ABSTRACT

GRAY, JARVIS KEVIN. A Case Study Examining Perceptions of Postsecondary Career and Technical High-Risk Education Instructors within the North Carolina Community College System. (Under the direction of Dr. James E. Bartlett, II).

The purpose of this research answers two research questions: How do community college welding instructors view the importance of teaching safety in the North Carolina community college welding classrooms and labs in certificate, diploma, and associate degree programs? How does it impact what they teach? What are the safety skills taught, and how do community college welding instructors interact with students in relation to teaching safety in the welding classroom and lab?

A mixed methods approach was utilized to generate multiple case studies. Each case study answered the individual questions. Two phases were utilized to collect and analyze data to generate case studies. In phase one welding instructors were sent an anonymous survey link to answer questions regarding their experience, comfort level, and understanding of safety within the welding laboratory. At the conclusion of phase one instructors were given the opportunity to participate in a virtual recorded Zoom interview. In Phase two of the research 10 instructors were interviewed and transcripts were coded, categorized, and themed to answer each of the research questions. In addition, multiple artifacts were evaluated. These artifacts also included welding instructor job postings from July 1, 2021 - June 30, 2022, the safety portion of welding textbooks, and curriculum guides.

Key themes that emerged from the research included: Instructors desire to teach students as much as they could about safety before they entered the workplace, recognition that workplaces differed significantly in their ability to provide adequate safety training, resources to ensure student safety are needed more than ever, the level of safety education has increased

dramatically since instructors were students. Instructors often focused on technique and proper equipment setup to prevent injuries.

Implications for research and practitioners in the classroom included a need for more professional development for instructors to teach supporting subjects in material handling, and fire prevention techniques. Textbooks are still lagging for up-to-date exposures that welders face in the current work environment.

A Case Study Examining Perceptions of Postsecondary Career and Technical High-Risk Education Instructors within the North Carolina Community College System

by
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DEDICATION

The last four years of my life my family and I have made many sacrifices. This program began with a pandemic that would eventually lead to a life changing health condition. Through all of it, my wife and son have stood by my side. The two of you have given up the one thing that I could never repay. Your time supporting me, your time loving me, your time pushing me when I just didn't feel like I could do anymore. This dissertation is a product of our family commitment to one another. I love you both with all my being and am thankful that God blessed me with the privilege to know you. For this reason, I dedicate this work to you.

BIOGRAPHY

Jarvis Kevin Gray, a dedicated professional and family man, was born on January 31, 1977, in the charming village of Avon, North Carolina. From an early age, he displayed remarkable determination and a thirst for knowledge, which would shape his future endeavors. Jarvis attended Cape Hatteras High School, where he discovered his passion for wrestling. Throughout his high school years, he dedicated himself to the sport, showcasing both skill and perseverance. His commitment to excellence and his ability to overcome challenges would become defining traits in his personal and professional life.

After graduating from high school, Jarvis continued his academic journey at Elizabeth City State University, where he pursued his undergraduate studies. During this time, he further honed his skills in time management, critical thinking, and leadership, preparing him for the challenges that lay ahead.

With a thirst for knowledge that knew no bounds, Jarvis went on to earn a master’s degree in management from the University of Phoenix. Recognizing the importance of occupational safety in the workplace, he pursued a second master’s degree in occupational safety from East Carolina University, further solidifying his expertise in the field.

In 2006, Jarvis embarked on a new career path, transitioning from the retail industry to state government. He joined the NC Ferry Division in Manns Harbor as a safety officer, bringing his comprehensive understanding of safety regulations and protocols to ensure the well-being of his colleagues and the public. Jarvis's dedication to creating a safe environment and his commitment to continuous improvement quickly became evident, earning him respect among his peers.

Beyond his professional achievements, Jarvis found love and companionship in his wife Melissa. Their union is a testament to their shared values, support, and unwavering commitment to each other. Together, they have raised a wonderful son, Kevin Tyler, instilling in him the same values of hard work, dedication, and integrity that have defined Jarvis's own journey.

In 2014, Jarvis became a member of the American Society of Safety Professionals, where he actively contributed to the advancement of occupational safety practices. His involvement in the society showcases his desire to make a lasting impact in his field and his dedication to sharing his knowledge and experience with others.

Throughout his life, Jarvis Kevin Gray has demonstrated unwavering perseverance, a commitment to personal growth, and a passion for ensuring the safety and well-being of others. His remarkable journey, both professionally and personally, serves as an inspiration to all those around him. As he continues to make strides in his career and cherish the love of his family, Jarvis remains a shining example of what can be achieved through hard work, determination, and an unwavering dedication to making a difference.

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To my parents Mark and Denise, I will never be able to thank you for all that you have done to motivate me and support me. Whenever I needed it, you have always offered to help. I could not have asked for a better set of parents. Wouldn’t be here without your continued encouragement.

I saved you my love Melissa, for last. You are my one and only. You have stood by my side. You waited for me as I have written. You have sacrificed time, money, and family experiences to help me get to this point.

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CHAPTER 1: INTRODUCTION

According to a recent report from Jobs for the Future, welding jobs are projected to grow seven percent—from 457,857 to 488,083—in the United States. between 2018 and 2028, equating to an additional 3,023 new welding jobs annually (Soricone et al., 2020). Nationally, there will be 54,364 openings each year for steelworkers, fabricators, shipyard ship filters, construction workers, agriculture technicians, manufacturing technicians, and other welding industries (AWS, 2022). If individuals are not properly prepared to enter these jobs, the gap in skilled trades workers will continue to expand, stalling projects and exacerbating the already problematic issue of increased consumer cost for American companies. (Soricone et al., 2020).

Welding as a profession is considered a skilled trade. Pathways into the skilled trades can include high school trade programs, apprenticeships, and training via community colleges. Welding certifications are conferred at 57 of the 58 community colleges in North Carolina, producing 2,105 welders combined in the 2019-2020 academic year, as shown in Appendix C. Graduates are entering the workforce with certificates, diplomas, or associate degrees. According to the North Carolina Community College System Office (NCCCSO), most welding graduates hold a certificate.

Business and industry in the U.S. have aligned themselves with community colleges to produce quality workers bearing the skills to effectively conduct welding. The welding industry must retain qualified employees that are not only capable of joining metal together but that meet applicable welding quality standards with the promise that what they manufacture will withstand the forces of nature. To simultaneously drive down cost and increase profits, economic forces have shaped the need for quality products and worker safety (Hallowell & Asce, 2011).

A highly skilled trade such as welding pays sustainable wages that can help to alleviate poverty for families in North Carolina and the U.S. broadly. According to the U.S. Bureau of Labor Statistics (BLS, 2020), the average salary of a welder in 2019 was $46,000. Furthermore, the BLS estimates that an additional 5,000 industry positions will be created nationally over the next 10 years, yielding a mean annual salary of $46,000.

