings of "modern-day slavery." Instead of quitting or complaining, he decided to endure the difficult times in hopes that it would pay off in terms of his education and career. Like James, he showed control over his cognitive thoughts and made an intentional choice based on the conditions.

Those examples focused primarily on work ethics and discipline, but there are learning scenarios that fit this concept, too. Making a conscious decision to continue in a class or program of study after facing challenges indicates that a student can consider the consequences of their actions. This action in itself exhibits cognitive control. Each of the study's participants engaged in study sessions with colleagues and tutors to build their content knowledge during this program. Jacob touched on this in his interview, sharing that:

> I took advantage of the tutoring in the library…I kind of made my own study guide. So, like Google Drive, I would make my own study guides on Google

> Drive. Pearson, I also took advantage of as well in some of our courses, including chemistry and math. Was very helpful in those subjects.

Taking the initiative to use nearly every resource available to him to master his classes illustrates that Jacob took the time to think about what actions he needed to take before successfully implementing them. Mary and Kay kept their study materials from their classroom training, which proved to be advantageous during their on-the-job hours with Contractor 1. Kay expounded:

> I also tied in my old Institution A Quizlet to the Quizlet that we study for at Contractor 1, and added more questions for it. So I definitely took advantage of old material and new material, and a lot of us would still form those study groups again and study together.

These cases collectively show how cognitive control played a pivotal part in the participants' success throughout their apprenticeship journeys. By consciously managing their thoughts, emotions, and actions in response to both academic and workplace challenges, they were able to make intentional decisions that supported their long-term career goals. When choosing to either seek out additional academic resources, continue through strenuous work settings, or form a study group to ensure success, each participant exhibited a level of self-management that aligns with Fischer's (1980) *Concept of Cognitive Control*.

Concepts for Defining Levels and Transformations

The last part of the Skill Theory that connects to factors that leave an impression on workplace confidence is *Concepts for Defining Levels and Transformations*. In short, this principle states that lower-level skills are included in higher-level skills, and the

difficulty or complexity increases (Fischer, 1980). Additionally, this principle stresses that levels are indicative of the skills a person has obtained, not the person themselves. A few of the participants in this study touched on how the training was arranged to start with courses that taught lower-level skills and conclude with the more challenging courses. Kay and Mary mentioned that their RadCon program started with math and bookwork first and placed equipment and procedures towards the end of the curriculum. Since Kay did not finish her program, she missed out on the classes that utilized hands-on learning. Mary suggested moving the hands-on classes to the beginning of the curriculum, with Mary suggesting, "Let them start learning about the instruments. Let them read them and show them and start knowing what to do instead of waiting until the end." However, this approach may not be the best structure for an apprenticeship program where students have to learn multiple levels of content over an extended time. A tiered learning design ensures that foundational knowledge and skills are acquired before moving on. In turn, a deeper understanding of the content is gained, and the skills will be sustained.

James appreciated the structure of his apprenticeship program, noting that he started with easier courses before progressing to the more higher-skill ones. This structure, and the fact that he only had to focus on one class at a time, supported his ability to master skills at varying levels. Overall, he felt like:

> They did a good job with not overwhelming you with all the big information at once. It kind of trickles down. You did the easy classes at first, so you kind of get introduced, and then the harder classes later on.

The gradual progression of his courses aligns with Fischer's (1980) concept that higher-level skills build upon a foundation of simpler ones, allowing learners to elevate their aptitude and understanding step-by-step. This sequence may also build apprentices' confidence early on as they celebrate small wins before moving to the more challenging courses. If higher education institutions and nuclear industry employers continue to recognize and apply this approach in their training programs, hard skill acquisition and workplace confidence may continue to grow.

Findings Overview: Research Question 2

The theme for Research Question 2, Many Factors Influence Workplace Confidence, directly reflects the participants' responses about the numerous experiences in the apprenticeship program that impacted their career preparedness and confidence levels. Being familiar with Site 1, the job opportunities it provides, and the culture that is instilled in its employees drew the former apprentices to seek employment in the nuclear field. Having prior knowledge about the site's work environment made interviewees feel more confident about the career choice they made. An increase in aptitude is another method of imparting confidence in apprentices. Like the subtheme of site Familiarity, developing hard and soft skills and learning content directly pertaining to the job before being fully immersed in the role sets apprentices up for success. As many participants shared, learning industry-specific skills while being introduced to the job made them feel more prepared compared to others who did not participate in an apprenticeship program. Finally, cultivating a strong work ethic throughout the apprenticeship was another way to boost the apprentice's sense of confidence. This subtheme also focuses on familiarity and comfort. Gaining an understanding of the school and workplace expectations made the

participants more aware of how to manage their time, study for their assessments, and handle potential conflicts in both settings. These three subthemes are critical for higher education institutions and employers to understand and implement as they create or modify new and existing training programs.

The Self-Efficacy Theory by Bandura (1977) tied into this theme by highlighting the ways in which participants could increase their self-efficacy and confidence. *Physiological Feedback*, which relates to overcoming challenges emotionally and mentally, was exhibited many times during the respondents' apprenticeship journeys. A few commented on managing their work ethic skills and persevering through difficult classes. In both cases, interviewees had to think critically about what could be done to ensure success in the program. *Performance Outcomes* and evidence that new skills can be obtained were also showcased during the training programs. As many participants recounted, there were ample opportunities to practice and apply what they had learned at school and on the job. Both the institutions and the employers supported the students by reinforcing concepts and allowing second chances if the passing standard had not been met. The simplicity and relief of this process also contributed to the subjects having a more desirable work/life balance, as described in the Boundary Theory. Together, these principles of Self-Efficacy foster motivation and play a key role in strengthening overall self-confidence.

Lastly, the Skill Theory by Fischer (1980) discusses how people learn and develop new skills. The *Concept of Cognitive Control* largely centers around how people think through scenarios before making a decision. Subjects of the study recounted many tough days in their programs, with one even describing it as "modern-day slavery." However,

due to critically thinking about how to proceed and learn during these times, participants were able to achieve success. This concept also ties into the principle of *Physiological Feedback* from the Self-Efficacy Theory. In order to prevail through mentally and emotionally challenging situations, a conscious decision has to be made after a thorough thought process. The study's respondents were able to control their thoughts and actions by using the *Concept of Cognitive Control* and *Physiological Feedback*. The Skill Theory also touched on how skills were built. The *Concept of Defining Levels and Transformations* was seen in the interviewees' training programs. A few participants recalled a structured program that introduced simple concepts first before transitioning to more complex topics. While some former apprentices did not appreciate this format, studies have shown that this approach positively benefits students. Collectively, the findings from Research Question 2 and its themes, subthemes, and theories emphasize that workplace confidence is not built on a single influence, but a combination of structured learning, emotional resilience, and practical experience. The Self-Efficacy and Skill Theories provide a deeper understanding of how apprentices may gradually build confidence through familiarization, skill development, and cognitive control. In the future, institutions and employers can utilize these findings to develop training programs that prioritize industry-specific skills and emotional intelligence.

Improving Academic Experiences

The academic portion of an apprenticeship is significant. It is where apprentices learn content and hard skills that will eventually be used in the on-the-job part of the training program. Inadequate classroom instruction can negatively impact self-efficacy, the quality of work exhibited by apprentices in the workplace, and the overall perception

of the program. It is essential to ensure that the quality of education trainees receive from their institution aligns with the needs of the employer. While the study's participants felt prepared for their nuclear careers by the conclusion of the apprenticeship, many of them suggested ways to improve their academic experience. Subtheme 1, The Need for Consistent Instruction, refers to the teaching methods employed within a technical college, across the technical schools, and in collaboration with employers. For example, Mary, who completed her training at Institution A, believed that "having an instructor who was also RadCon who could come to Institution A and teach" would have greatly benefited her and her colleagues. Jacob agreed, and in his interview, he stated that, "having facilitators from the site themselves teaching the content would have helped to flow a little bit better." At first glance, it appears that a disconnect between the instructors and the employer exists.

The next section will dive further into this concern. Subtheme 2, The Desire for Hands-On Learning, also addresses ways to improve the academic experience. In a technical field such as nuclear, there are many aspects of a job that should be taught in conjunction with a textbook, such as dressing out or performing electrical maintenance. Additionally, there are areas of that career that are not accessible to everyone, like highly contaminated rooms. To efficiently prepare apprentices for their specific roles, hands-on labs and practical exercises should be incorporated into training programs. The former apprentices yearned to see more application-based lessons throughout the program, but particularly at the beginning. Mary specified, "Let them start learning about the instruments, let them read them and show them, and start knowing what to do instead of wait [*sic*] until the end." Likewise, Kay, who shared that her cohort had more practice

with math concepts than applicable tasks, declared, “In the actual field, we were kind of the same level as everyone else, just doing field work.” Comments by Mary and Kay show that not only did the participants want more hands-on training, but they also feel as if they would have had a higher advantage than non-apprentices if they had. Other interviewees shared their perspectives on these topics as a means of expressing constructive criticism for improvement. Changes to the academic experience can boost the learning and confidence of future apprentices.

The Need for Consistent Instruction

After analyzing the individual and focus group interviews, it was revealed that many participants felt their confidence grew due to an increase in aptitude. However, despite these positive results, there was still a desire to have more consistent instruction between Institutions A, B, and C, as well as between the technical schools and Contractors 1, 2, and 3. Suggestions for consistent instruction included having more knowledgeable teachers and having uniform study materials and assignments across the programs. The first participant to express this need was Mel. Twice, he stated that he had “good instructors” and “knowledgeable teachers” who provided “all the support he needed.” However, he mentioned that his employer, Contractor 3, was only “piggybacking off some of the classes that he was taking.” This statement, along with the fact that Mel was in the very first cohort of his program, leads me to believe that there is room for improvement with how Institution A and Contractor 3 planned the classroom portion of the apprenticeship.

Mary was more direct with her ideas for better training. When discussing her classroom experience, she suggested stronger lines of collaboration between her

institution and employer by saying, “I guess if they actually talk to the professors, because I don’t think they really connected with them. They knew of them because they worked out here, but I don’t think they really communicated back and forth with them.” Another proposal by Mary was to have current industry professionals deliver the course material. She elaborated:

> I don’t know if you can recruit someone to do that, but that might be helpful because it’s somebody who’s been in the field, who knows what to expect, and can show you exactly how it’s done and tell you “Well, this is how you do it, but as a perspective inspector, develop your own technique.”

Mary’s wishes show that even though she was successful, the program could have been easier, or there could have been a more seamless transition from the school to the site if there had been more teamwork between the partners. Research supports Mary’s position. Previous studies have shown that a close relationship between higher education institutions and employers fosters confidence and academic success if both entities establish these as top goals (Relly & Laczik, 2022). Additionally, Kezar and Lester (2009) discovered that students in the program are aware of when efforts by both entities are made to encourage their personal and professional growth. Mary was able to sense a lack of cohesion between Institution A and Contractor 1, leading her to make these suggestions during her interview.

Jacob was very vocal about his viewpoint, which was close in proximity to Mary’s. He, too, deemed that a dedicated set of instructors would enhance his learning and the overall outcomes of the apprenticeship. Even though Jacob praised the instructors’ willingness to help him and his cohort understand the content by providing

ample study time, supplying additional resources, and maintaining a suitable pace for the classes, he still felt like something noteworthy was missing. Jacob admitted:

> If there was anything that I like it [the apprenticeship] was missing, I feel like some of the classes that were taught, we did have really good teachers, but I feel like having a set, I guess you could say, a particular set of teachers already knowledgeable on the content, because I felt like sometimes, whenever we would get a course, the teacher was also kind of learning the material in a way that we had to learn it as well. So, I feel like maybe if we had teachers who were already knowledgeable in the subject, possibly facilitators from the site themselves teaching the content, that it would have helped to flow a little bit better. But I think that would be one of the main things I felt like the program was missing: teachers that something knew the content in a way to, you know, make it applicable to us.

Comments such as Jacob's are very important for constituents of the apprenticeship program to see and hear. It lets them know that while the program is great in its own way, there are strategies available to make it even better and relevant to the apprentices' new job positions. James, who was in a program that was similar to Jacob's, echoed that feeling. He thought, "It's a little difficult for the teachers who never been there who don't know themselves what's going on to try to teach us." James may be very accurate in his assessment of his teacher's perspectives. Martin et al. (2020) conducted a study that revealed educators felt stressed when teaching in a program without preparation. Relly and Laczik (2022) also noted that instructors in the same position did not feel internally motivated to teach. Rather, it was another job requirement for them. With this

information, the nuclear apprenticeships in this geographical area will be equipped to make improvements for the students and instructors.

The topic of consistent instruction came up again during the focus group interview when a question was asked about apprentices at different schools potentially having an advantage. Kay spoke first, saying:

> Consistency is key, especially if you're working in different areas. If you're going to a tech school like Institution A or Institution C, you kind of know where you're going. You're going to Site 1. So, it makes it difficult for Site 1's training when there's not consistency across the board from the school.

Jacob chimed in, agreeing:

> Yeah, I definitely agree. And one of those things, as far as consistency, is having facilitators that are knowledgeable in the subjects. Sometimes, I felt like we were given a class where the facilitator was kind of having to learn the material as we learned it as well. So, I feel like having the same teacher, maybe through some type of contract where, you know, they're locked in for X amount of years, X amount of classes. That way, they're kind of more knowledgeable about the classes, and the flow can be a lot better.

Lastly, James depicted his opinion:

> It's kind of hard to teach something at the school…the teachers don't really know what is going on itself [*sic*], and then trying to, you know, correlate what you're doing and what you're learning. A lot of times, it's easier to learn stuff when you know actually what you're doing and how it relates to what you're doing.

Kay, James, and Jacob did not indicate that an advantage would be given for a particular institution. Instead, they focused on how both apprentices and instructors could benefit from the consistent instruction provided by the employers for the technical schools. These sentiments align with what Mel and Mary recommended in their individual interviews. Not only do the former apprentices care about their learning, but they are also concerned with the teachers' ability to keep pace with the program while enjoying their job. These comments are compelling enough to share with stakeholders in hopes of timely change.