These high-paying jobs come with a high level of risk for injury, however, making the safety of welders a major concern for business and industry. The U.S. Bureau of Labor Statistics indicated that jobs such as ironworking that include welding are in the top 10 most dangerous jobs (BLS, 2020). These injuries include several Occupational Health and Safety Administration (OSHA) fatality causation types: falls, electrocution, strikes by equipment, and catching in-between moving parts. Although it is the employer's responsibility to protect workers, workers must also protect themselves. Occupational hazards can be mitigated by engineering controls, administrative controls, and personal protective equipment.

The skill of welding is delivered in welding laboratories, and learning is demonstrated through certified welding testing. Unfortunately, the skill of recognizing and mitigating hazards does not appear to be a part of the required curriculum within the community college system in North Carolina. After reviewing recommended curriculum of 57 community college system, only three programs recommended a course on occupational safety as part of welding certificate. According to the North Carolina Department of Labor Occupational Fatality Inspection Review (NCDOL OFIR), 26 construction deaths occurred in North Carolina in 2020; twelve of those 26 were from minority populations. The number of fatalities, however, remains under 30 as it has for the previous four years. Nearly all these deaths involved the four fatality types: falls, electrocution, struck by, and caught between. (NCDOL OFIR, n.d.).

The risks posed to welders are both physical and related to general health. These health exposures are often created through the inhalation of hazardous fumes, the byproduct of heating metals generating particles that easily travel into the lungs. Symptoms such as asphyxiation may be immediate, or they may be delayed without recognition until well after a welder has retired or changed professions (Antonini et al., 2003). Slow exposures such as these gradually lead to significant health problems affecting major organs and manifesting in physiological issues such as labored breathing or hearing loss (Beaumont & Weiss, 1981). More immediate and severe risks are outlined in the anecdotes that follow.

In April 2021, a family lost a man who served as both father and husband, a welder who was tasked to cut metal from a bridge to demolish it. At roughly 1:00 PM, the captain of a boat had radioed a site supervisor to tell him that he believed that the bridge structure on which the welder was standing appeared to be leaning. After a quick aerial survey was conducted, the all-clear was provided. Work resumed, and before the welder knew it, he fell more than 50 feet. Crews rushed to his aid to no avail; he succumbed to his injuries while surrounded by coworkers.

Unsurprisingly, this incident sparked an OSHA investigation. Less than six months later, the company was fined just over $23,000 for two serious violations (Stadler, 2021). Findings indicated that the structure had been improperly loaded, and the welder had seemingly taken all precautions to protect himself. The looming questions remained: Did the welder recognize the severity of the situation in which he had found himself? Did he recognize that the structural load was shifting as he cut the metal near him? While answers are not forthcoming, it is apparent that the welder did not recognize the severity of the hazards on the work site. Incidents such as these underscore the fact that welders should be trained to recognize the hazards they may create or be faced with in the course of their work. Information is limited, however, to document how well instructors are trained to recognize hazards not necessarily associated with construction in CTE general.

On December 20, 2021, another unfortunate case occurred when a worker was crushed by a seam welder. This employee had been located behind the Reweld Seam Welder, helping to make necessary adjustments with a second worker, who activated the two-hand control while his partner had his upper torso between the two towers of the machine. The left tower moved toward the right tower to entrap the individual as the second worker looked on. The entrapped worker was killed when the towers caused a crushing injury to his head (U.S. OSHA Fatality Inspection # 1506013.015).

These two cases demonstrate activities that welders may be involved in as part of their work. Thus, the need to adequately recognize and manage hazards is an intricate part of their ability to not only work but also to live to work another day. According to the United States Bureau of Labor Statistics (BLS), the workforce experienced 4,572 fatalities, 48 million workplace injuries, and more than 1 billion dollars in costs. In 2019, private industry and metal working trade employees aged 16 to 19 experienced 25,530 injuries that led to time away from work (BLS, 2020). Workers aged 20 to 24 incurred an additional 89,800 injuries with similar outcomes. According to Guerin et al. (2020), workers between 18 and 19 experienced the highest number of emergency room visits compared to other workers over 25 years of age. The solution to injury reduction may be present in our local economic engines: community colleges.

Community colleges provide education and training for skilled trades through career and technical education (CTE) programs. CTE programs serve as the platform from which many students enter skilled trades such as metal fabrication and construction work. According to Miller (1984) “safety is paramount in vocational education” (p. 139) and was referenced by the Federal

Board for Vocational Education as early as 1919. The safety skills, habits, and perceptions developed in these training programs have been shown to reduce the number of accidents in the first two years of employment (Boini et al., 2017). It is apparent that labs that are used to develop skilled trades must present environments where students and instructors recognize hazards, have the technical knowledge to mitigate exposure, use resources to implement strategies that follow the occupational safety hierarchy of controls, and instill a safety climate that seeks to prevent harm to students and staff. Students and instructors must have the will and authority to communicate site hazards.

Background of the Problem

Safety is a primary principle of vocational education. Since many CTE programs have safety risks, accident prevention is clearly a work of education. Educating for safety generates economic gains for employers and employees through the creation of sound work environments (Marshall & Mayer, 1992). While safety is a critical component in all CTE programs, some career paths have higher fatality risks than others. Trades that operate in general industry—such as manufacturing trades—have rates of 1.1 per 100 workers (BLS, 2020). Construction injury rates of 2.5 per 100 workers (BLS, 2020) These injuries appear to disproportionately impact certain populations. For example, in the construction trades, more Hispanic workers than their Caucasian counterparts reported injuries (Menzel & Gutierrez, 2010).

Welding is an inherently dangerous occupation. Workers may necessarily perform activities involving loud noise, hazardous substances, fire exposure, intense vibration, oxygen-deficient atmospheres, extreme heights, and electrical hazards. The aforementioned high risk of occupational exposure underscored the need for welders who face these exposures to recognize the risk of injury as they begin to complete their assigned work tasks. If safety is not addressed appropriately, the risk and unfortunate incidents of injury will only increase.

To address this need, OSHA has developed and authorized coursework to be delivered by administering 10-hour and 30-hour training modules for both general industry and construction. This training is conducted through the OSHA Instructor Training Institutes (OTI's) that are located throughout the U.S. The OTI's authorize OSHA trainers in specialty areas of general industry and construction. Each training of the two training programs, regardless of length, is dedicated solely to hazard identification and hazard mitigation strategies that can be employed to prevent serious injury or death (OSHA Training Institute, 2022).

The American Welding Society (AWS) also provides an 11-module safety training for welders that are new to the profession or who are interested in continuing education. The training is accessible without age restriction in a fully online format via the AWS website, and includes a pretest, learning materials, and a posttest for each module in both English and Spanish. Modules cover many hazards that may be present in the workplace and include content that ultimately identifies the employer as responsible for communicating hazards to the worker. The material presented does not cover all occupational hazards that students or employees may face in the classroom or the workplace.

Some safety training may occur at welding institutions certified by the AWS, which has five institutions listed as certified testing sites. Table 1 lists these schools and their year of accreditation. Based on review of those schools' curriculum, it does not appear that they require safety training as a stand-alone course.

Table 1

American Welding Society Accredited Testing Facilities in North Carolina

Community College	Year Accredited
Forsyth Technical Community College	2012
Johnston County Community College	2018
Randolph Community College	2018
Central Piedmont Community College	2001

In 2018, the AWS partnered with the American Board of Engineering Technology for the opportunity to improve the quality of the AWS welding instruction curriculum. The success of this partnership between ABET and AWS, and its benefit to students is still unknown. The review of the curriculum from the four AWS accredited institutions have adopted course requirements currently found in Program Code A50420. Many North Carolina community colleges followed and listed the North Carolina Department of Public Instruction Program Code (A50420) during an examination of the curricula offered at each participating school. This career standard for welding prescribes coursework for manufacturing. The curriculum lists workplace safety and industrial safety as a potential elective, though it does not require that an occupational safety course be a part of the graduation requirement.

The OSHA Training Institute sets guidelines for faculty qualifications for authorized training instructors within CTE programs. The OSHA Training Institute notes many instructors should carry minimum qualifications in order to competently deliver occupational safety training. The institute requires instructors to have a minimum of an OSHA 501/500 course to deliver hazard recognition training to students. Additionally, instructors that are allowed to issue OSHA 10- or 30-hours cards must meet a minimum amount of work experience and complete two passing written examinations with either the 501 or 500 course. Required OSHA courses include a basic OSHA 510 course and OSHA 501 course. Many community colleges may already have qualified instructors present that are prepared to instruct students on hazard recognition.

The North Carolina Community College System (NCCCS) has 58 campuses that offer various CTE programs. Welding technology education is offered at 57 campuses in certificate, diploma, or associate degree programs. Only 9% of the 57 programs that offer certificate programs require a standalone workplace safety and industrial safety course. Approximately 76% of schools that offer diploma programs in welding technology do not require workplace safety and industrial safety courses. An Associate of Applied Science (AAS) in Welding Technology requiring a standalone course of workplace safety and industrial safety is offered at 54% of the schools, as shown in Appendix A. For those schools that require a safety course, the NCCCS has also given latitude to colleges to require the training if local employers have indicated that it is needed for graduates of schools seeking employment. There is no research illustrating industry demand is such that the framework is needed; however, a skill gap analysis performed through *JobsEQ* demonstrates that industry perceptions are less safety-sensitive and merely require the training due to industry demand.

Jones et al. (2020) noted that CTE educators cite safety as a required part of instruction. However, upon reviewing the suggested curriculum of the NCCCS, it was hard to identify a required safety curriculum to teach students the valuable skills associated with safety. Furthermore, Jones et al. (2020) predicted that upstream prevention management will be the direction taken by the world's industries, a technique seeking to eliminate hazards before workers have to contend with them later (Lingard et al., 2013).

Gambatese et al. (2005) asserted that workers are at risk due to the legal concerns of engineers and architects; therefore, workers within the construction industry are being exposed to hazards that might be avoided through design. Gambatese et al. (2005) further advocated that protecting workers' exposures should be considered well in advance of construction activities. Newly qualified students who will be performing this work must learn to recognize and practice mitigation in the classroom and perform on the worksite.

Problem Statement

The problem for this study will be presented in terms of defining safety, job duties of teaching safety, training to teach safety, and the need to teach safety for work.

Defining Safety

The term safety has many different definitions and interpretations. According to Hollnagle (2014), these definitions have changed over time and have different meanings depending on the context in which they are used. Many researchers have discussed the perceptions of laboratory safety in agricultural mechanics programs (Bram, 2018). Only a few studies conducted explored the perceptions of welding technology. All these studies describe the perceptions of the facility in teaching safety, managing the laboratory, and working with personal protective equipment for students. High-risk occupations, including pipe fitting, plumbing, steelwork, and electrical powerline installation, face a high degree of occupational risk. With such risk of injury, welding certificate programs must integrate occupational safety training through hazard recognition. The AAS in Welding Technology Education within North Carolina Community College offers such coursework. Failure of appropriate occupational safety education within these educational programs will only perpetuate the current trend of severe injuries and fatalities for welders.

Training to Teach Safety

In a 2011 study, McKim and Saucier observed that teachers in CTE laboratories need safety education to enable them to manage safety within these laboratories. The study further recognized that unqualified educators leading the classroom could create an environment that was unsafe for both students and teachers and stated that the curriculum should be adjusted to meet students' needs of safety education (McKim & Saucier, 2011). Safety in CTE is hardly a novel concept: in 1983, Cahoon concluded that technical programs such as welding need to continue to address curriculum development and equipment purchases, utilizing and heavily prioritizing safety as a factor when making decisions.

Job Description of Welding Instructors

A review of three welding instructor job description advertisements from three different community colleges across the state was conducted as part of this research. None of the job postings indicated that student safety was considered a primary function of the job description. Some descriptions revealed a demand for American Welder Certification as Instructor and others sought credentials from the National Construction Center of Education and Research. Both credentials often enforce safety during the task of welding, but they do not teach students to evaluate tasks for safety. This failure to educate students to identify hazards greatly increases the risk for acute and chronic health concerns.

Job postings for welding instructors were reviewed to understand which safety qualifications the NCCCS had recommended for instructors to teach in the state. These job advertisements were analyzed for multiple positions offered across the NCCCS. In all three schools, the job advertisement bore no mention of student safety within the postings. This finding incited a review of the job classification from the NCCCS PeopleAdmin system, which found that instructors' understanding of safety management was not required as part of the job description.

The use of a safety management system within the classroom and laboratory may further provide students with exposure to risk**.** A safety management system is designed to manage an organization's exposure to risk proactively and has proven to be an effective in this task. Several systems have been developed to help organizations protect their most valuable resources, the human elements. Two of the most widely used systems are ANSI Z10 and ISO 45001. The ISO 45001 standard is more modern and is internationally recognized.

The OSHA Training Institute offers two different certifications; one is for general industry, the other for construction. Instructors teaching students to recognize hazards for certification are required to have a minimum of five years of experience in occupational safety within the general industry or the construction industry. Additional training for these credentials is also required, including a written examination and teaching proficiency demonstration.

The OSHA Act requires that employees be trained before they are exposed to hazards in the workplace (OSHA Act 1970). Buniya et al. (2021), Othman (2010), and Anton and Anton (1989) all noted that a lack of safety training results in employee fatalities, higher incident rates, higher indirect costs to the business, and poor workplace morale. Other researchers such as Bush et al. (2019) observed that instructors in CTE programs believe safety training is important; however, instructors have recognized that time is a factor in delivering training. Additionally, instructors were cognizant that an OSHA authorized training course in a 10-hour format did not provide enough instruction for students.

The Need for Safety Education of Work

Steel working trades such as welding pose a significant risk of injury to students regardless of the education level they are seeking. The courses associated with the various types of welding and certificate or degree all expose students to welding fumes, molten metal, flying debris, noise, and electricity. Regardless of CTE area, students begin to face hazards in the lab from the moment they are accepted into the program of study. Hazards in labs include but are not limited to: inhalation of toxic fumes, crushing, burns, eye damage, radiation, strain, falls, noise, and intense vibration (Tammar, 1997). Clearly, instructors must have some level of safety competency to help students recognize and protect themselves from harm. The inability of instructors and program managers to convey and promote these skills further leads to significantly higher risks for students when they enter the workforce (Guerin et al., 2020).