This topic appeared once more during the focus group interview. This time, the study material was the subject. Kay, who initially described the tools offered to her in the RadCon program, expressed how she would have liked to see the material:

> They gave you a bunch of material and all that. I do think that they should be provided consistently throughout, because, I mean, you can't just find a CCP question online very easily. It should be stuff that they give you to study. So, I do think that should be consistent.

Jacob was in agreement again and added:

> I think it just depends on the organization that you're coming from, that you have their own particular catalog of study material that helps you in that particular work group, and not so much the same thing throughout all three groups, because they are different organizations, so they require different material. So, I think it would be okay for them to have their own particular study guides and stuff.

The perspectives and recommendations of the study's participants highlight the need for a review of the teaching and training curriculum. Not only should the instructors be well-

versed in what they are teaching, but dedicated study guides should also be available. These concerns can be rectified through instructor professional development sessions prior to the apprenticeship's commencement. Additionally, the institution can create textbooks or study guides based on the employers' needs to give apprentices a resource that parallels their specific role. Ultimately, it will be up to the institution and employer to decide how they will navigate changes in response to this feedback.

In an apprenticeship program, students can be considered clients of both the school and their employers. As their needs change in the ever-changing nuclear industry, both units must adjust to serve them better (Carver, 2020; Dolasinski & Reynolds, 2023; S., 2024; Voeller, 2022). When feedback indicates that the content is not meeting industry standards or student needs, stakeholders should collaborate to determine the next appropriate steps. There should be flexibility from both parties to ensure a compromise can be made (Martin et al., 2020). It can be said that the participants' reflections emphasize the need for consistency to support student learning and enhance the overall quality of their training program. Having well-prepared facilitators with a curriculum that matches job expectations can reduce confusion, improve confidence, and foster greater continuity between educational and employment settings.

The Desire for Hands-On Learning

Another subtheme related to improving academic experiences was discovered as the interviewees' transcripts were analyzed. A few of the former apprentices talked about the need for hands-on learning to further drive home the concepts taught in the classroom. Mary was the first participant to mention the need for hands-on learning, and

she described how it would have benefited her and other apprentices during their training. She stated:

> The only thing I wish that Institution A would have done was, instead of specific classes where you learn about the instruments, I would say, introduce them early on. Introduce how the inspector is supposed to understand what an RBA is, what a CA is, and how to free somebody. How do they dress out when they're getting ready to start a job? I wish that they would start that off. Tell them this is what you do, instead of waiting until, like, the end of the program to do it, because I feel that if you see it early on and do it throughout the program, they'll be ready for it. The potential inspectors will be ready for it. And when they say, "Oh, I've seen this at school, now I know what to do on my job," and…It'll show you how to respond to contamination and radiation and show you what it looks like. But that's the only thing. I just wish that they would at least get the students prepared.

Mary's breakdown of the benefits of hands-on training is correct. A previous study compared two apprenticeship-like programs, where one was focused on hands-on learning and the other on soft and transferable skills (Mindham & Schultz, 2019). At the study's conclusion, more students in the hands-on-based program persisted in their fields of concentration than in the soft skills program. Using this knowledge, it could be assumed that apprentices in Mary's cohort will have the type of success if more hands-on practice is implemented.

In James's individual interview, he brought up hands-on learning when asked about what the program was missing. He also shared thoughts about the assessments used in the classroom portion of the apprenticeship, stating that "the tests have a lot of just

definitions on it than just actual applied information. So, I think that would have done better for me, too, than just definition answers." He continued:

> I think more hands-on. We did a lot of stuff off pictures or diagrams, which it was kind of hard to relate, or kind of hard to see what it actually meant or how it works [*sic*]. We saw, like, some diagrams of some valves, which, most of those were alright, but how [*sic*] it actually work? And when we did the classes, you know, they would describe stuff, but actually seeing it, visually, or having your hands on, I think that will be a lot better for me. Personally, I'm more of a hands-on person than just somebody trying to tell you stuff, and you're trying to visualize it in your head and make it all connect.

James's belief about hands-on learning and assessing via skills versus simple recall of definitions is a classic example of using Bloom's Taxonomy of Educational Objectives to deepen students' understanding of concepts (Krathwohl, 2002). First published in 1956, Bloom's Taxonomy is a hierarchy of teaching methods that increasingly require more skills for students to master (Krathwohl, 2002). The principle was revised in 2001, but the foundation of its purpose remains the same. The definition questions that James declared were on his test would be grouped in the lowest order category of thinking skills, Remembering. The hands-on, practical training and assessment that he is requesting would be two categories ahead in the Applying section. Using methods that employ a high level of complexity may be more challenging for apprentices, but it will foster a greater appreciation and understanding of what is needed to successfully complete a task in the nuclear field. In turn, their workplace confidence and readiness may reach even higher levels.

During the focus group interview, the need for hands-on learning arose. Both Kay and Jacob shared their viewpoints, which mirrored the thoughts of others in the study. Kay insisted:

> I think the apprenticeship programs, all of them, would do better with actual hands-on time at Site 1, like, actually job shadowing people on-site, than just focusing on classroom stuff. I think all the apprenticeship programs would benefit from that.

She added, "Yeah, I just wish they gave us more hands-on in the field." Jacob agreed with Kay, explaining that, "The actual work itself is something that you can't really get your hands on until you get out there because of what we do and how unique it is." Both apprentices expressed how challenging it can be to get more practical training due to the nature of the work, while still hoping for more opportunities to build their skills and knowledge through experiential learning. Those tasked with designing apprenticeship programs can aim to increase aptitude by using principles like Bloom's Taxonomy and referring to previous research. Consequently, the apprentices in the programs will emerge with a greater understanding of hard and soft skills, contributing to their overall confidence and preparedness to persist in the nuclear field.

Self-Efficacy Theory

Performance Outcomes

Performance Outcomes, which are a key principle of the Self-Efficacy Theory (Bandura, 1977), have already been related to a theme of this study. However, it also pertains to hands-on learning and available instructional materials. Both of these training components can have positive or negative effects on learners. Having relevant study

material ensures the student is reviewing the appropriate content to reach their goals. For technical training with an employer, this material should also be consistent between instructors, cohorts, and learning facilities. Doing so narrows down the risk of employees learning different or incorrect procedures for the same task. For an industry like the nuclear field, it is imperative that all employees learn the same policies and procedures. Practicing a new skill gives people the opportunity to notice their mistakes and correct them before applying it in an authentic scenario. This method can be challenging in the nuclear industry, but if schools and businesses work together, a suitable but safe alternative can be established. Seeing oneself improve over time is critical to the learning process. Also, small progress throughout the practices increases the person's motivation, making them more inspired to continue training. As explained by Bandura (1977), motivation is connected to self-efficacy, which plays a role in developing confidence. Providing enough opportunities to study appropriate coursework and test new skills in a relevant setting should be at the forefront of structuring apprenticeships.

Hearing the participants discuss their desires for the program shows that they are aware of some best practices for teaching. Although the RadCon program adequately prepared apprentices for the math techniques and exams, Mary and Kay both believed they entered their profession at the same level as other new hires when comparing field work experience. Again, Kay recalled being on "the same level as everyone else, just doing field work." More hands-on training could have set Mary, Kay, and other RadCon apprentices apart from those who did not participate in an apprenticeship. Regarding learning and assessment, James believes experiential lessons and assessments would have elevated the apprenticeship program to the next degree. He wanted to enrich his learning

through more than simple memory questions. Higher classification of learning strategies, as shown on Bloom's taxonomy, supports deeper understanding of the workplace objectives, increases self-efficacy, and boosts confidence.

The same could be said when knowledgeable instructors are used in training programs. Seeing teachers exude confidence during their lessons makes the trainees more in tune with the lesson and motivates them to continue learning as well. James shared an experience with an instructor in his program who did not maintain a high level of confidence in class. He remembered:

> I know at one point, we had the same teacher for both of the classes, and you could kind of tell she didn't want to teach anymore. After that time, one of the other teachers left the program, so another teacher took over, and you could tell in that second half that she was kind of over teaching for the day, also.

To have instructors who visibly showed they were not interested in teaching or engaging with students can be a blow to the students' wish to learn and their self-confidence. Educated instructors who have field experience or can relate the lessons to the nuclear field and have the passion to inspire apprentices should be hired for these roles. Otherwise, the apprentices may not succeed or learn as much as they could have, resulting in lower self-efficacy and confidence levels. These instances can also be tied into two other principles of the Self-Efficacy Theory. Both *Vicarious Experiences* and *Verbal Persuasion* relate to positive feedback and role models (Lopez-Garrido, 2025). When instructors behave like the ones in James's example, apprentices are not witnessing an inspirational leader or hearing encouraging confirmations about their training, new career, or overall experience. Going forward, it may be beneficial for higher education

institutions and employers to hire instructors with high levels of self-efficacy and confidence who want to transmit those feelings to their new students.

Findings Overview: Research Sub-Question 2.1

Improving academic experiences is a significant component of the participants' feedback from the interviews. Through consistent instruction and more opportunities for hands-on learning, they can maximize their professional and personal growth. It is impressive that the former apprentices were able to articulate these needs; they know that their success in the nuclear industry depends on their progress in the program. Managers who create and oversee nuclear apprenticeships should value this type of feedback. The goal of apprenticeships is to train and prepare students for their desired career. Since there is a labor and skills gap in the nuclear field, those in charge of the training programs should take necessary steps to ensure the participants are adequately learning new skills to feel confident and prepared to work in their new roles by implementing these suggestions from the participants.

Using the Self-Efficacy Theory and its *Performance Outcomes* principle, learners, managers, and instructors can understand how the phrase "practice makes perfect" applies to quickly building skills. The need for consistent study material across disciplines, technical schools, and contractors can also be explained using this principle. Students must effectively and correctly practice what they intend to do in the workplace to progress from one skill level to the next. This includes having course material that accurately reflects the information required by the employer. Collaboration between the institutions and employers is the first step in making these propositions a reality. The

stronger the relationship between the two, the more likely the student success goals will be achieved.

The participants shared their perspectives and ideas on how to improve classroom training instruction and how to incorporate more practical learning experiences at the institution and the employer. Although the participants agreed they were ready for their new roles, they still wanted more from the program. If those opportunities were available during their apprenticeship, they would have gained more hard skills, boosted their confidence, and felt more prepared. This is especially important and timely for the nuclear industry, which is desperately looking for new talent to fill its needs. These two components, along with work/life balance, should be at the forefront of planning the next phase of nuclear apprenticeships if longevity in the field is an anticipated goal.

Mentorship in the Workplace

The last theme, Mentorship in the Workplace, was developed from the participants' comments about instructors, managers, and others who went out of their way and dedicated time to assist the participants in their journey. Although there were no official mentorship programs with pair mentors and mentees, the relationship between those individuals and the former apprentices created a welcoming space with a nurturing environment that focused on academic success and workplace strategies. Previous research has highlighted the benefits of mentorship programs. Howe et al. (2023) reported that mentors help raise retention rates of new hires in various industries. Quew-Jones and Rowe (2022) showed that active mentorship contributed to higher achievements in both academic and professional settings. Lastly, studies have shown that apprentices who have a committed mentor or contact person have a healthy

school/work/life balance, which directly impacts their ability to persist in the training program and their career (Fabian et al., 2022). Instances of these scenarios can be heard in the participants' stories.

Mary spoke briefly about her access to mentors during her program. For her, the mentors she sought out were not only instructors, but employees with Contractor 1. She felt as if this was a bonus because she could ask them specific questions about the content and job both in class and at work, indicating that she would talk to them if she needed to. Mary gave a little more insight into her encounters:

> I would say [name redacted] was not only our professor, but she was also a good mentor to help us through it. I can say that she really gave her best effort and really wanted us to do well. Also, [name redacted], he works in health physics. He was very helpful as well. So all of them were very helpful, and they pretty much were good mentors.

Mary's reflection indicated that she had contacts available to assist with numerous aspects of the program. More importantly, she recognized that the mentors cared for her well-being and wanted her to reach her goals. This may have internally motivated Mary to continue striving in her program. These mentors were unofficial; there was no established program or set up between Mary and her mentors. However, if there was, then their influence on her learning and career accomplishments could have been even greater.

Kay's involvement with mentors paralleled some of Mary's. She also articulated how her instructors were valuable resources. She began by sharing, "I will say the teacher [name redacted] would take time out of her day or evening to help you if you needed extra help." A few moments later, she followed up with "[Name redacted] really gave us

extra studying if we needed it," and that she felt "very supported" by this mentor. The mentor's inspiration was so strong that Kay faced some challenges when her mentor switched to a new role. Kay disclosed, "It was a little difficult because [name redacted] was transitioning from working on site to working at Institution A at the time." This situation underscores the need for dedicated mentors. In a formal mentorship program, Kay would have been assigned to a new mentor when her initial mentor moved on to a new position. Doing so would have granted continued support and assistance throughout the rest of her program.

In Victor's interview, he specified that mentorship was missing from his program. He referred to the person in this role as a stationary counselor and even suggested tasks for them to help the apprentice with. When asked about the support that was missing from his employer, he said:

> Everybody's going through different things in life, and I feel like the cohort always varies in age, like, there is no specific age range that they're hiring people at. So, we're all going through different things and different stages of life. So, I guess, if anything, probably a more stationary counselor to help you throughout your everyday life and transitioning from, I guess you could say, regular civilian work to nuclear work, because there is a big transition in that.

This is an interesting take on mentorship. Victor was focused on having someone help apprentices establish a smooth work/life balance while navigating their new job in the nuclear field. This insight connects to other themes and theories in this study; work/life balance was discussed in Theme 1 as a key to ensuring progress and success in the training program. It also connects to the subtheme Familiarity under Theme 2. The

mentor could instill awareness about the job site, specific role, and the nuclear field as a whole, increasing the participants' prior knowledge before completing their preparation exercises. Having a mentor oversee students as they learn about the nuances of the nuclear industry could increase the apprentices' confidence levels as well, making the goal of closing the labor and skills gap even more attainable.

Jacob's recollection of mentorship seemed to align closely with what Mary shared. The major difference between the two scenarios is that Mary relied on instructors who were also nuclear employees, while Jacob referenced specific site employees. In each instance, both former apprentices had someone to contact when questions arose. Jacob remarked, "If I did have any assistance that was needed throughout the program, I was able to vocalize that to them, and they were able to find me the proper support." He then goes a step further:

> We had a facilitator, and he would regularly check up on us. We would do monthly one on ones, where he would kind of come in and check up on us, make sure everything's good, and then we would normally meet with our management team that would also kind of look into everything, ask us questions like "How we're doing" or if there's anything that they could offer to assist us. So, we were regularly checking in with management and our facilitator through the apprenticeship program.

This arrangement is the closest to a formal mentorship program described by the participants. Regularly scheduled check-ins gave the students a routine to abide by; they knew when to have their questions and comments ready to be shared with the facilitator. Also, this format allowed for questions outside of the check-in period, which Jacob

greatly appreciated. Expanding this structure to include dedicated mentorship activities and more frequent meetings could strengthen the relationship between the apprentices and mentors. In turn, the students could feel more confident as they work to complete their program, knowing they have that additional support.

James also engaged with employees of Contractor 1, who served as unofficial mentors. They were available to answer questions and provide support to apprentices who were assigned to work in their facilities. He did not seem to mind the fact that there was no formal mentorship program because he did receive the help he needed most of the time. For the record, these are the same people who would sometimes "brush his concerns under the rug" if they got too busy. Still, James was fond of the help received from them throughout the training program. He began by describing his interactions with his advocates:

> You had [name redacted], who knew the nuclear stuff, so he was a support. And then a couple of other people like [name redacted], and then [name redacted]. I think [name redacted] is in the background more, but if you ask her questions, or if you had questions you needed help [with], she was a good support, and actually helped me out in of the classes too when I had a little bit of difficulties and she showed me some tricks to help with that.

From there, he continued:

> They're more on the administrative side. But like [name redacted], she was at the Tritium facility. So, she did know a lot of stuff. And then [name redacted], I think she makes the questions for the tests. She has a little bit of insight to kind of guide you the right way.

From James's comments, it appears that these individuals were stepping out of their roles to aid James and his colleagues. While helpful, this approach can be hit or miss. For instance, Jacob mentioned that his concerns were often unanswered if his facilitator and manager were busy. If the administrators who assisted James get called away for more pressing tasks, the apprentices would be left without a person to contact. This further emphasizes the need for a proper mentorship program. Input from apprentices, higher education institutions, and employers could be combined to create a group of professionals with resources that serve the needs of every student, regardless of their age or background. Collaboration between the three parties allows for increased communication about improvements and student progress (Fabian et al., 2022; Howe et al., 2023; Quew-Jones & Rowe, 2022). The result of this joint effort should be increased motivation, self-efficacy, and confidence (Fabian et al., 2022; Smyth & Zimba, 2019).

Self-Efficacy Theory

The Self-Efficacy Theory by Bandura (1977) also ties into the theme of Mentorship. Two of its principles are used to connect the participants' stories to building self-efficacy and confidence. First, *Vicarious Experiences* is explored. This principle discusses how having a role model who exemplifies positive traits and success can make a person believe they are capable of achieving similar goals. Then, *Verbal Persuasion* is incorporated into the former apprentices' encounters. *Verbal Persuasion* reflects on how people react to hearing positive feedback and words of wisdom while completing a difficult task. When they hear good things about their performance, they are more likely to believe they have the necessary skills to succeed. Both principles bridge the efforts between apprentices and others (instructors or managers) to increase self-confidence.

Vicarious Experiences

Vicarious, as defined by the APA Dictionary of Psychology (2018), refers to the satisfaction obtained by viewing the experiences of others. The definition also states that *Vicarious Experiences* can reinforce fears in humans, or gratification can be nourished through watching the actions of others (APA Dictionary of Psychology, 2018). Having a strong, dedicated mentor who guides apprentices through tough times and continues to show support during the easy periods can serve as a positive vicarious experience. Not only are these individuals needed to champion apprentices during their program, but they are also desired, as indicated by this study's participants. Victor specifically asked for someone who could assist him "through everyday life and transitioning from…regular civilian work to nuclear work." James and Jacob spoke about the convenience and benefits of having facilitators and managers check in periodically. Jacob received prompt and accurate support when he had concerns. James not only got his questions answered, but he also obtained help with his class content and assessments. During his interview, he recalled his mentor "was a good support, and actually helped me out in of the classes… showed me some tricks to help with that." Mary and Kay both cited the use of instructors and trainers who served as unofficial mentors. These individuals gave the participants key study tips and the motivation to continue in their program, as expressed by Mary when she said her mentor "really gave her best effort and really wanted us to do well." All of these participants acquired guidance and inspiration from someone who cared about the apprentices and the completion of their program. Without these people, the participants may have had different confidence levels at the end of their training.

Each mentor mentioned by the participants was unofficial; they were managers, instructors, or affiliated facilitators who stepped in when help was needed. Although this was extremely beneficial, there was potential for more support and guidance during the training. An official mentorship program where each apprentice or a pair of apprentices is assigned to a mentor who specializes in their field and role could significantly boost the self-efficacy and confidence of their mentees. When these mentors spend time with the apprentices, they curate meaningful learning moments that serve as *Vicarious Experiences*. These moments, if positive, will boost the apprentices' self-beliefs about what they can achieve (Lopez-Garrido, 2025). The mentors also profit from this relationship. Howe et al. (2023) showed that mentors have higher rates of satisfaction when actively involved in mentorship opportunities. In turn, this may inspire them to be even better mentors, creating a cycle that continues to lift self-confidence in their mentees. Whether official or not, the participants found that having a support person was a key part of their success. To expound on this, a formal system should be in place to establish dedicated meeting times and target goals. Doing so may increase the apprentices' self-confidence and contribute to a lifelong career in the nuclear field.

Verbal Persuasion

Verbal Persuasion can go hand in hand with *Vicarious Experiences*. The former apprentices shared moments of interacting with unofficial mentors, speaking about how their facilitators and instructors encouraged them throughout their training. Mel mentioned having "knowledgeable and supportive" instructors who assisted in his learning and adapting. Jacob called attention to the monthly check-ins from his program that allowed his cohort to voice their concerns. During those instances, kind words and

reassuring gestures were exchanged. When cheerful, pragmatic confirmations are spoken unto people, they internalize the statements and use them to increase their faith in their abilities (Lamarche et al., 2014). Per the Self-Efficacy Theory, the increase in their internal beliefs will lead to higher self-confidence over time (Bandura, 1977). As emphasized throughout this section, a structured mentorship program will increase the interactions between apprentices and their mentors, creating more pleasing verbalizations for the mentees. Employing a mentorship program that cultivates a spirited effort and unwavering advocacy from trained professionals in the nuclear field will likely spearhead a substantial amount of growth in self-confidence in future apprentices. This growth is needed, as preparing for a fulfilling career in the nuclear industry starts with self-confidence to know one can succeed in such a thrilling, fast-paced environment.

Findings Overview: Research Sub-Question 2.2

Research question 2.2 is addressed by the theme of Mentorship in the Workplace. Many participants sought out instructors or managers to serve as mentors as they navigated their apprenticeship program. Providing clarification on complex tasks and modeling professional behavior that is expected in the field are two ways that the participants felt strengthened by their mentors. These actions, and the positive results that arose from them, demonstrated the need for devoted, endorsed mentors within the program. These mentors have the means to influence their mentees through *Vicarious Experiences* and *Verbal Persuasion*, both of which are key ideologies of the Self-Efficacy Theory (Lopez-Garrido, 2025). Using this theory to develop a mentorship program should yield favorable results for the higher education institutions, apprentices, and employers, as each stakeholder will be involved in its creation. Lastly, setting devoted

meeting times, customized goals for each apprentice, and scheduling shadowing windows with the mentors are reliable ways to boost self-confidence through *Vicarious Experiences* and *Verbal Persuasion*. These initiatives will foster improved skills, strong work ethics, and enhanced confidence for future apprentices and employees of the nuclear industry.

Conclusion

After transcribing and analyzing the participants' interviews through In Vivo coding, pattern coding, and thematic analysis, four themes were developed to showcase their experiences and opinions about their apprenticeship program. These themes cross an array of topics, indicating that the training program had an impact on various parts of their lives and learning journey. The first theme was The Impact of Financial Support on Work/Life Balance. In this theme, participants fell under two umbrellas: Financial Stability or Financially Challenging. While many of the participants cited financial stability as their reason for pursuing a career in the nuclear field, there were also some who had financial troubles during their apprenticeship. Not being paid as a Full-Service Employee took a toll on some of the former apprentices. One even stopped out of her program due to the financial stress. However, she did remain employed in the nuclear industry because she was able to receive pay as an FSE once she quit the program.

The next theme was Many Factors Influence Workplace Confidence. This theme highlighted the activities that contributed to an increase in self-confidence in the nuclear field. Listening to family and friends' stories about employment at Site 1 encouraged many of the apprentices to see work in this industry. Getting first-hand details about the pay, benefits, and culture of the contractors lured them into applying for the

apprenticeship in hopes of a more stable career. Quickly learning the skills needed to be a RadCon inspector or Production Operator also made the participants feel more comfortable with taking on a job in the nuclear field. Described as an increase in aptitude, many of the interviewees felt as if mastering the content needed for their role before entering the position as a non-apprentice made them even more prepared for the job. This was especially noted as some participants worked alongside those who did not complete an apprenticeship program, and there was a stark difference between what each group knew upon the first day. On a similar note, the former students were exposed to the work ethic of the site. Being immersed in the contractor's safety culture and knowing what is expected of workers from day one made the participants feel more knowledgeable and prepared to join the workforce. Combining these three factors created a significant advantage for apprentices who successfully completed their program; they now have a solid base of what the mission of the site is, the skills needed to carry out the work, and the high standards of their employer. With this information, apprentices felt more prepared than ever to join and remain in the nuclear field.

The third theme was Improving Academic Experiences. Although the participants shared details about increasing their aptitude in the previous theme, they still shed light on possible ways to make the classroom portion of the training more relevant and valuable. For example, consistent instruction between technical schools and roles within each contractor was suggested. This could be in the form of aligned study guides or instructors who are teaching from the same material. The participants also desired instructors who had experience in the nuclear field, specifically in the positions that the cohorts were training for. From this perspective, the skilled instructors could provide

more hands-on learning assignments and assessments. The former apprentices asked for more applicable learning strategies, and they want them earlier in the programs. The benefits of having experiential training exercises and knowledgeable instructors are positive. Although it may be challenging to arrange the training exercises due to the nature of the nuclear field, having apprentices practice hard skills in a real-life setting will prepare them for the job site, boosting their confidence. Instructors from the nuclear field can give job-specific examples in the classroom portion of the apprenticeship. Both requests from the participants are sure to increase the aptitude and understanding of apprentices aspiring to succeed in this industry.

Finally, the last theme was Mentorship in the Workplace. Simply stated, the participants mentioned receiving help and guidance from instructors and managers during their training courses. Analyzing these statements led to the conclusion that the apprentices would like to have a committed mentor to be there with them during each phase of the apprenticeship. Having a dedicated person to explain the complexities of the job or to vent to could make a significant difference in an apprentice's experience. Instead of hoping a manager or instructor is available, the mentees could have scheduled meetings with the mentors, allowing for a more formal and streamlined process.

Each of these themes describes an aspect that can be added to the current structure of the apprenticeship programs. Creating more financial stability will improve the apprentices' work/life balance, as outlined by the Boundary Theory. Continuing to build upon the factors that have already been confirmed as confidence amplifiers will enhance the quality of apprentices entering the nuclear workforce. The Self-Efficacy and Skill Theories emphasize this by connecting *Physiological Feedback* and *Performance*

Outcomes to how people build motivation and confidence. Performing tasks and being able to persevere through difficult situations mentally builds confidence in individuals learning new skills. The *Concept of Cognitive Control* from the Skill Theory is related to the Self-Efficacy Theory because they both put the innate response to the trigger on the individual. Being able to do so shows that a person is more capable of learning skills, leading to an eventual increase in confidence. The academic experiences are also related to *Performance Outcomes*, as indicated in the Self-Efficacy Theory. Students use their results on assessments such as tests and active learning projects to gauge their knowledge and determine their readiness to take the next step in their education or career. Lastly, mentorship programs would increase the opportunities for positive *Vicarious Experiences* and *Verbal Persuasion*. As part of the Self-Efficacy Theory, these principles explain how seeing a role model, such as a mentor, navigating the career field, will inspire apprentices to be successful like them. Additionally, the mentor should provide encouraging words to their mentee, elevating their mentee's self-confidence. Each theme, subtheme, and supporting theory supports the experiences and stories of the study's participants. Adding in their requests and building on the praised aspects of the apprenticeship program allows for more opportunities to strengthen the self-confidence of future nuclear employees.

Chapter Summary

Chapter V pulled together the responses from the participants' interviews and presented themes that elaborated on their experiences in the apprenticeship program. Suggestions for maintaining or improving methods of developing self-confidence were presented for each research question by connecting the themes and subthemes to supporting theories and prior research. Statements from the interviewees reinforced each

recommendation. The chapter ended by reviewing the theories and themes while relating them to confidence-building practices. This layout leads to a transition into Chapter VI, where the discussion and conclusion tie these suggestions to real-world practices and outline future research directions.

Chapter VI

Discussion and Conclusion

The purpose of this comparative case study was to provide key information about building confidence and career retention factors in apprentices. The findings from this study have implications to higher education institutions, businesses, and other constituents as they utilize apprenticeships to quickly supply adequately trained workers to the nuclear industry to assist in closing the skills and labor gap. Areas in this study centered around work/life/home balance and support from the academic institutions and employers. The study's theoretical framework employs a constructivist worldview, where researchers believe that meanings are developed as people interact with the world around them (Creswell & Creswell, 2018). These meanings are then explained by the researcher from the participants' point of view (Creswell & Creswell, 2018). To do this, principles and concepts from three theories were connected to the study's purpose and research questions.