A review of the NCCCS proposed curriculum was conducted. The results of that review indicated that less than 10% of North Carolina community colleges require an occupational safety course in welding certificates. Less than 33% require an occupational safety course for a diploma, and less than 54% recommend it for an AAS degree. The review further revealed that for the 2019–2020 school year, 1,556 certificates were awarded, 275 diplomas were awarded, and 184 associate degrees were awarded (JobsEQ, 2021). Further analysis revealed that some students may have completed an occupational safety course, though course completion numbers did not identify which certificate, diploma, or degree seeker completed the work, nor did the certificate completion reveal if these were high school students or adults pursuing education. Such low completion rates with the number of CTE students that had access to the course would suggest that welding technology students are not receiving occupational safety training.

The North Carolina Community College system prepared a model of a recommended schedule. This has led to inconsistency and lack of required safety hazard training in North Carolina with the guided pathways model. None of the programs in the state utilizing the model contain a curriculum requirement of an occupational safety course. The structure of guided pathways is to provide students with clear direction on the courses they should complete in order to attain a certificate, diploma, or degree. The guidance system in place within these programs allows any advisor that is available to offer guidance to students who may or may not have the technical knowledge to recommend the appropriate coursework that would include a safety course within the required curriculum.

During a phone conversation with a personnel technician for the NCCCS, the credentials for welding instructors were discussed (April Tibbs, personal communication, August 2, 2021). Tibbs pointed out that the North Carolina Community College System was decentralized, and that each community college sets its hiring standards. The lack of guidance provided by the central office would suggest that up to 57 different hiring standards of welding instructors may be used with the North Carolina System.

Purpose Statement

The purpose of this study is to examine welding faculty and program directors' perceptions of teaching safety in welding programs of the NC Community College System, and how they teach safety skills in both lab and classroom settings. This qualitative study will focus on the instructors' perceived ability to identify hazards in the lab and to take proactive measures based on those hazards. An assessment of their level of knowledge will determine their perceived need for ongoing professional development. The study will further explore whether instructors in these labs feel that they have adequate safety supports, such as access to a trained occupational safety professional.

In one study, Chumbley et al. (2018) noted many instructors in these areas felt they knew enough about student and worker safety to provide adequate instruction. A significant percentage, however, felt the college system had not adequately provided suitable safety equipment, such as fire blankets. The study found that instructors of agriculture mechanics felt that safety was important: "Various studies have found that there are problems with safety instruction" (Chumbley et al., 2018 p.1).

Parker and DeRung (2019) noted CTE instructors lack the necessary background and qualifications to facilitate health and safety training in high-risk programs, which are those programs considered to have a high probability of significant injury and frequent exposure to hazards. Such programs include construction, agriculture technology, welding, and other skilled trades, and are among the most dangerous in the nation (U.S. Bureau of Labor Statistics, 2020).

Gunter (2007) noted that technology educators (TE) should build safety instruction focused on exposures into the classroom. Learning to recognize hazards is a skill that is essential to student safety at all stages of the educational trajectory and is transferable regardless of whether a student is in a lab or a worksite.

Lindholm et al. (2019) recommend that more research should occur to understand teaching and learning within occupational safety and health, suggesting that educating students has not been refined. The failure of institutions to help students make the connections between their own health and safety and the hazards they face in the work environment is a disservice to graduates of these programs.

Research Questions

This study will enhance welding instruction knowledge by addressing the following research questions:

1. How do community college welding instructors view the importance of teaching safety in community college welding classrooms and labs in certificate, diploma, and associate degree programs? How does it impact what they teach?
2. What are the safety skills taught, and how do community college welding instructors interact with students in relation to teaching safety in the welding classroom and lab?

Significance of the Study

Community colleges are a major provider of workforce development for welders, producing 2,015 students graduating from welding certificate, diploma, or associate degree programs in North Carolina during the 2019-2020 academic year (JobsEQ, 2022)**.** The current study's significance lies in its ability to heighten the urgency regarding the teaching of safety to students. The transfer of knowledge to the workplace bears the potential to preserve the health and lives of future welders and those already practicing within the industry.

As noted by Uddin et al. (2020), workplace injuries continue to rise because workers have not recognized hazards that they encounter. Welding instructors are responsible for delivering safety instruction to their students. The current study is critical to understanding the perceptions of welding instructors and program chairs within in community colleges, and how they use of safety programs within the classrooms and laboratory. These instructors and managers provide valuable insights as to how student safety is understood. Their perceptions could be used to reshape the recommended curriculum, requiring industrial and workplace safety programs within the certificate, diploma, and associate degree programs offered. If students receive more comprehensive safety training, future research could then examine if this type of policy change reduces injuries to young workers from ages 18–25 years.

Furthermore, changes in faculty and their supervisors' behaviors surrounding lab safety would reduce the risk of their personal injury and injury to students while in labs. These behavior shifts may include more safety audits being conducted with faculty and student's participation, and more support from professional safety staff within the community college system to become better educated of the hazards within the lab and the worksites that students will inhabit upon completion of the program.

Albert et al. (2014) noted that many experienced workers do not recognize hazards due to a lack of knowledge. This concept is illustrated by workers (e.g., welders) involved in different processes such as heavy equipment operations that may be working around or near them.

Since there is no single and uniform way that all the community colleges deliver safety training, it is essential to build a visage of the current landscape. The varying 57 community college programs offer many ways to train welders about workplace hazards and safety and the career path of welding is dynamic. When students select the career path of welding, they may know where they want to work. As times change, however, and opportunities arise, welders may work in general industry or construction settings. Regardless of the setting in which they choose to work, the hazards associated with the work environment will present inexperienced welders with unique and perilous challenges. It is incumbent upon community colleges to ensure that these inexperienced welders can recognize hazardous situations and take steps to protect themselves in the welding classroom/laboratory and the worksite.

Of equal import is the assessment of the level of safety training that is currently being provided to welders trained in community college settings. Failure of schools to provide adequate safety training may lead to greater and more severe injuries for graduates. Additionally, the cost of these preventable accidents is passed onto the employers that hire credential holders. These costs come at the price of human capital and the companies that employ them. The Liberty

Mutual Safety index estimates that employers will spend $58.61 billion on injuries claims annually (Liberty Mutual Insurance, 2021). The top four injury types involve over-exertion, falls, being struck by objects, and awkward postures (Liberty Mutual Insurance, 2021). This report further emphasizes the need for adequate instruction of hazard recognition within the classroom to prevent injuries of new workers.

Due to the vast number of individuals being prepared for NC welding jobs, the lack of adequate safety training has the potential to impact a larger number of students. In the 2019-2020 school year, 1,556 welding technology certificates were awarded (JobsEQ, 2021). The significance of these awards is that students who graduated from the certificate program may not have had any form of hazard recognition training outside of the content that an instructor believed they needed to know. Appendix C illustrates the number of credentials awarded in the 2019–2020 school year by community colleges in North Carolina. The chart also documents that a higher number of awards that do not require safety training as part of the curriculums in the NCCCS.