The first theory was the Boundary Theory by Nippert-Eng (1996) and Ashforth et al. (2000). In this theory, transitions between work, home, and other domains were explained and categorized by the amount of integration and separation each domain has. The strength of the boundary helps determine how much control an individual has over separating or blending components of their life, which impacted their overall satisfaction at work and home (Desrochers & Morgan, 2021). The next theory was Bandura's (1977)

Self-Efficacy Theory, which suggested that confidence is affected by motivation and self-efficacy. Four principles were established to defend practices that influence self-efficacy and confidence. They are *Vicarious Experiences*, *Physiological Feedback*, *Verbal Persuasion*, and *Performance Outcomes* (Lopez-Garrido, 2025). Lastly, Kurt Fischer (1980) used his Skill Theory to arrange concepts that exemplify how learning occurs in various people. The *Concept of Cognitive Control*, *Nature of Skills*, and *Concepts for Defining Levels and Transformations* all showcase how skill learning involves several complex levels and conscious thinking from each person. These three theories were the foundations of the comparative case study. With this approach, I strived to understand the experiences of former nuclear apprentices and uncover the factors that strongly shaped their confidence levels and desire to persist in a nuclear career. The stories shared by the participants were used to voice praises, concerns, and suggestions for forthcoming nuclear apprentices to employers and higher education institutions to create an even more beneficial training program.

Research Questions

Two research questions, as well as two sub-questions for the second research question, were developed to learn about the influences on self-confidence from different aspects of the participants' apprenticeship programs. Each question was connected to and supported by at least one theory from the theoretical framework. When answering these questions, I described the former apprentices' journey through their training program and also suggested methods for improvement based on their responses. The research questions for this study were:

1. What are the lived experiences portrayed by the graduates of a nuclear apprenticeship program?
2. How does engagement in a nuclear apprenticeship program affect graduates' confidence in their ability to succeed in their nuclear careers?
    2.1. How do graduates depict the impact of variety and utilization of academic resources available throughout the apprenticeship program on their level of confidence in job performance as they transition to their careers in the nuclear field?
    2.2. How do graduates portray the influence of support strategies provided by their employer for the duration of the apprenticeship program on their confidence levels of occupation-related duties as they prepare for their career in the nuclear field?

Interpretation of Findings

After analyzing the participants' data, four themes emerged that highlight the overall findings. Some of these themes included sub-themes. Each theme and sub-theme were outlined in the previous chapter and supported with theories. Here, the research questions are answered while showing connections to the themes, subthemes, literature, and theoretical frameworks.

Research Question 1: What are the lived experiences portrayed by the graduates of a nuclear apprenticeship program?

Lived experiences can take on various meanings when described by several people. However, this question aimed to understand the day-to-day operations of the apprenticeship program as well as the transition from their program to their home life and

other areas. When listening to the participants and reviewing their interviews, one central theme and two subthemes were generated. The main theme was "The Impact of Financial Support on Work/Life Balance," and the two subthemes were "Financial Stability" and "Financially Challenging." Using these themes and subthemes, the research question can be adequately answered.

While other aspects of the apprenticeship journey did surface, the financial piece seemed to have a more lasting and influential impact on the participants. Finances were listed as a reason to join and remain in the nuclear field. Some participants were financially stable throughout the entire program. For instance, James and Jacob were hired as Full-Service Employees (FSE) during their apprenticeship. This means they were paid for 40 hours of work each week and immediately had access to benefits like healthcare and vacation time. Both Jacob and James were appreciative of this incentive. They were unaware that other apprentices did not share that experience until they participated in the focus group interview. James stated that he "definitely couldn't have done it without getting paid." Jacob went into a bit more detail, citing:

> I've met a couple of the students who came through, and they were saying they were having to work like second or third jobs, you know. Not only go to school, but do the program and also have another job. So, you know, with us being able to just do everything and get paid for that is a huge advantage and a lot less stress; that's something we don't have to deal with. So, keeping that a part of the program because that allows them to focus solely on their job and not have to worry about additional things going on to meet their needs in life.

These comments show just how much apprentices relied on financial support during the training. For James and Jacob, it was beneficial to have the support supplied by their employer, eliminating the need to seek out and hold other jobs. Doing so allowed the former apprentices to concentrate on their academics and workplace training.

On the other hand, many of the participants struggled financially through their apprenticeship. This was due to the fact that apprentices were not paid for 40 hours of work each week; these cohorts were labeled as Limited-Service Employees (LSE) during their time. Therefore, in addition to taking classes and working at Site 1, these apprentices often had to seek outside employment to make ends meet. This decision was extremely challenging for Kay, who did not complete her program due to the financial struggles and poor work/life balance. She believed she might have completed her program if financial support had been available. She stated:

> I think I would have actually finished my program if that was it, because I was going through the apprenticeship, going to school unpaid…So, I feel like that would help better with my work/life balance and would have just been better all around.

Additionally, Victor remarked on how tough finances could be during his program. He concluded that the program was good for him, "outside of the need for more money". He was able to maintain a decent work/life balance after making adjustments to his lifestyle. Mary juggled different activities to establish financial stability during the program. She worked as a facility assistant at recreation centers in the city to make ends meet while she was going to school. Her work/life balance was possible due to the understanding nature of her supervisors. Mary shared, "It balanced out. I also had supervisors that were willing

to work with me and work with my schedule so that I can work and go to school…I appreciate them being understanding." Without the kindness and flexibility of her supervisors, Mary's work/life balance could have suffered, leading her to potentially make lower grades or stopping out of her program.

Based on the responses from the participants, finances were more important to their success and work/life balance than initially perceived at the beginning of this study. It directly impacted the former apprentices' ability to prioritize their academic and job obligations without worrying about duties at home or a secondary place of employment. The lack of segregation between work and home life ties into the Boundary Theory. Participants with a poor work/life balance were not able to establish boundaries amid their home and work domains. While some level of integration is fine for work/life balance, it can cause stress when it is not properly managed (Piszczek & Yestrepsky, 2024). Kay's story is a prime example of this, as she declared:

> I couldn't go to work for 10 hours to 12 hours, then drive all the way to Institution A for night school, then drive all the way home, especially because I ended up getting pregnant, and it was just way too much.

A poor work/life balance is bound to not only affect the employee, but their friends and family as well (Piszczek & Yestrepsky, 2024). With this knowledge, future apprenticeship programs should aim to supply trainees with the tools and options to establish their desired levels of integration and separation.

On another note, some former apprentices had a well-suited work/life balance and did not worry about time constraints for their responsibilities during the apprenticeship or at home. When a proper balance is achieved, employees have higher rates of job

satisfaction and are more likely to reach their personal and professional goals (Piszczek & Yestrepsky, 2024; F. Wang & Shi, 2023). James expressed his fulfillment with his capability to meet the program's expectations while still spending time with his family. He recollected:

> It [the program] really gave me time and chance to do the school work at school…I did have to study at home, but it wasn't as much…I still had time to go to my son's football games and basketball games, and in fact, I saw for the first time, probably in my whole life, every single game that he went to. So that was nice."

Jacob echoed that sentiment and went on to mention that his cohort had plenty of opportunities to study during the day, so they could have more time to direct their attention to other tasks outside of the program.

The lived experiences of the six participants centered around starting or maintaining financial stability. While some of the former trainees were able to achieve their financial goals from the beginning, others grappled, and their progress in the program was impacted. The various structures of the apprenticeship programs led to differing outcomes and situations for each cohort. The risk of being stressed or not finishing the training was a possible result for several former apprentices. Combining this feedback with the Boundary Theory gives researchers, higher education institutions, and businesses the tools needed to understand the participants' points of view. Through these means of understanding, future training programs can be structured with work/life balance and financial security in mind.

Research Question 2: How does engagement in a nuclear apprenticeship program affect graduates' confidence in their ability to succeed in their nuclear careers?

Each of the study's participants gave examples of what, if anything, contributed to their increase in confidence about beginning their career in the nuclear field. Some of the driving forces were unexpected and not explicitly stated as a confidence booster. Collectively, the listed contributions included internal, cognitive changes and external impressions from various individuals. At the end of the data analysis, it was determined that a suitable theme for this research question was "Many Factors Influence Workplace Confidence." Under this theme were three subthemes, "Familiarity of Site," "Increase in Aptitude," and "Developing Work Ethics," which describe the three factors identified as confidence builders. According to the data collected in the interviews, having prior connections to Site 1, mastering the classroom and workplace material, and understanding the work standards of the nuclear field prepared the participants for long-term careers in the nuclear industry. These elements are outlined below.

It has been established in this study that many of the participants sought a career in the nuclear field due to the financial benefits associated with these positions. However, another aspect that drew their attention to this industry was the positive reflections from family members and friends. Before applying for and beginning the apprenticeship, some of the former apprentices were approached by loved ones and encouraged to learn more about what Site 1 and its contractors had to offer. These words of wisdom included information about their safety culture, work hours, various positions, leadership opportunities, and monetary gains. Mary, Kay, Jacob, and James all had these conversations with family and/or friends before looking into nuclear careers. Mary had a

brother who worked on site and connected her to a fellow Radiation Control (RadCon) worker. Kay's husband worked at Site 1, too, and she had several friends tell her to "Try for RadCon." Likewise, Jacob had family and friends who were employed at Site 1, and he enjoyed seeing how their work culture and knowledge were applicable at home. Lastly, James spoke of his friends who loved their careers at the site. Knowing what to expect about the possible positions and programs gave them more insight into Site 1 and the nuclear world, putting them a step ahead of others. This small but significant advantage improved their confidence and thoughts about succeeding on this new professional journey.

Seeking employment in the nuclear field can be a daunting task for some individuals. There may be questions about the types of positions available at a nuclear site and whether it is truly safe to work in that environment. Once the apprentices began their program, they quickly realized that there was much to be learned about their new professions. Courses such as math, nuclear physics, and heat transfer were listed in the curricula, while tasks such as dressing out, inspecting electrical equipment, and surveying for radiation were part of the day-to-day agenda. By the end of the program, most participants had successfully mastered all of the requirements needed for their positions. This increase in aptitude served as a massive confidence enhancer for those individuals. The former apprentices shared that they had an advantage over others who did not participate in an apprenticeship program, with Jacob stating that the program "gave us the foundational tools in order to help us identify and kind of hit the ground running." He made a specific comment about how he knew what to expect versus those who were hired through traditional means:

> I now have that skillset to do the job and or navigate it appropriately, whereas some of these guys just came in like you said, not knowing what they were going to be doing and just having to kind of learn the skills as they were actually learning the job.

Kay, who did not complete her apprenticeship, still felt as if being in the program gave her a head start compared to others. She gained tremendous skills in math and was prepared for the major exams that Contractor 1 administers every 2 years. Mary noted, "The training that I got from Institution A pretty much prepared me for the training that I got as an LSE apprentice." Lastly, Mel expressed, "The actual apprenticeship program did help [me] retain important and pertinent information." Participating in the nuclear apprenticeship gave the study's participants the opportunity to gain technical skills before being placed directly in the new positions. Knowing ahead of time made them feel more ready and confident to do their jobs, especially once they compared themselves to those who did not have the same training opportunity. Being confident in oneself due to content mastery and job-site experience before completing the program sets individuals up for higher success in a field that requires many specific hard skills.

The last piece of the program that influenced graduates' confidence was the acquisition of soft skills needed for their new positions. Coined as work ethic, the participants were exposed to the high standards of their new employer early in the program. Specific grades had to be maintained, and punctuality was critical during the workday. Observing and understanding these expectations influenced how the former apprentices viewed their position, employer, and responsibilities (Pantelakis, 2023). Many of the trainees appreciated the approach in which they were introduced to the

school's and contractor's expectations. Mel remarked that, even though it felt like "modern-day slavery" because he had to learn as much as he could in 7 weeks, he understood that learning the content "was put on us as students to succeed." Through his individual interview, Victor added, "It really increased my ability to perform jobs on site, or just in general, just because of the level that they hold you to." Victor's statement is a testament to knowing how Contractor 1 expects its employees to operate, which gives him great power in achieving his goals and being prepared for his position. Another example of using work ethics to be equipped for the profession is from James. He initially proclaimed that "It [the program] gave me a good idea of a lot of people's work ethics." Then, he went on to say, "That work ethic that you do in school, kind of, you know, goes further into the job itself." Understanding the work ethic and requirements of his employer built his confidence and even allowed him to support himself when assistance from his supervisor was not available. James went on to complete his apprenticeship program and is thriving in his career.

The Self-Efficacy Theory by Bandura (1977) supports this research question and the findings from the participants' responses. Many techniques can be implemented to strengthen self-efficacy and motivation, which corresponds to self-confidence (Lopez-Garrido, 2025). Two in particular stand out for this theme. *Physiological Feedback*, which refers to managing moods and mental perspectives during tough times, can explain how the participants built their work ethic traits and used the new skills to navigate through the program's challenges (Lopez-Garrido, 2025). For example, James, Mel, and Victor all mentioned having an "adjustment period" where they had to learn the flow of the institution and their employer. More specifically, James had encounters where he had

to answer and solve his own questions and concerns. He thought back to a time when he needed his managers, but when he would reach out to them, his concerns "got brushed under the rug." Instances like these required James to use grit to persevere. Grit is the pursuit of a goal despite setbacks (Duckworth & Gross, 2014). Grit directly impacts self-efficacy, which correspondingly impacts academic achievements (Alhadabi & Karpinski, 2020). Each of the former trainees expressed some characteristic of grit as they completed their program. The physiological capacity to be mentally and emotionally mature during challenging moments underscores how the Self-Efficacy Theory elucidates the former apprentices' confidence building.

Performance Outcomes stand out as another principle of the Self-Efficacy Theory connected to the findings of this study. The participants' increase in aptitude can be attributed to watching their instructors, classmates, and coworkers perform job and classroom-specific skills (Bandura, 1977; Lopez-Garrido, 2025). Interacting with those as they complete a task is the entire premise of *Performance Outcomes*. There are a few examples of this from the former trainee's responses. Many of them talked about using a tutor to master the course standards. Mary, Victor, James, and Jacob each expressed how a tutor was "always available to help." There were times when managers assisted students. Kay's supervisor worked with employees who failed assessments, allowing them to study and "try again." Finally, instructors, who doubled as mentors, took time out of their day to help their students succeed. Victor, Kay, and Mary shared cases of instructors going above and beyond. Victor's instructor held learning sessions after class for those who were struggling. Kay and Mary's source of help was an instructor who was employed at Site 1 as well. She gave them extra tricks and tips to do well on both their

exams and practicals. Both participants appreciated her guidance and gave her credit for some of their accomplishments in their careers.

The Skill Theory by Fischer (1980) ties into workplace confidence, too. The *Concept of Cognitive Control*, which is one of three ideas of the Skill Theory, has similarities to the *Physiological Feedback* principle of the Self-Efficacy Theory (Fischer, 1980). It states that individuals control how they think and act in certain circumstances (Fischer, 1980). Like *Physiological Feedback*, this principle places the responsibility of learning on the students. They are able to make conscious decisions about how to move forward when learning a new skill in a difficult situation. As the participants mentioned in their interviews, there were times when immediate help was not available, or they had to persist through long days of class and work. While some participants were able to overcome their challenges, others, like Kay, could not, and eventually left her program. Decisions like Kay's have a lasting impact on gaining new skills and applying them to new scenarios. Under the *Concept of Cognitive Control*, apprentices must realize that they have the ability to choose how to proceed through every juncture of their training and that the outcomes will be a result of those choices.

Engagement in a nuclear apprenticeship program has a positive effect on graduates' confidence levels. Participation in a training program of this structure exposes apprentices to aspects of their new positions and field that they may not have otherwise studied until they were well immersed in the role. Mastering the instructional material at the higher education institutions and then applying the concepts in the workplace allowed apprentices to not only practice what they had learned but conjointly gain a deeper understanding of their job responsibilities. The same can be said for those who intensified

their work ethic characteristics. They are aware of what their employer expects before they set foot in the facility. Unlike other employees who are hired through typical procedures, the apprentices can decide if the standards are too high early on in their careers. Both of these aspects serve as a way to increase the workers' confidence levels because they have more insight into their nuclear position than others. The additional information provided by family and friends about how working at the site is beneficial encourages confidence growth. The more the apprentices know about the institutions, contractors, nuclear industry, and their specific positions upfront, the more likely they are to feel prepared for their roles and maintain a long, prosperous career in the nuclear field.

Research Sub-Question 2.1: How do graduates depict the impact of variety and utilization of academic resources available throughout the apprenticeship program on their level of confidence in job performance as they transition to their careers in the nuclear field?

With academics being approximately 50% of the apprenticeship program, the participants spent a great deal of time in the classroom at the higher education institutions. Doing so gave them plenty of opportunities to interact with the school's resources, such as the library, tutoring center, or student center, and their instructors. Within these interactions, former apprentices were able to discern positive and negative components of the school's structure. Listening to their feedback prompted the generation of the next theme, "Improving Academic Experiences." Although the prior trainees indicated feelings of preparedness for their nuclear careers, there were many suggestions about ways to make the program even more effective when teaching the content. The recommendations led to two subthemes, "Need for Consistent Instruction" and "The

Desire for Hands-On Learning." Participants' responses clearly acknowledge that having better trained instructors and more opportunities to apply practical knowledge would have improved their journey at the technical colleges.

The "Need for Consistent Instruction" transpired from the participants' experience with their instructors. While many instructors were excellent and went above and beyond their duties, some fell short. Two examples of the disappointing performance were given. In the first situation, instructors seemed to be unaware of either what the apprentices were studying for, or what their new careers entailed. While they were content experts, they did not have the nuclear field experience to apply the lessons to the apprentices' jobs. This created confusion and frustration for those in the program. James said, "It's a little difficult for the teachers who never been there who don't know themselves what's going on to try to teach us." Jacob agreed, stating that "whenever we would get a course, the teacher was also kind of learning the material in a way that we had to learn it as well."

Several of the interviewees suggested the same solution to this problem: Hire instructors from Site 1 who have industry experience to teach the courses at the technical school for a certain time period. Mary, who studied RadCon, verbalized her thoughts by declaring, "I don't know if you can recruit someone to do that, but that might be helpful because it's somebody who's been in the field, who knows what to expect, and can show you exactly how it's done." Similarly, Jacob emphasized that "maybe if we had teachers who were already knowledgeable in the subject, possibly facilitators from the Site themselves teaching the content, that it would have helped to flow a little bit better." He doubled down on this opinion by feeling:

> …like having the same teacher, maybe through some type of contract where, you know, they're locked in for X amount of years, X amount of classes. That way, they're kind of more knowledgeable about the classes, and the flow can be a lot better.

It is evident that the former apprentices did not appreciate the shortcomings of some of their instructors. The fact that the participants noticed their newness to the job and material indicates just how much some of the instructors were struggling. Thankfully, most of the apprentices were able to continue through the program and graduate.

Another topic related to consistent instruction came up during the interviews, namely that the participants thought it would be a great idea for the contractors to provide the institutions with the same study materials and curricula so each apprentice, regardless of what school they attended, would learn the same content in nearly the same way. Kay and Jacob, who attended different technical schools and are employed in different roles with the same contractor, expressed, "It should be stuff that they give you to study. So, I do think that should be consistent," and "I think it would be okay for them [the contractors] to have their own particular study guides and stuff," respectively. These suggestions would benefit the instructors and students because each part would know what needs to be learned in each class. The curriculum could be streamlined, eliminating the potential for irrelevant information to be taught or for pertinent information to be omitted.

The next factor that would improve instruction is the use of hands-on learning practices. The apprenticeship's structure was designed to get people new to the nuclear industry well-acclimated to the environment before sending them into the field.

Experiential learning techniques are an excellent way to achieve this goal (Mindham & Schultz, 2019). However, participants felt as if the hands-on portion of the apprenticeship came too late towards the end, or there were not enough opportunities to turn conceptual knowledge into applicable procedures. Mary stated, “The only thing I wish that Institution A would have done was, instead of specific classes where you learn about the instruments, I would say, introduce them early on.” Jacob agreed because he believed that “The actual work itself is something that you can’t really get your hands on until you get out there because of what we do and how unique it is.” James described himself as a kinesthetic learner and said, “When we did the classes, you know, they would describe stuff, but actually seeing it, visually, or having your hands on, I think that will be a lot better for me.” He equally desired more hands-on assessments instead of definition or recall questions. Being able to show what he learned through actions would have been easier for him. Kay suggested using active learning techniques during job-shadowing sessions for all the apprenticeships to get trainees prepared for the day-to-day tasks quickly. The participants' comments demonstrate that they are serious about their education and want to take advantage of every opportunity to improve their technical skills. With this study and their help, that may be a reality for future apprentices.

The Self-Efficacy Theory’s principle of *Performance Outcomes* also correlates with this research question. Watching classmates perform interactive activities and learning from their mistakes and correct actions can increase the apprentices’ internal motivation (Bandura, 1977). As explained in the theory, motivation is connected to self-efficacy and self-confidence (M. Wang & Liu, 2023). Several studies have shown that the higher a person’s self-efficacy, the higher their self-confidence will be (Hamamcioğlu &

Ferit, 2024; Pandya, 2021; M. Wang & Liu, 2023). This is even more true when hands-on practices are involved, as seen in Ko et al.'s (2023) study. Sharing the concepts of the Self-Efficacy Theory with apprenticeship stakeholders may draw their attention to increasing the amount of participatory exercises in their programs.

Overall, the participants depicted that the academic institutions supplied many helpful resources for them, such as tutors, opportunities to study with classmates, outside study resources, and more. However, to make the learning experience truly beneficial and to generate greater self-confidence, more was needed from the instructors. Finding enthusiastic, educated teachers with a nuclear background to lead the courses could have resulted in a higher increase in aptitude, self-efficacy, and motivation. Moreover, the addition of more practical methods and assessments at the institutions and the site would have given the apprentices a deeper understanding of the concepts covered in the classroom. These changes, coupled with the practices that were deemed valuable, can increase self-confidence among future trainees, encouraging them to stay in the nuclear industry for years to come.

Research Sub-Question 2.2: How do graduates portray the influence of support strategies provided by their employer for the duration of the apprenticeship program on their confidence levels of occupation-related duties as they prepare for their career in the nuclear field?

The final research question asks about the participants' perspectives on employer-provided support systems. Three core supports were captured in the interviews. First was financial support and employee benefits for those in particular cohorts. The second was ample time for student-led study sessions with job-specific study material. The third and

most outstanding of the three was the use of mentors. Hearing the participants speak about finding people to rely on at the job site led me to develop the fourth theme, "Mentorship in the Workplace." What I gathered from their interview transcripts is that the former apprentices appreciated being heard and feeling seen throughout their training program. However, the relationship between the participants and their mentors was student-initiated. None of the apprenticeship programs had a formal mentorship program, and that seemed to be doing a disservice to the students. An established program could escalate the level at which trainees felt prepared for their new careers by supplying a dedicated person who knows the apprentice's strengths and weaknesses and is available for meetings at dedicated times during the program.

Kay and Mary, who both studied RadCon, spoke of instructors at their institution who were RadCon employees at Site 1. These instructors who served as unofficial mentors made Kay and Mary feel cared for. Mary recalled how her mentor "really gave her best effort and really wanted us to do well." Similarly, Kay's mentor "would take time out of her day or evening to help you if you needed extra help." Conversely, Victor noted that he did not have a mentor at all. He desired one and described that he wanted a "more stationary counselor to help you throughout your everyday life and transitioning from, I guess you could say, regular civilian work to nuclear work, because there is a big transition in that." James and Jacob had mentors who were employees of Contractor 1 as well. However, there was no defined mentorship program for their cohorts either. Both latched on to individuals like the facilitator and supervisors to ask for guidance and resources.

A formally established mentorship program would have been beneficial for each apprentice at some point during their training. A dedicated mentor would get to know their mentee and schedule regular check-ins to monitor progress and resolve concerns. Conversely, the mentee would have a point of contact for emergencies or pressing questions. The relationship between a mentor and mentee is usually strong, and it helps to foster a healthy school/work/life balance and higher achievements in both the school and the workplace (Fabian et al., 2022; Quew-Jones & Rowe, 2022). Additionally, effective mentors elevate the new hire retention rate across several industries, which would greatly contribute to closing the labor and skills gap in the nuclear industry (Howe et al., 2023). Collectively, these points should encourage constituents of nuclear apprentices to consider implementing an official, regulated mentorship program to further aid trainees with gaining new skills, drawing from a positive role model, and increasing the quality of their work/life balance. These improvements, if implemented correctly, will result in greater self-confidence in the apprentices (Lejonberg & Tiplic, 2016).

Vicarious Experiences, a principle of the Self-Efficacy Theory (Bandura, 1977), focuses on how role models can exemplify favorable traits, leading others to believe they are capable of achieving the same goals as that person. A mentorship program can instill this principle in the nuclear apprentices by partnering each participant with someone who was once in their position and has climbed to greater heights. A mentee could be motivated by their mentor's story and use that as inspiration to do well in their program and nuclear career. The *Vicarious Experiences* created by the mentor enhance the mentee's self-beliefs, leading to more self-efficacy and more workplace confidence (Lopez-Garrido, 2025). *Verbal Persuasion*, the final principle of the Self-Efficacy Theory

(Bandura, 1977), pertains to when individuals internalize positive feedback during tough tasks to mean that they have what it takes to master that situation (Lamarche et al., 2014). This concept aligns with mentorship and *Vicarious Experiences*. When a mentor speaks positively to their mentee, the mentee's self-confidence increases over time (Bandura, 1977). Since mentors are expected to be with their mentees during the entire program, there is plenty of time for mentees to develop self-confidence through these actions. Principles of the Self-Efficacy Theory should be a core component when employers are designing mentoring programs for their new team members.

The graduates and participants of the nuclear apprenticeship programs showed satisfaction with the way the employers supported their transition into the nuclear field. Positive comments about study tools and company benefits were noted, but the conversation was dominated by the mentors who assisted students throughout the training. While these mentors were self-acclaimed and not appointed, they still helped the trainees in various areas, making them feel more comfortable and prepared in their new role. Only one of the study's participants asked for a formal mentorship program, but studies show that mentors have a positive influence on mentees (Fabian et al., 2022; Lejonberg & Tiplic, 2016; Quew-Jones & Rowe, 2022). With student and employee input, a newly created mentorship program should have at least the same effect as the unofficial mentors, if not more.

Implications for Practice

The answers to the two research questions and two sub-questions under research question two provide suggestions for implementation when preparing for the next cohort of nuclear apprentices. These implications can be grouped as recommendations for the

employer, the institution, or both. Incorporating these ideas into the training programs will assist in bridging the gap between classroom-based theory and the complex realities of the nuclear work environment. The suggestions emphasize how critical these support strategies from each entity are in shaping apprentices' immediate training experiences and laying the foundation for long-term occupational confidence and career development. In time, these adjustments will have a positive impact on closing the labor and skills gap in the nuclear field.

Recommendations for Employers

Research Question 1 implies the need for apprentices to have the ability to establish or maintain financial stability. Hiring apprentices as FSEs instead of LSEs is a step that has already been taken towards this goal. This change provided apprentices with access to full benefits, including paid time off and health insurance, helping to create a suitable work/life balance for them. The findings from this study support the decision to transition workers from FSEs to LSEs. Although the modification occurred before my study commenced, the participants shared their thoughts and experiences about working with or without full-time pay and benefits. Those who were hired as LSEs struggled considerably more than those who worked at FSEs; constituents of the apprenticeship programs noted that the absence of financial support and stability contributed to a lack of motivation and impeded apprentice success. Continuing to pay apprentices a livable wage for 40 hours of work is recommended to sustain the financial flexibility that has improved the experiences of individuals in the training programs. Additionally, future programs should strive to achieve the same level of financial freedom that has been incorporated into the existing apprenticeships. Regardless of the structure, apprentices need to be

adequately paid for their time as workers and students to eliminate a potential barrier to their work/life balance, career success, and confidence growth.