Although some programs suggest safety training exists within the associate degree pathway, others lack the requirement and are not educating young employees to protect themselves when they enter the workforce. The types of programs for safety management that should be communicated to students or apprentices include hazard communication, control of hazardous energy, respiratory protection, personal protective equipment, permit required hot work, confined space entry, fall awareness, and hand/power tools. The current study aims to investigate each of these programs, seeking the perceptions of instructors and their technical knowledge in executing instruction on those specific topics.

Welding is not just a profession; it is also a skill that is used by other trades workers that may utilize the skill to accomplish a particular task. In agriculture, the skilled trade of welding may be used to repair equipment by a person that has an agricultural education and small business. These individuals may only use the skill of welding on an as-needed basis or infrequently. This is a significant because of the roles that these individuals play in the educational process. Facility and program directors assist students with planning to participate in educational experiences. The current study will help researchers, instructors, and program directors to understand their own perceptions of welding safety more deeply, and how occupational safety training is delivered in the welding laboratory.

Theoretical Framework

The theoretical framework for this study is based on Ajzen's Theory of Planned Behavior (TPB). The TPB aims to understand the influences that affect the decision-making process. The constructs are made up of attitude, subjective norms, and perceived behavioral control. Attitudes can be defined as a person's decisions that are made in favor of or finds fault in when evaluating behavior (Ajzen, 1991). While both the Theory of Reasoned Action (TRA) and the TPB rely on attitudes and subjective norms to influence intention, which later leads to behavior. The TRA, however, was expanded from the TPB upon to include behavioral control. The TBP remains widely accepted as a robust theory to explain intention (Ajzen, 2020).

Based on the TBP, one's ability to identify hazards is the use of knowledge; this knowledge will force us to consider how we feel about perceived risk. Depending on one's attitude toward the situation, we may or may not recognize the significance of the hazard we encounter. Therefore, a student's ability to understand the exposure they may face may be critical to their well-being. Additionally, an instructor's ability to recognize that students face risk is critical. However, the TPB does not account for management's external pressures (Bergeson et al., 2002). Thus, using a specific course may shape attitude, subjective norm, and perceived behavioral control.

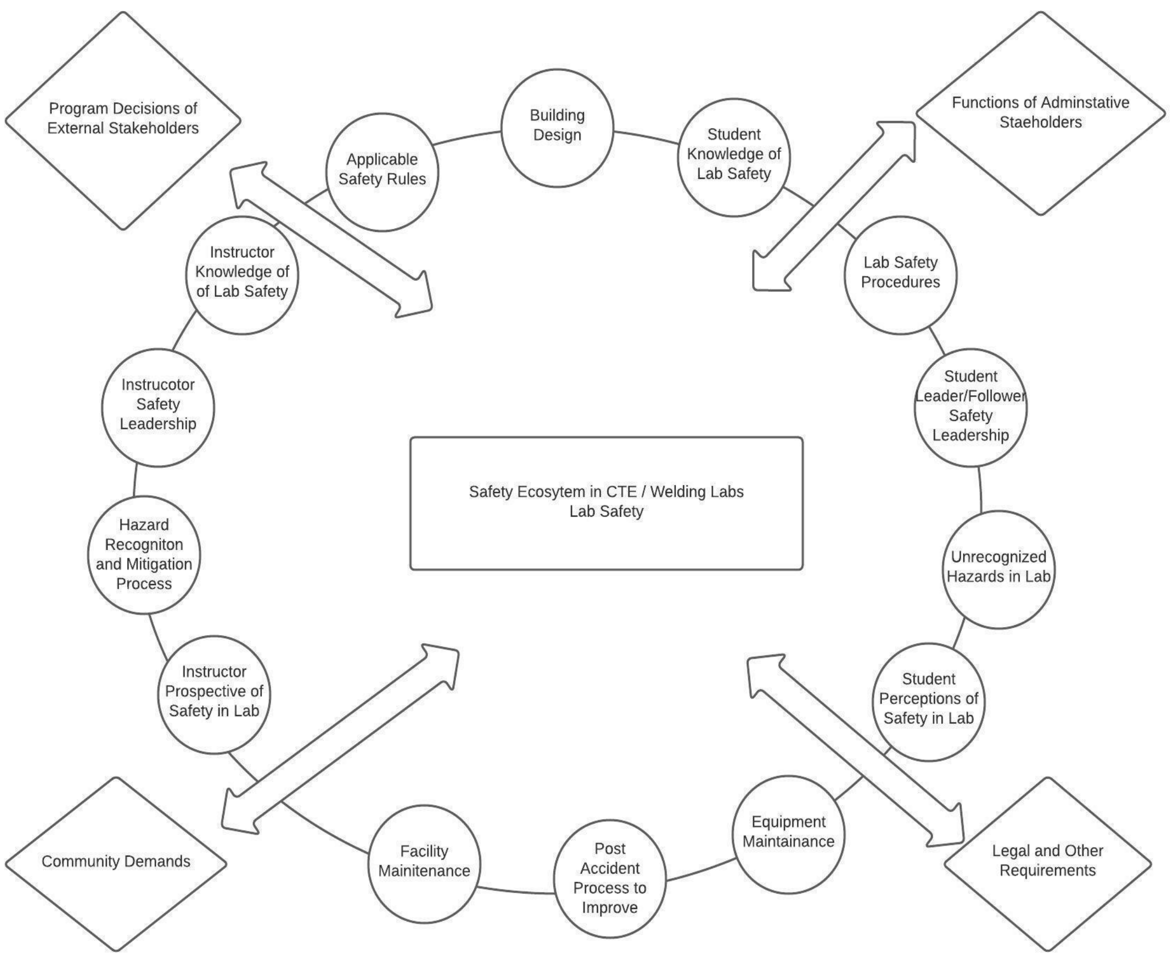
Bandura's (1977) theory of self-efficacy and motivation provides a framework to explain how people will perform during situations. The theory does not explain the reasons behind all human behavior, but sheds light on actions during specific situations. Bandura further suggests that efficacy can be increased or decreased given stimulation outcomes (1977). For example, consider a lab instructor displaying a high level of self-efficacy while demonstrating how to use a welding torch safely that then injures themselves or a student. In this instance, the instructor's level of self-efficacy may decrease regarding teaching safety. Similarly, if a lab instructor taught the safety of using fume extractors and completed the task successfully without injury, the instructor may gain a higher level of self-efficacy.

When high levels of self-efficacy are present, positive safety behaviors decrease statistically significantly due to overconfidence (Zhao, 2018) The theory has some opportunities to help people overcome areas in their lives in which they feel need improvement. The theory may also demonstrate, however, that high self-efficacy can lead to adverse outcomes. Salanova et al. (2012) found high-risk settings such as construction sites demonstrate that construction workers tend to subject themselves to higher risk and would suggest that self-efficacy helps make up a portion of self-behavioral control found in the TPB.