The responses and themes for Research Question 2 were generally positive, leaving very few suggestions for changes from the participants. Their self-confidence was impacted by several factors that can remain in future sessions of the program. Increasing apprentices' aptitude in their soft and hard skills is one of the program's main goals. While there are ways to intensify that gain, it is reassuring to know that previous apprentices felt knowledgeable and prepared to move forward in their nuclear career. Another factor was learning the work ethic traits that are needed to thrive in the nuclear industry. This aspect of the program should stay as it helps apprentices understand the culture of Site 1 and their contractor. Punctuality, safety expectations, and leadership skills all benefit the apprentice; the earlier they are exposed, the more likely they are to succeed (Mazzetti & Schaufeli, 2022). Participants reported feeling more confident and prepared in these areas compared to those who did not participate in an apprenticeship program. Therefore, continuing to incorporate these features or enhancing them further throughout the program will likely increase the confidence of future trainees.

Familiarity with Site 1 was also addressed in Research Question 2. Learning about the culture of the site before beginning the apprenticeship program cannot be controlled by the program's structures or features, but it can be impacted by those who enroll in the training program. Many of this study's participants first learned about the site and what it had to offer through a mix of family, friends, and community events. Those who graduated from the program can now speak to friends and family members about how the site has impacted their lives. As long as the apprenticeship program

continues to have a beneficial effect on nuclear careers, personal well-being, and financial status, former apprentices will continue to spread the word about how great an opportunity the program is, making this word-of-mouth exchange a cyclical occurrence.

Research Question 2.2 focuses on the need for mentorship in the workplace. At this point in the apprenticeship's history, no formal mentorship program has been constructed. Students do not have a dedicated person they can reach out to or meet with to ask questions, review study material, or inquire about other nuclear career opportunities. Instructors and managers have been serving in a counseling role when time permits. The participants benefited from their unofficial mentors, and taking this coaching to the next level in the form of a structured mentorship program may improve the confidence levels of future apprentices. The mentoring program should foster a positive relationship between the mentor and mentee, provide opportunities for growth, build psychological safety and trust, and offer a sense of purpose in the partnership. It can reinforce the work ethic traits that many apprentices described as a significant influence on their self-confidence as well. Doing so increases the chances of student success, talent retention, and closing the skills gap (Rubbi Nunan et al., 2023).

Well-thought-out mentorship programs can benefit the mentor and mentee. Eby and Robertson (2020) studied the effects of mentorship on both entities and noted that mentors can be more motivated to help their mentees after spending some time in the program. When the goals of the mentorship program are clear for the mentor and apprentice, self-motivation expands and directly impacts self-confidence (Bandura, 1977; Eby & Robertson, 2020). Rubbi Nunan et al. (2023) agreed that mentoring relationships can be mutually beneficial, too. Future apprenticeship programs must consider the mental

and physical benefits of implementing an official mentoring program, such as catering to the apprentices' and employers' shared desire to master their new role and preparing trainees for a long-term nuclear career.

Recommendations for Institutions

Research Question 2.1 covered academic experiences in the training program. There are two subthemes and two suggestions that address the participants' concerns in this area. Not having consistent instruction among the technical colleges and employers was a point of friction and frustration for the study's participants. Based on the analysis of the qualitative data collected from the participants, many of the instructors seemed ill-prepared for their teaching duties, or they could not relate the content to the nuclear field because they had no experience in the nuclear industry. To better serve the students, it is recommended that the schools seek to hire professionals from the field who can teach the content and apply it to the specific roles at Site 1. These individuals could be current employees of each contractor or retirees who are still familiar with the material. A long or short-term teaching contract could be developed to increase buy-in and persuade nuclear industry specialists to venture into the classroom. To further support the industry professionals in their roles as instructors, co-teachers or instructional specialists could train the content experts in effective teaching strategies. Andragogical and pedagogical methods that have been proven to increase learning and understanding should be shared with instructors at the higher education institutions to enhance their teaching practices.

Additionally, instructors can even teach at multiple technical colleges, further refining the concepts each cohort is exposed to. This can be achieved in numerous ways. First, a staggered schedule could be implemented, allowing the instructor time to travel to

numerous locations to meet with students. For example, an instructor can teach a morning session at Institution A and then travel to Institution B in the evening to teach the same lesson to a different cohort. Alternating days would work for this suggestion as well. Using technology to reach multiple cohorts simultaneously is another method that allows trained instructors to maximize their time. Video conferencing applications like Zoom and Microsoft Teams are practical. However, other technological advances, such as Technology Enhanced Classrooms (TEC) and OWL Labs conferencing devices, have been developed to reach students in different physical locations. Instructional specialists would be available to train industry experts on how to incorporate this technology into their lessons, further aiding in utilizing subject matter experts to transfer tacit knowledge. These changes would greatly benefit the apprentices and enhance their self-confidence and growth.

Another suggestion that arises from Research Question 2.1 is for the higher education institutions to secure class materials, study guides, exams, and other teaching tools from the contractors and provide them to all instructors at their technical college. As a result, continuity between what is being taught at each school and cohort is supported. A standardized curriculum coupled with common instructional resources and assessments would be specific to the role of the apprentice, eliminating the need to guess what each trainee should be exposed to. Streamlining the instruction using these methods will improve the apprentices' self-confidence as they will feel certain that the instructors are capable of supplying them with the expertise needed to grow and persist in the nuclear field.

Recommendations for Employers and Institutions

As determined from the participants' responses to Research Question 1, apprenticeship designers should consider using methods that create a more structured program with demarcated domains to support a healthy work/life balance. Y. Park et al. (2020) discussed how various domains, such as work, home, and school, exist physically and psychologically. The current structure of the apprenticeship program leans into the integration of the work and home domains. As many of the apprentices shared, there were times when they had to study at home to prepare for the next day of class or work. Studying at home for work and school assessments bled into their family time and left little time for other activities. A revised apprenticeship structure could provide more time for apprentices to complete all of their requirements at the institution or the workplace. This can be done by dedicating more time during the work or school day to studying and completing assignments. Condensing assignments based on the updated curriculum could be another method of reducing the amount of work that may be taken home. Prioritizing the apprentices' work/life balance will result in higher job satisfaction and an overall increase in self-confidence as they begin their careers (Hadi et al., 2023).

Another suggestion to improve the apprentices' learning experience is to provide more hands-on learning opportunities. These occasions can occur at the site or in the classroom, depending on the curriculum and resources. Many of the participants recalled wanting to apply the concepts they learned, such as how a pump works or what instruments are used to monitor radiation, to real-life scenarios encountered in the workplace. One apprentice mentioned being a hands-on learner, so more active learning assessments would benefit people like him in the training program. Research shows that

kinesthetic activities generate higher confidence levels and retention in schools and careers (Simamora et al., 2025). These activities additionally require students to interact with each other; these discussions contribute to increased skills and confidence (Simamora et al., 2025). These learning opportunities can be vetted and curated by employers of each contractor for use at the technical schools and in the workplace. Implementing experiential learning into the program can connect theory and practice and ensure the apprentices are effectively preparing for their new roles. This desire for practice-based instruction enhances technical proficiency and sets the stage for long-term career success.

Increasing the amount of hands-on learning activities and improving work/life balance are two methods that positively influence self-confidence in nuclear apprentices (Hadi et al., 2023; Simamora et al., 2025). These methods, combined with the other suggestions in this section, are critical to helping the nuclear industry thrive. Higher self-confidence levels at the educational facility and workplace generally results in better prepared workers, leading to retention in their positions, which is imperative to closing the labor and skills gap in the nuclear industry. Educated and confident workers who desire long-term careers would sustain the nuclear field through its projects and anticipated changes.

Limitations

In all research, there are limitations, and this study is no different. In my estimation, it can be reported with certainty that there are two definitive limitations to this study. The first limitation is the use of former apprentices from only the states of Georgia and South Carolina. While the participants in this geographical area presented rich data,

others across the Southeast and the United States could have added their meaningful experiences and enhanced the research's findings. Given that the labor and skills gap is persisting across the country, knowing how graduates navigated their training in other regions may have broadened the overall results of this study. Citizens of various geographical areas would possibly have different needs regarding financial stability and access to education. Unfortunately, the findings cannot be generalized to larger populations, so another study that includes other geographical areas must be conducted.

The second limitation is the use of apprentices affiliated with the Department of Energy (DOE) complexes instead of all nuclear sites. While the DOE has many facilities across the nation and services several missions, they are not the only branch dedicated to expanding nuclear use. Commercial nuclear plants are increasing their projects as well, such as restoring the Palisade nuclear plant and continuing the use of the Diablo Canyon power plant in California (The White House, 2024). The commercial nuclear industry equally suffers from a skills and labor shortage, as indicated by National Nuclear Security Administration (NNSA) administrator Jill Hruby (Parsons, 2023). Since the results of this study do not include commercial sites and cannot be generalized across the nation, many areas of significant data may have been left untouched. Due to the fact that the service area and industry partners chosen were so small, diverse regional, economic, and cultural factors were not represented in the findings. These additional insights could have highlighted best practices and suggestions across sectors and strengthened the broader application of the findings.

Recommendations for Future Research

Considering the limitations of this study, a few recommendations for future research have been identified. First, a study on commercial nuclear plants and their use of apprenticeships to train workers should be conducted. This study did not include that population of workers, but they are experiencing similar retirements and turnovers, creating a gap in skilled employees (Parsons, 2023; The White House, 2024). A qualitative, quantitative, or mixed-methods approach could be taken when investigating the experiences of former apprentices in the commercial nuclear industry, providing a comprehensive view across the nuclear sector.

Another potential study could widen the research area to a larger region or the entire United States. Seeing that the labor and skills gap is nationwide, gathering data from other areas could supply critical information needed to address the hiring deficit. This study could be done in multiple steps, such as gathering data from each region and then comparing it, or the entire country can be used for the population. Furthermore, the findings could be used to create apprenticeship and workplace policies on a national scale.

The next suggestion for future research is to conduct this same study from the employers' perspectives. While it is necessary to know how training programs prepare students for the workforce, it is equally important to know how apprentices' managers feel during the apprenticeship program. Questions can be asked about how they perceive the trainees' confidence levels throughout the program. In turn, they can provide suggestions for improvement that students may not have considered. This new information would create a more balanced understanding of the apprenticeship

experience, contributing to a deeper understanding of employer needs and workplace preparation.

The findings from this study can be extended by gathering quantitative data from former apprentices who meet the same criteria. The quantitative data could confirm the findings of this qualitative study, or even potentially present patterns, correlations, and trends that cannot be identified through a solely qualitative method. When quantitative measures are added, a more balanced perspective on the participants' stories can be generated. Both qualitative and quantitative data would strengthen the validity of the findings in this study and may offer new insights and suggestions for apprenticeship program stakeholders.

Conclusion

Former participants of nuclear apprenticeship programs in Georgia and South Carolina shared their experiences and perspectives on how their training program prepared them for a long-term career in the nuclear field. Exploring the areas of work/life balance, academic support systems, and workplace support strategies opened the door for conversations about the strengths and areas for improvement of the apprenticeships. Although the program was not perfect, especially regarding financial stability and instructor expertise, each participant reported positive feelings and experiences about learning new skills, preparing for leadership roles, and mentoring, which influenced their self-confidence and perception of readiness.

Apprenticeships have a long history of facilitating education and employer goals for the working class in the United States. However, they have been underused compared to other countries, and the United States is striving to reap the full benefits of

apprenticeship training programs (Fortwengel et al., 2021). This study has highlighted some of the advantages of using apprenticeships to train employees, such as the ability to learn content in the classroom and immediately apply it to their new role. There were also discoveries of ways to improve these programs, such as ensuring a work/life balance that includes financial stability, more consistent instructors and material between participants, the use of more hands-on opportunities, and the implementation of a formal mentoring program. Combining these findings with the results of future studies will add vast amounts of information to the body of knowledge needed to address the issues in the nuclear industry.

Quickly closing the labor and skills gap in the nuclear industry depends on how new workers understand the nuclear field and the expectations of the employer. According to the Boundary Theory (Nippert-Eng, 1996), Self-Efficacy Theory (Bandura, 1977), and the Skills Theory (Fischer, 1980), gaining hard and soft skills while maintaining a suitable work/life balance determines self-motivation, self-efficacy, and confidence in one's ability to establish a successful career. Using the findings from this study, higher education institutions, businesses, and other stakeholders can continue to improve their training programs to transition individuals into the expansive field of nuclear work.

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Appendix A:

Citi Completion Reports

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COMPLETION REPORT - PART 1 OF 2
COURSEWORK REQUIREMENTS*

* Scores on this Requirements Report (Part 1) reflect quiz completions at the time all requirements for the course were met. The Transcript Report (Part 2) lists more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Aherial Polite (ID: 10395099)
- **Institution Affiliation:** Valdosta State University (ID: 475)
- **Institution Email:** alcofield@valdosta.edu
- **Institution Unit:** Leadership, Technology and Workforce Education
- **Phone:** 6783578227

- **Curriculum Group:** Human Research
- **Course Learner Group:** IRB Basic
- **Stage:** Stage 1 - Basic Course
- **Description:** This course is suitable for Investigators and staff conducting SOCIAL / HUMANISTIC / BEHAVIORAL RESEARCH with human subjects. The VA module must be completed if you plan to work with subjects at a VA facility.

- **Record ID:** 44548207
- **Completion Date:** 28-Aug-2021
- **Expiration Date:** 27-Aug-2024
- **Minimum Passing:** 80
- **Reported Score*:** 94

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Defining Research with Human Subjects - SBE (ID: 491)	28-Aug-2021	5/5 (100%)
Basic Institutional Review Board (IRB) Regulations and Review Process (ID: 2)	28-Aug-2021	5/5 (100%)
Assessing Risk - SBE (ID: 503)	28-Aug-2021	5/5 (100%)
History and Ethical Principles - SBE (ID: 490)	28-Aug-2021	4/5 (80%)
The Federal Regulations - SBE (ID: 502)	28-Aug-2021	5/5 (100%)
Informed Consent - SBE (ID: 504)	28-Aug-2021	4/5 (80%)
Privacy and Confidentiality - SBE (ID: 505)	28-Aug-2021	5/5 (100%)
Valdosta State University (ID: 746)	28-Aug-2021	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

This document was generated on 24-Sep-2024. Verify at:
www.citiprogram.org/verify/?k3175e93b-cec5-4c45-b4cf-bb36af26953b-44548207

Collaborative Institutional Training Initiative (CITI Program)
101 NE 3rd Avenue
Suite 320
Fort Lauderdale, FL 33301 US

Email: support@citiprogram.org
Phone: 888-529-5929
Web: https://www.citiprogram.org

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COMPLETION REPORT - PART 2 OF 2
COURSEWORK TRANSCRIPT**

** Scores on this Transcript Report (Part 2) reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. The Requirements Report (Part 1) lists the reported scores at the time all requirements for the course were met.

- **Name:** Aherial Polite (ID: 10395099)
- **Institution Affiliation:** Valdosta State University (ID: 475)
- **Institution Email:** alcofield@valdosta.edu
- **Institution Unit:** Leadership, Technology and Workforce Education
- **Phone:** 6783578227

- **Curriculum Group:** Human Research
- **Course Learner Group:** IRB Basic
- **Stage:** Stage 1 - Basic Course
- **Description:** This course is suitable for Investigators and staff conducting SOCIAL / HUMANISTIC / BEHAVIORAL RESEARCH with human subjects. The VA module must be completed if you plan to work with subjects at a VA facility.

- **Record ID:** 44548207
- **Current Score**:** 94

REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES	MOST RECENT	SCORE
History and Ethical Principles - SBE (ID: 490)	28-Aug-2021	4/5 (80%)
Defining Research with Human Subjects - SBE (ID: 491)	28-Aug-2021	5/5 (100%)
Basic Institutional Review Board (IRB) Regulations and Review Process (ID: 2)	28-Aug-2021	5/5 (100%)
The Federal Regulations - SBE (ID: 502)	28-Aug-2021	5/5 (100%)
Assessing Risk - SBE (ID: 503)	28-Aug-2021	5/5 (100%)
Informed Consent - SBE (ID: 504)	28-Aug-2021	4/5 (80%)
Privacy and Confidentiality - SBE (ID: 505)	28-Aug-2021	5/5 (100%)
Valdosta State University (ID: 746)	28-Aug-2021	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

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COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COMPLETION REPORT - PART 1 OF 2
COURSEWORK REQUIREMENTS*

* Scores on this Requirements Report (Part 1) reflect quiz completions at the time all requirements for the course were met. The Transcript Report (Part 2) lists more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Aherial Polite (ID: 10395099)
- **Institution Affiliation:** Valdosta State University (ID: 475)
- **Institution Email:** alcofield@valdosta.edu
- **Institution Unit:** Leadership, Technology and Workforce Education
- **Phone:** 6783578227

- **Curriculum Group:** Human Research
- **Course Learner Group:** IRB Basic
- **Stage:** Stage 2 - Refresher course
- **Description:** This course is suitable for Investigators and staff conducting SOCIAL / HUMANISTIC / BEHAVIORAL RESEARCH with human subjects. The VA module must be completed if you plan to work with subjects at a VA facility.

- **Record ID:** 62991675
- **Completion Date:** 19-Aug-2024
- **Expiration Date:** 19-Aug-2027
- **Minimum Passing:** 80
- **Reported Score*:** 100

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
SBE Refresher 1 – History and Ethical Principles (ID: 936)	19-Aug-2024	2/2 (100%)
SBE Refresher 1 - Instructions (ID: 943)	19-Aug-2024	No Quiz
SBE Refresher 1 – Federal Regulations for Protecting Research Subjects (ID: 937)	19-Aug-2024	2/2 (100%)
SBE Refresher 1 – Informed Consent (ID: 938)	19-Aug-2024	2/2 (100%)
SBE Refresher 1 – Research with Prisoners (ID: 939)	19-Aug-2024	2/2 (100%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

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COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COMPLETION REPORT - PART 2 OF 2

COURSEWORK TRANSCRIPT**

** Scores on this Transcript Report (Part 2) reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. The Requirements Report (Part 1) lists the reported scores at the time all requirements for the course were met.

- **Name:** Aherial Polite (ID: 10395099)
- **Institution Affiliation:** Valdosta State University (ID: 475)
- **Institution Email:** alcofield@valdosta.edu
- **Institution Unit:** Leadership, Technology and Workforce Education
- **Phone:** 6783578227

- **Curriculum Group:** Human Research
- **Course Learner Group:** IRB Basic
- **Stage:** Stage 2 - Refresher course
- **Description:** This course is suitable for Investigators and staff conducting SOCIAL / HUMANISTIC / BEHAVIORAL RESEARCH with human subjects. The VA module must be completed if you plan to work with subjects at a VA facility.

- **Record ID:** 62991675
- **Current Score**:** 100

REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES	MOST RECENT	SCORE
SBE Refresher 1 - Instructions (ID: 943)	19-Aug-2024	No Quiz
SBE Refresher 1 – History and Ethical Principles (ID: 936)	19-Aug-2024	2/2 (100%)
SBE Refresher 1 – Federal Regulations for Protecting Research Subjects (ID: 937)	19-Aug-2024	2/2 (100%)
SBE Refresher 1 – Informed Consent (ID: 938)	19-Aug-2024	2/2 (100%)
SBE Refresher 1 – Research with Prisoners (ID: 939)	19-Aug-2024	2/2 (100%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

This document was generated on 24-Sep-2024. Verify at:
www.citiprogram.org/verify/?k14d83014-0082-4bcb-b72a-48b06bea5574-62991675

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Appendix B:

Letters of Cooperation

February 3, 2025

Dear Dr. Tina Wright, Dr. Kathy Nobles and other members of the committee:

I, [redacted] will serve as the liaison and point of contact at [redacted] for Aherial Polite as she completes her dissertation. She is permitted to use [redacted] and the campus as a research site for her case study interviews regarding apprenticeships and the nuclear workforce.

Do not hesitate to call me if any questions arise. You may reach me at the contact information below.

Sincerely,

[redacted]

Vice President of Academic Affairs and Workforce Innovation

[redacted]

02/03/2025

Dr. Tina Wright, Dr. Kathy Nobles, and other members of the Committee,

I, [redacted] will serve as the liaison and point of contact for Aherial Polite as she completes her dissertation. She is permitted to use [redacted] as a research site for her case study interviews regarding apprenticeships and the nuclear workforce. Do not hesitate to call me if any questions arise. You may reach me at the contact information below.

Sincerely,

[redacted]

[redacted]
Vice President for Economic Development

[redacted]

March 4, 2025

[redacted]

Dear Aherial Polite,

We are pleased to inform you that your request to use [redacted] as a primary resource for your dissertation research has been approved. We understand the importance of your research on: *A Comparative Case Study of Nuclear Apprenticeship Participants' Perceptions of Self Confidence in Nuclear Workforce in South Carolina and Georgia*.

[redacted] who will serve as your primary contact for this data and information, are happy to support your academic endeavors.

You are granted permission to access and utilize the resources available on [redacted] for the duration of your dissertation project. Please ensure that all information and data obtained from our site are used solely for academic purposes and are properly cited in your dissertation.

Should you require any further assistance or have any specific questions regarding the use of our resources, please do not hesitate to contact us. We wish you the best of luck with your research and look forward to seeing the results of your hard work.

Sincerely,

[redacted]
Director of Institutional Effectiveness
[redacted]

FROM: [redacted] Director

TO: Dr. Tina Wright, Dr. Kathy Nobles, and other members of the Committee,

DATE: January 6, 2025

RE: Aherial Polite, Letter for Dissertation

I, [redacted], will serve as the liaison and point of contact for Aherial as she completes her dissertation. She is permitted to use the [redacted] and the following contractors as a research site for her case study regarding apprenticeships and the nuclear workforce: [redacted]

Do not hesitate to call me if you have any further questions.

Regards,

[redacted]
[redacted] Director Site Training
[redacted]

Appendix C:

Informed Consent Instructions

For Individual Interviews

Before we get started, I will read the research consent statement. Here is a copy of the document I will be reading (hand over the document to participant(s). If virtual, share screen to review). (Reads statement).

Individual Interview Statement: You are being asked to participate in an interview as part of a research study entitled **"**A Comparative Case Study of Nuclear Apprenticeship Participants' Perceptions of Self-Confidence in the Nuclear Workforce in South Carolina and Georgia", which is being conducted by Aherial Polite, a student at Valdosta State University. The purpose of the study is to discover former nuclear apprentices' confidence levels regarding their readiness to enter and persist in the nuclear field. The confidence levels will be tied to the experiences surrounding work, school, and home/life balance and the use of academic and workplace support during their nuclear apprenticeship programs. These findings will then be shared with stakeholders such as businesses, managers, higher education institutions, and other leaders who want to use apprenticeships and colleges to close the labor and skills gap in the nuclear industry. You will receive no direct benefits from participating in this research study. However, your responses may help us learn more about the resources needed by apprentices to build their confidence while preparing for their careers in the nuclear field. Contributing to the body of knowledge in this discipline will supply industry and educational leaders with the tools they need to combat the labor and skills gap in the nuclear industry by providing quality training programs. There are no foreseeable risks involved in participating in this study other than those encountered in day-to-day life. Participation should take approximately 60 minutes. The interview will be audio recorded to capture your concerns, opinions, and ideas. Once the interview recording has been transcribed, the recording will be deleted from recording devices. **This research study and your participation will be kept confidential.** Your identifiable information will be replaced with a pseudonym in publications or presentations**.** No one, including the researcher, will associate your responses with your identity. Your participation is voluntary. You may choose not to participate, to stop responding, or to skip questions you do not want to answer. You must be at least 18 years of age to participate in this study. Your participation in the interview serves as your voluntary agreement to participate in this research project and your certification that you are 18 years of age or older.

Questions regarding the purpose or procedures of the research should be directed to Aherial Polite at alcofield@valdosta.edu. This study (IRB-**04570-2025**) has been exempted from Institutional Review Board (IRB) review in accordance with Federal regulations. The IRB, a university committee established by Federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-253-2947 or irb@valdosta.edu.

For Focus Group Interviews

Focus Group Consent Statement: You are being asked to participate in a focus group as part of a research study entitled, **"**A Comparative Case Study of Nuclear Apprenticeship Participants' Perceptions of Self-Confidence in the Nuclear Workforce in South Carolina and Georgia"*,* which is being conducted by Aherial Polite, a student at Valdosta State University. The purpose of the study is to discover former nuclear apprentices' confidence levels regarding their readiness to enter and persist in the nuclear field. The confidence levels will be tied to the experiences surrounding work, school, and home/life balance and the use of academic and workplace support during their nuclear apprenticeship programs. These findings will then be shared with stakeholders such as businesses, managers, higher education institutions, and other leaders who want to use apprenticeships and colleges to close the labor and skills gap in the nuclear industry. You will receive no direct benefits from participating in this research study. However, your responses may help us learn more about the resources needed by apprentices to build their confidence while preparing for their careers in the nuclear field. Contributing to the body of knowledge in this discipline will supply industry and educational leaders with the tools they need to combat the labor and skills gap in the nuclear industry by providing quality training programs. There are no foreseeable risks involved in participating in this study other than those encountered in day-to-day life. Participation should take approximately 60 minutes. The focus group session will be ***audio or videotaped*** to capture concerns, opinions, and ideas that are offered by the group. Once the recordings have been transcribed, recordings will be deleted from the recording and storage devices used. Participant names will be replaced with a **pseudonym**. No one, including the researcher, will be able to associate your responses with your identity. Your participation is voluntary. You may choose not to participate, stop responding, or leave the focus group at any time. Participants must be at least 18 years of age to take part in this study. Your participation in the focus group serves as your voluntary agreement to participate in this research study and your certification that you are 18 years or older.

Questions regarding the purpose or procedures of the research should be directed to Aherial Polite at alcofield@valdosta.edu. This study (IRB-**04570-2025**) has been exempted from Institutional Review Board (IRB) review in accordance with federal regulations. The IRB, a university committee established by federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-253-2947 or irb@valdosta.edu.

Now, please take a few minutes to review this document (hand over the document to participant(s). If virtual, share screen to review). This is the informed consent document you signed before you set up your interview appointment. This document explains the study in writing, and you signed it saying that you understand what the interview is about and that you have had the opportunity to ask any questions you feel you need to clarify any questions or concerns you may have. If you have any questions, you may ask them now or anytime during or after this interview. (Pause to allow a moment for questions).

Appendix D:

Institutional Review Board Protocol Exemption Report

Institutional Review Board (IRB)
for the Protection of Human Research Participants

PROTOCOL EXEMPTION REPORT

Protocol Number: 04570-2025

Responsible Researcher(s): Aherial Polite

Supervising Faculty: Dr. Kathy Nobles

Dissertation Research Member: Dr. Matthew Smith

Project Title: *A Comparative Case Study of Nuclear Apprenticeship Participants' Perceptions of Self-Confidence in the Nuclear Workforce in South Carolina and Georgia.*

Institutional Review Board Determination:

This research protocol is **exempt** from Institutional Review Board (IRB) oversight under 45 CFR 46.101(b) of the federal regulations, **category 2.** If the nature of the research changes such that exemption criteria no longer apply, please consult with the IRB Administrator (irb@valdosta.edu) before continuing your research study.