In examining the interactions, processes, policies, and ecosystem that make up the welding laboratory culture, further considerations should be made. Yu et al. (2021) observed other factors such as physiological endurance or sleep might have an additional effect on peoples' perceived level of control. Complex factors make up the safety ecosystem within which instructors and students work and learn. This environment is comprised of instructional knowledge of safety, student knowledge of safety, the design of the lab, and the equipment used by the students and instructor. Each contributes to the overall perception of the instructor's ability to create, operate, and influence behaviors within the laboratory environment. Depending on the circumstances, these elements may weigh more heavily in the decision-making process. Figure 1 illustrates the CTE laboratory ecosystem.

Figure 1

CTE Safety Lab Ecosystem



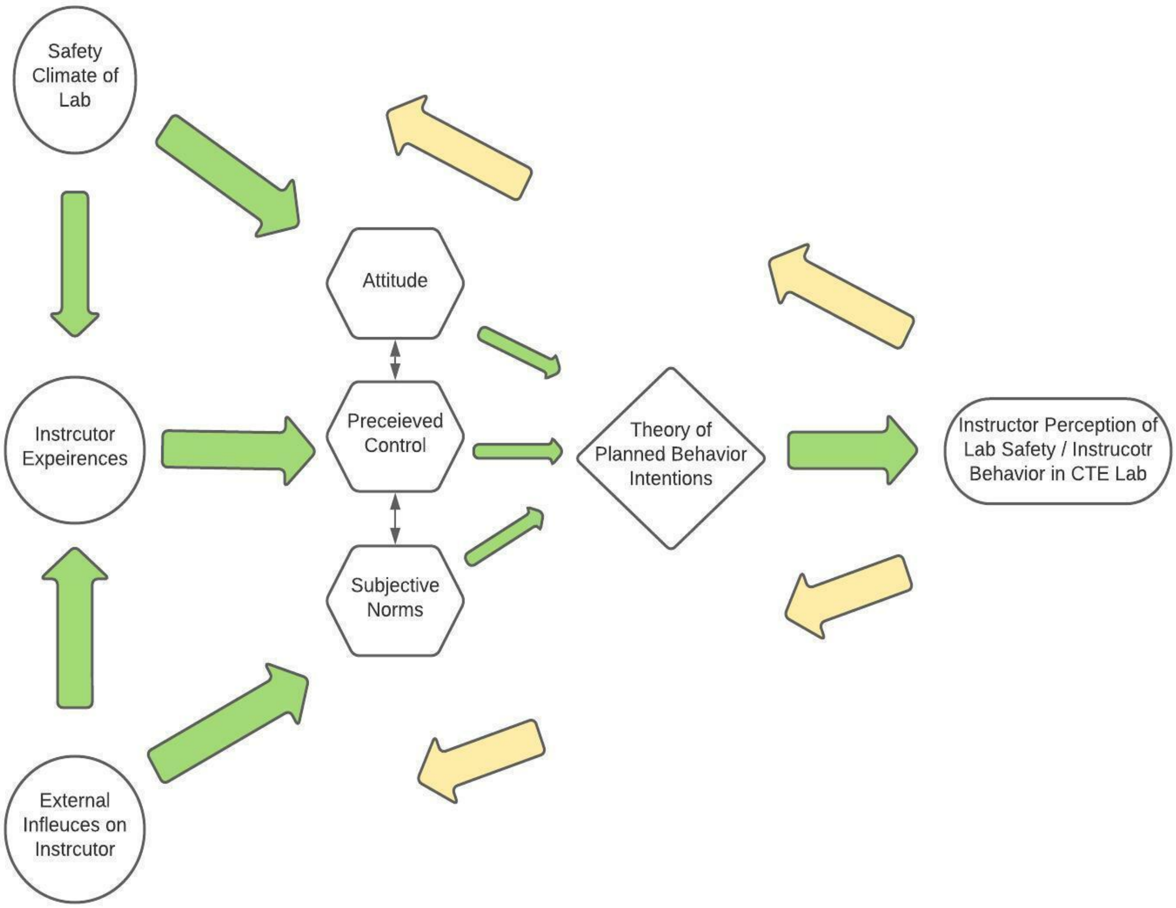
The welding lab environment is dynamic, changing from one day to the next. An examination from of the lab from multiple lenses sheds light on the rationale behind peoples' actions. Each of the identified factors may play a more significant role in decision-making based on the circumstances experienced on any given day.

The safety ecosystem contains a multitude of variables over which instructors and students may have control. When these variables are combined, they shape the perceptions of students and faculty to form a safety culture. Safety culture has a variety of definitions (Wiegmann et al., 2004).

The environment that shapes the instructor's perceptions and subsequent behaviors within the laboratory environment are formed from attitudes, perceived control, and subjective norms. These three variables lead to perceptions that shape behaviors carried out within the laboratories. Risky behaviors could be further influenced if, over time, the instructor continues to accomplish tasks without injury to students or equipment. A view of the laboratory environment through the lens of the TPB is presented in Figure 2. It is apparent that implicit or explicit conditions feed the perceptions of anyone that would learn or work in the environment.

Figure 2

CTE Theory of Planned Behavior Welding Laboratory



Definition of Terms

The following definitions are provided to give to provide both context and meaning when used throughout this study.

Administrative controls: Methods of reducing hazard exposures by use of policies or practices such as rotating workers or isolating the area where exposures are occurring (ANSI A10.38)

ANSI Z49.1: 2021 American Welding Society Safety Standard for the setup and operation of welding equipment (AWS, 2021)

Construction industry: As defined by the U.S. Department of Labor, construction, alteration, and/or repair, including painting and decorating (OSHA.gov)

Gatekeeper: Someone who may provide access to research participants (Namageyo-Funa et al., 2014)

General industry: As defined by the U.S. Department of Labor, all industries not included in agriculture, construction or maritime (OSHA.gov)

Health hazard: A chemical that is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenetic; reproductive toxicity; specific target organ toxicity (single or repeated exposure); aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in appendix A of the Hazard Communication Standard (Occupational Safety and Health 29 CFR 1910.1450b)

Occupational hazard: risks associated with working in specific occupations (OSHA).

Occupational health: Occupational health deals with all aspects of health and safety in the workplace and has a strong focus on primary prevention of hazards. (World Health Organization, n.d.)

Occupational safety hierarchy of controls: A standard protocol that states that as hazards are identified, they are to be eliminated by not proceeding with the exposure, by removal of the exposure with a substitution of a different product, by use of engineering design to eliminate exposure, by use of administration to reduce the exposure, and the use of personal protective equipment to protect the exposed person

Total Worker Health: National Institute for Occupational Safety and Health program that encourages an organization to emphasize safety and health for the workers throughout their entire working career (NIOSH, 2007)

Welder: An operator of the electric or gas cutting equipment or allied processes, a welder may be considered a teacher, student, or employee (ANSI Z49.1, 2021)

Organization of the Study

This study will seek to address the following research questions:

1. How do community college welding instructors and program directors view the importance of teaching safety in community college welding classrooms and labs in certificate, diploma, and associate degree programs?
2. What are the safety skills taught, and how do community college welding instructors interact with students in relation to teaching safety in the welding classroom and lab?