Comments:

- *Your research study may begin at the following approved research locations: **Savannah River Site, Denmark Technical College, Augusta Technical College, & Aiken Technical College.** Additional locations will be considered upon receipt of a letter of cooperation.*
- *The IRB approval number (04570-2025) must be included at the bottom of consent, correspondence, and recruitment documents (flyer, email, social media, etc.).*
- *According to exempt protocol guidelines, interview/focus group sessions may be recorded to create an accurate transcript. However, it's important to note that guidelines **strictly prohibit** collecting, storing, and/or sharing the recordings. Therefore, it is imperative that once the transcript is created, the recorded sessions must be deleted immediately from all recording and storage devices used. **This measure is in place to uphold confidentiality and ensure that the sensitive information contained in the recordings is adequately protected.***
- *To comply with consent guidelines, recordings must capture the researcher reading the consent statement aloud, ensuring the participant's understanding and their readiness to participate. **Each transcript must document the researcher's reading of the consent statement and the participants' consent.** A copy of the consent statement must be provided to participants.*
- *Pseudonym lists must be maintained in a separate, secure file from corresponding data.*
- *Upon completion of the research study, collected data must be securely maintained (locked file cabinet, password-protected computer, etc.) and accessible only by the researcher for a **minimum of 3 years**. At the end of the required time, collected data must be permanently destroyed.*

☒ ***Proposed modifications must be submitted to the IRB Administrator at tmwright@valdosta.edu for review and approval before implementation is permitted.***

Elizabeth W. Olphie 03.05.2025

Elizabeth W. Olphie, IRB Administrator Date

Thank you for submitting an IRB application.

Please direct questions to irb@valdosta.edu or 229-259-5045.

Revised: 06.02.16

Appendix E:

Recruitment Flyer

VALDOSTA STATE UNIVERSITY

APPRENTICESHIP RESEARCH OPPORTUNITY!

Here is a chance to share your perspectives on various nuclear apprenticeships in the states of Georgia and South Carolina. These training programs directly affect the lives of those entering the nuclear field you have the opportunity to improve their structure and impact.

Participation involves a 60 minute individual interview and the opportunity to participate in a 60 minute focus group interview. There will be no compensation for your participation.

01 Registered Nuclear Apprenticeship

Did you participate in a Department of Labor registered nuclear apprenticeship within the last 5 years?

02 Technical College Classes

Were the apprenticeship classes held at Aiken Technical College, Augusta Technical College, or Denmark Technical College?

03 Nuclear Field Employment

Were you a limited service employee (LSE) or full service employee (FSE) at Savannah River Nuclear Solutions, Savannah River Mission Completion, or Savannah River National Laboratory?

04 You Qualify!

If you answered yes to questions 1, 2, and 3, then you qualify to participate in this research opportunity!

Questions regarding the purpose or procedures of the research should be directed to Aherial Polite at alcofied@valdosta.edu. This study (IRB-04570-2025) has been approved by the Valdosta State University Institutional Review Board (IRB) for the Protection of Human Research Participants. The IRB, a university committee established by federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-253-2947 or irb@valdosta.edu.

Appendix F:

Interview Protocol

Setting

For both Individual and Focus Group Interviews

There are several local options for in-person interviews. If in person, I will conduct interviews in a well-lit, quiet, private room. They can be held at the participants' workplace, or the interview can be held at Institution A, B, or C. This will depend on the participants' convenience.

If virtual, I will conduct the interview via the internet through a communication application like Microsoft Teams, which has the capability for voice, video, and typed dialogue that can be recorded. I will conduct interviews in a well-lit, quiet, private room, such as my home or work office.

Prior to the participants arriving or logging in

For Individual Interviews

If in person, I will arrange the table and chair so the participant will sit across from me. I plan to have a pen and folder with the interview protocol and additional paper inside to take field notes throughout the interview that otherwise may be forgotten or not audibly recorded. I will set the recorder on the table between the participant's and my seats to record the conversation. The audio recorder will be tested to confirm that it functions properly.

For Focus Group Interviews

If in person, participant seats will be arranged around a table, and my seat will be placed at the head of the table. If the table is round, the seats will be evenly spaced. If there is no table, I will arrange the seats in a semi-circle around my chair. I will have my chair facing towards the participants with a distance of five to 10 feet. I plan to have a pen and folder with the interview protocol and additional paper inside to take field notes throughout the interview that otherwise may be forgotten or not audibly recorded. A chair will be placed between the participants and me to hold the recorder used to record the conversation, or the recorder will be placed at the center of the table. The audio recorder will be tested to confirm that it functions properly.

For both Individual and Focus Group Interviews

If virtual, I will join the virtual meeting room so that it appears I am directly facing the participant. I plan to have a pen and folder with the interview protocol and additional paper inside to take field notes throughout the interview that otherwise may be forgotten or not audibly recorded. I will ensure the video, audio, microphone, and chat features work correctly.

Preliminary engagement

For both Individual and Focus Group Interviews

If in person: As the participant(s) arrives and enters the room, I will welcome them and allow them to sit and get comfortable. I will ask for the participant's first and last names and pronouns and share mine. At this moment, I will ask the participant(s) to begin thinking of a pseudonym to use in the study. After talking about the participant's day for 2-3 minutes, I will let the participant(s) know that I will read the introduction for the interview to remain consistent among all participants. I will ask the participant(s) if they are ready to begin, and once they confirm, I will begin reading the introduction.

If virtual: As the participant(s) joins online, I will welcome them and ask them to test their video, audio, microphone, and chat functions. I will ask for the participant's first and last names and pronouns and share mine. At this moment, I will ask the participant(s) to begin thinking of a pseudonym to use in the study. After engaging in small talk about the participant's day for 2-3 minutes, I will let the participant know that I will read the introduction for the interview to remain consistent among all participants. I will ask the participant(s) if they are ready to begin, and once they confirm, I will begin reading the introduction.

Introductions

For both Individual and Focus Group Interviews

Good morning (or afternoon or evening, as appropriate). My name is Aherial Polite. Thank you for agreeing to be interviewed for this research project. The purpose of this study is to provide key information about confidence-building and retention factors to institutions and businesses as they plan apprenticeship programs to acquire new talent and help close the skills and labor gap in the nuclear industry. This interview should last between sixty to ninety minutes and will generally consist of me asking a few questions to guide the conversation.

Informed Consent Instructions

For both Individual and Focus Group Interviews

Before we get started, I will read the research consent statement. Here is a copy of the document I will be reading (hand over the document to participant(s). If virtual, share screen to review). (Reads statement).

Individual Interview Statement: You are being asked to participate in an interview as part of a research study entitled **"**A Comparative Case Study of Nuclear Apprenticeship Participants' Perceptions of Self-Confidence in the Nuclear Workforce in South Carolina and Georgia", which is being conducted by Aherial Polite, a student at Valdosta State

University. The purpose of the study is to discover former nuclear apprentices' confidence levels regarding their readiness to enter and persist in the nuclear field. The confidence levels will be tied to the experiences surrounding work, school, and home/life balance and the use of academic and workplace support during their nuclear apprenticeship programs. These findings will then be shared with stakeholders such as businesses, managers, higher education institutions, and other leaders who want to use apprenticeships and colleges to close the labor and skills gap in the nuclear industry. You will receive no direct benefits from participating in this research study. However, your responses may help us learn more about the resources needed by apprentices to build their confidence while preparing for their careers in the nuclear field. Contributing to the body of knowledge in this discipline will supply industry and educational leaders with the tools they need to combat the labor and skills gap in the nuclear industry by providing quality training programs. There are no foreseeable risks involved in participating in this study other than those encountered in day-to-day life. Participation should take approximately 60 minutes. The interview will be audio recorded to capture your concerns, opinions, and ideas. Once the interview recording has been transcribed, the recording will be deleted from recording devices. **This research study and your participation will be kept confidential.** Your identifiable information will be replaced with a pseudonym in publications or presentations**.** No one, including the researcher, will associate your responses with your identity. Your participation is voluntary. You may choose not to participate, to stop responding, or to skip questions you do not want to answer. You must be at least 18 years of age to participate in this study. Your participation in the interview serves as your voluntary agreement to participate in this research project and your certification that you are 18 years of age or older.

Questions regarding the purpose or procedures of the research should be directed to Aherial Polite at alcofield@valdosta.edu. This study (IRB-**04570-2025**) has been exempted from Institutional Review Board (IRB) review in accordance with Federal regulations. The IRB, a university committee established by Federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-253-2947 or irb@valdosta.edu.

Focus Group Consent Statement: You are being asked to participate in a focus group as part of a research study entitled, **"**A Comparative Case Study of Nuclear Apprenticeship Participants' Perceptions of Self-Confidence in the Nuclear Workforce in South Carolina and Georgia"*,* which is being conducted by Aherial Polite, a student at Valdosta State University. The purpose of the study is to discover former nuclear apprentices' confidence levels regarding their readiness to enter and persist in the nuclear field. The confidence levels will be tied to the experiences surrounding work, school, and home/life balance and the use of academic and workplace support during their nuclear apprenticeship programs. These findings will then be shared with stakeholders such as businesses, managers, higher education institutions, and other leaders who want to use apprenticeships and colleges to close the labor and skills gap in the nuclear industry. You will receive no direct benefits from participating in this research study. However, your

responses may help us learn more about the resources needed by apprentices to build their confidence while preparing for their careers in the nuclear field. Contributing to the body of knowledge in this discipline will supply industry and educational leaders with the tools they need to combat the labor and skills gap in the nuclear industry by providing quality training programs. There are no foreseeable risks involved in participating in this study other than those encountered in day-to-day life. Participation should take approximately 60 minutes. The focus group session will be ***audio or videotaped*** to capture concerns, opinions, and ideas that are offered by the group. Once the recordings have been transcribed, recordings will be deleted from the recording and storage devices used. Participant names will be replaced with a **pseudonym**. No one, including the researcher, will be able to associate your responses with your identity. Your participation is voluntary. You may choose not to participate, stop responding, or leave the focus group at any time. Participants must be at least 18 years of age to take part in this study. Your participation in the focus group serves as your voluntary agreement to participate in this research study and your certification that you are 18 years or older.

Questions regarding the purpose or procedures of the research should be directed to Aherial Polite at alcofield@valdosta.edu. This study (IRB-**04570-2025**) has been exempted from Institutional Review Board (IRB) review in accordance with federal regulations. The IRB, a university committee established by federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-253-2947 or irb@valdosta.edu.

Now, please take a few minutes to review this document (hand over the document to participant(s). If virtual, share screen to review). This is the informed consent document you signed before you set up your interview appointment. This document explains the study in writing, and you signed it saying that you understand what the interview is about and that you have had the opportunity to ask any questions you feel you need to clarify any questions or concerns you may have. If you have any questions, you may ask them now or anytime during or after this interview. (Pause to allow a moment for questions).

Audio Recording Instructions

For both Individual and Focus Group Interviews

I will be recording our conversation's audio, visual, or chat (if applicable) throughout the interview. The purpose of this is so that I can be able to have all of the details about our conversation while being able to talk freely with you during the interview. All comments made will remain confidential. The recordings will be kept until the completion of the study, at which point they will be destroyed.

INTERVIEW QUESTIONS/PROMPTS

Individual Interview Questions

1. Please tell me the pseudonym you chose for yourself.
2. Tell me about yourself.
    a. What is your age, race, gender, pronouns, highest educational level, and number of career changes?
3. Which technical school did you attend for your apprenticeship program?
    a. Why did you choose to attend this particular technical school?
4. Which apprenticeship program were you enrolled in?
    a. Did you complete the program?
        i. If yes, what month and year?
        ii. If no, what month and year did you stop out?
5. Which Site 1 contractor were you employed with during the apprenticeship?
6. Do you still work in the nuclear field? (If yes, ask them a, b, c, & d. If no, ask them e & f)
    a. Are you still employed with the contractor from the apprenticeship?
    b. Are you in the same position?
    c. What led to your decision to remain in the field?
    d. Thinking about the future, do you see yourself working in this industry in 5 years? 10 years? Retirement age?
    e. What led you to your decision to leave the nuclear field?
    f. What fields have you worked in since leaving the nuclear field?
7. Do you think this program effectively prepared you for the nuclear field?
8. Describe the pacing of the program for you. Was it too fast, too slow, or suitable for you? Several models of classroom-based learning and work experience were used in this program (I will describe the various models). Which model did your cohort use?
    a. Did this model suit your needs?
    b. If not, which model would you have preferred?
9. Can you list the academic supports available to you through the school?
    a. What supports did you take advantage of?
    b. What supports do you wish had been offered through your school's academic support system?
    c. Did you feel supported by the school's academic support systems?
10. Can you list the supports available to you through your employer?
    a. What supports did you take advantage of?
    b. What supports do you wish had been offered through your employer's support system?
    c. Did you feel supported by your employer's support system?
11. How do you define work/life balance?
12. How do you feel this program allowed you to maintain your work/life balance?
    a. Were you able to accomplish your responsibilities at work and at home?
13. What was the program missing in your opinion?

14. Do you think the apprenticeship program increased your level of confidence in your ability to perform your job at the nuclear site?
    a. If there was an increase, what contributed to this increase?

Focus Group Interview Questions

1. What attracted you to the nuclear field?
    a. Do you have any history with Site 1?
2. According to your peers, these are the academic supports from the three tech schools (list supports reported from individual interviews). How do you think having those different supports affected the outcomes of apprentices at different schools?
3. According to your peers, these are the workplace supports from the three site contractors (list supports reported from individual interviews). How do you think having those different workplace supports affected the outcomes of apprentices with different employers?
4. When it comes to being prepared, how do you feel compared to those hired without going through an apprenticeship program?
    a. Do you believe you have an advantage over your peers who did not participate in an apprenticeship program?
        i. If yes, what advantages do you see yourself having compared to these peers?

Wrap up

Thank the interviewee(s) for participating in the interview and remind them that I will contact them after the transcription is complete and after analyzing themes so they can verify those at their respective times. I will also ask them if they have any questions before they leave.

After the interviewee(s) leave, I will rewind devices and check to ensure that the entire interview was recorded. Should I detect that the interview was not completely recorded on the device, I will immediately contact the interviewee(s) to reschedule a time for the interview. Upon verifying that the interview was recorded in its entirety, I will either clean up and leave the room or log off of the electronic means used to conduct the interview and submit the recordings for verbatim transcription.