To answer these questions, Chapter 2 will explore a broad range of literature that explores the research around perceptions of instructors from community colleges in multiple states, multiple theories that have some application of when understanding instructors perceptions, the impact of leadership on safety culture in work and the classroom, instructor competencies of student safety, hazard recognition and mitigation techniques, technology's role in the classroom, and the world's recognized need for standardized safety education for all CTE programs.

Chapter 3 will focus on the research methodology to be used to answer research questions. The study will utilize a seven-answer Likert survey to reach the upper limits of perception (Allen & Seaman, 2007). Results will then be analyzed to select participants to answer the research questions.

Chapter 4 will be completed after the 60 days that have been allotted to capture data. The results will be exported from Qualtrics and imported into SPSS to use a correlation of perceptions. Additional discussion will be provided to understand how this research has aligned with studies that have been completed in other studies.

Chapter 5 will focus on the conclusion and further research recommendations to continue to build on the body of knowledge in CTE programs as it relates to student safety in laboratories and the workforce to come.

Chapter Summary

In this chapter, the scope and purpose of this study were discussed, and the significance behind the search for understanding welding instructors' perspectives regarding student lab safety in the North Carolina Community College System. The theoretical framework and conceptual framework provide the scaffold for the analysis of the study findings. Limitations and delimitations of the research were outlined, and a set of definitions put forth that will be used throughout the paper. Finally, the organization of this the following chapters was provided.

CHAPTER 2: LITERATURE REVIEW

The purpose of this chapter is to review the literature related to teaching safety in postsecondary careers and technical education and specifically, welding. Additionally, the review describes the principles of vocational education that have evolved into the principles of career and technical education. The review then synthesizes the literature on safety principles in vocational education, welding training, teaching welding safety, and educators' perception of safety in education. The chapter ends with a review of the theoretical framework, Ajzen's (1991) Theory of Planned Behavior, that will be used to provide a framework to understand postsecondary welding instructors' intentions and attitudes toward teaching safety, normative and subjective beliefs, and how they are teaching safety in postsecondary welding instruction. The chapter will end with a summary.

Need for Welders

There are a variety of welding positions and occupations that need the vital skill of welding in the United States and abroad. These positions include metal working, agricultural mechanics, pipefitters, and transportation skilled trades. According to the American Welding Society (2022), data revealed that more than 375,000 welders will be needed in the United States alone (American Welding Society, 2022). According to JobsEQ (2022) North Carolina had more than 1,100 open welding positions posted just in the month of October 2022. The greatest demand was found in Mecklenburg County

High-Quality CTE Programs and the Principles of Vocational Education

Within the Association of Career and Technical Education (ACTE) framework for high-quality CTE programs (Imperatore & Hyslop, 2018), safety was integrated within the classroom and laboratory components to ensure that students learn the aspects of occupational safety. The quality standard asserts that instructors are responsible for ensuring the classroom environment meets the requirements of federal, state, and local occupational safety laws (p.4). Standards such as these have not always been present, however, the concept of safety is not new to career and technical education. The safety principle was also a key component in Miller's (1984) principles of vocational education in terms of people, programs, and processes. In terms of people, the principles include guidance, lifelong learning, open to all, placement, sex bias/stereotyping, special needs, student organizations, teachers, and work ethic. In terms of programs, the principles include career and prevocational education, comprehensive education, curriculum, families of occupations, innovation, job entry, safety, and supervised occupational experience. The principles related to processes include advice seeking, articulation and coordination, evaluation, follow-up, legislation, planning, and research.

Within these principles, safety is integrated within several of the components. Within the program, Miller states that safety is "paramount in vocational education" (1984, p. 139) and is a key principle. The focus on safety with career and technical education programs has been the case historically. In 1919, the Federal Board for Vocational education identified safety as a critical principle. Miller stated, "Safety is primarily an attitude," (1984, p. 130).

With the significant impact of safety in most of the career and technical education occupations, safety becomes a concern in the education of all students. According to the literature, novice students can be highly vulnerable to safety issues due to a lack of knowledge (Salminen, 2004) and the impact of not providing safety education could harm business partners that are hiring students (Aragon-Sanchez et al., 2003). Part of this principle stresses teachers should have a positive attitude toward safety, model safety in practice, and teach about and use safety practices (Miller, 1984). The proactive development of safety-conscious vocational education students has the potential to positively impact workers, create economic mobility, and reduce the risk of employees working in unhealthy conditions if these skills are transferred from the classroom to the workplace.

The safety education of students also connects to the principle of the curriculum. In a recent article that discusses the development of a postsecondary welding curriculum for agricultural mechanics in Iowa, Samson (2019) found that there was not a prescribed welding program for students and recommended safety should be part of a common curriculum. Samson (2019) noted schools with high accident rates as part of their programs should consider making safety a higher priority. There are recommended pathways for certification, diplomas, and associate degrees in the North Carolina Community College System. However, the system-level course for safety education in certificate programs is not required. (NCCCS Welding Technology, n.d.).

While safety is part of the historical principles, different perspectives of safety culture may exist in a classroom depending on the demographics of the students. Marginalized groups of welders may experience a different educational experience, as instructors are not required to teach in a foreign language. However, OSHA mandates this requirement in standards such as Chromium VI which is commonly found in welding stainless steel welding rods (OSHA Act of 1970). This dynamic is of particular interest, as foreign workers in high-risk occupations are injured more frequently, and the need for education and training is necessary to protect these workers (Mekkodahtti, 2016). The COVID-19 pandemic has created a great deal of worker transition (BLS, 2020), but regardless of why a person is transitioning between companies or career fields, workers may need nondegree technical credentials. Thus, the need for students to have training that would not only provide safety protections would also provide students additional marketability in the workplace.

As the world continues to evolve, welding technologies will also evolve, and new training for welding, such as friction stir welding, may be necessary. According to Jamal et al. (2020), the world's economy will need to measure the environmental, social, and economic impact of various types of welding. During the 2020 study, Jamal et al. found that Frictional Stir Welding had the least impact on the environment and social elements, both of which include health and safety considerations, while still being economically profitable.

Preparation of Welders at Postsecondary Institutions

Across the country, community colleges are one of the largest providers of training for welders. According to JobEQ (2022), North Carolina has significant demands for blueprint reading, cutting, welders, and chippers. The North Carolina Community College System has multiple credentials and degrees that students may complete to attain a credential in welding, including an Associates of Science in Welding Technology, through the creation of a career cluster for welding technology in production. The cluster, created in 2013, would allow students that have completed the degree, diploma, or certificate to work in construction, manufacturing, energy, transportation, or work as an entrepreneur (NCCCS, n.d.). Students within this career cluster learn a variety of welding mediums including GMAW (Tig), GMAW (Mig), and SMAW (Stick) welding. The difference between the three types is the way metal is joined together and the type of energy source to join the metal.

In 2019, Mehrifar et al. found that various welding types pose varying levels of risk in laboratory settings. MIG welding was found to produce the highest level of occupational health exposure. The higher degree of exposure came from the way that the process forced the welder to be in direct contact with materials and tools that were being used to complete the weld (Mehrifar et al., 2019).

Incorporation of Safety in Welding Curriculum

The decentralized nature of the NCCCS has demonstrated that each college sets different standards for instructors within the 58 community college systems. As there are no set requirements for credentials, this can yield varying instructional quality levels and safety subject matter covered in the coursework. This variation in educational quality could lead to economic impacts through loss of life, indirect costs of overtime, company image, and administered fines that contribute to business profitability (Aragon-Sanchez et al., 2003).

There are several standards of safety that welders must adhere to while on the worksite. These standards include OSHA standards found in regulations in general industry, construction, or maritime operations (29 CFR 1910 General Industry, 29 CFR 1915 Shipyards, and 29 CFR 1926 construction). These standards are focused on ensuring that employers provide workers with the minimum amount of protection through employer working practices. The American Society of Welding has established further protections for safety during welding through the establishment of the American National Standards Institute (ANSI) z49.1.2021. This is important to note because the classroom is designed to operate much like a worksite. The similarities include risks from occupational health exposures, radiation, electrical shock, and falls.

Howell (2003) stated that safety in technical education classrooms should be a partnership between teachers and students. The emphasis on student ownership to create a safe environment was suggested to improve the classroom culture. Howell (2003) also pointed out that in many instances, safety training is conducted early in a course and may never be brought back up. Howell's solution was to integrate safety into the daily activities of the classroom.

American Welding Society Standards

The American Welding Society has produced several guidelines for institutions focusing on core welding techniques. These guidelines primarily focus on the design of welding stations in the classroom to eliminate possible hazards to students. The American Welding Society has further produced a safety standard for welders, which also encompasses teachers and workers (ANSI Z49.1,2021). The standard focuses on welding setup and operation in specific working environments. The particular focus on settings relates to additional hazards created by working in these environments. For example, confined spaces are addressed in Chapter 7 of the standard. The chapter references locations and regulatory measures that may be applicable depending on the scope of the work being performed. Ultimately, the standard sheds the responsibility to ensure that the management is the responsible party for ensuring that workers are safe and prepared to contend with hazardous situations.

The standard uses a logical framework to protect workers. Additionally, ANSI Z49. 2021 gives the welder and supervisor responsibility for proper welding equipment setup. Thus, welders should have adequate safety knowledge to identify hazards when they arrive on the worksite. Cunningham et al. (2018) identified that these industries, regardless of size, struggle with training the workforce. Other standards also demonstrate the importance of standardized safety training. The ANSI standard's last revision took place in August of 2021. Since then, several OSHA standards related to welding safety have been updated. Throughout the ANSI standard, the term material safety data sheet is present. When OSHA updated the hazard communication standard in 2012, the terminology changed with the term material safety data changed to a safety data sheet. The most significant change in the updated OSHA hazard communication standard was the introduction of global harmonization. Global harmonization created a universal format that all producers of products are now mandated to follow regardless of country of origin. If the product is used in the United States and is required to produce a safety datasheet, it must follow the required format. The datasheet contains manufacturers' names, physical and health dangers from using the product, emergency procedures, and other important information. Welders have specific exposures that they must be able to identify. Onyango (2021) noted that welders in construction are experiencing many health-related conditions due to exposure to nanotechnology. The OSHA act of 1970 requires employers to protect workers from exposure. Paid welders, welding instructors, and those learning to weld must understand the materials they are subjecting themselves and others to due to the welding profession.

Asplund and Kilbrink (2020) have surmised there is little data as to how CTE instructors receive professional development activities (p. 2). This suggests that very little research concerning the types of professional development instructors receive is not well documented, and a gap exists in providing further information to the research community. Postholm (2018) further concluded that there are many ways teachers learn to teach and that more research is needed to understand what strategies work best for various groups of instructors.

According to Breslow (2015), welding instructors teach 19th and 20th-century skills that have dangerous implications if mistakes are made. Breslow notes that the interaction between instructors and students uses a variety of modalities to achieve knowledge transfer. Interestingly, this was observed during a conference where a welding instructor was attending professional development for online learning. That would suggest that some instructors seek opportunities to develop their skill sets.

Types of Approaches to Protect Welders

Ensuring the safety and well-being of welders and welding students is of paramount importance. Welding processes involve numerous hazards, including exposure to intense heat, harmful fumes and potential accidents. To mitigate these risks and create a safe working environment, various approaches have been developed and implemented. This section of the literature review explores two key types of approaches aimed at protecting welders and welding students: prevention strategies to occupational injuries and proactive approaches to protection.

Prevention Strategies to Occupational Injuries

Proactive approaches to train employees entering the workplace as welders is needed because these new welders will face both physical safety and hygiene hazards when conducting their work. As noted by Onguto (2020), welders are far more likely to develop chronic diseases that affect the respiratory system and these are issues that can be avoided. In 1965, The Ohio State University produced a manual on Metal Fusion and Fabrication in Welding in Agriculture Mechanics in service applications. The manual identified the need for safety to be instructed within the classroom. Though the manual did not address many of the inherent risks that welders face, the manual did point to the fact that welding in agriculture mechanics had inherent danger. The manual recommended that students wear goggles while welding and use gloves. Therefore, it is logical to suggest that the profession of agricultural mechanics recognized that curriculum needed to have some hazard recognition as part of student learning for over 50 years.

The amount of welding activity that an Agricultural mechanic worker may perform may lead to similar exposures. Those that use welding to accomplish their primary work objective may be at greater risk. Many incidents within trades that have been investigated are searching for a single failure in these trades. Safety professionals must recognize that incidents are a result of many factors, not just a single root (Manuel, 1997)

There are strategies that workplaces utilize to prevent injury in the workplace. Some are interrelated and may feed other processes. Such an example is teaching employees to perform hazard recognition and then utilizing employees to work with safety professionals to develop and perform the task of hazard assessment. The process is often known by other names such as job hazard analysis, risk assessment, or job health analysis. These techniques are utilized if hazards cannot be eliminated and people will have some level of exposure. Therefore, programs should, at a minimum, teach hazard recognition and mitigation strategies to persons that may be exposed.

Proactive Approaches to Protect

In addition to teaching welding in the curriculum, it is critical that instructors are also competent with these standards in the classroom and lab. Jellani et al. (2017) began exploring why construction hazards may not be recognized as dangerous. The study did not focus on components of adequate training or management's effect on hazard recognition but sought to understand the failures of hazard recognition from the workers' perspective. Workers, which in this case would be welding instructors in the classroom, could fail to recognize the less common hazards, accept what they believe to be a reasonable number of recognized hazards, and identify that other workers failed to perceive the tasks to be completed. This research and modeling safety in the classroom could be used to condition students to look for the less common hazards, while pushing instructors who practice hazard recognition in the laboratory to work with students to identify all hazards and not just the most common ones. Exposures such as needle sticks and animal/insect bites that are less common in construction workplaces are difficult to simulate or even be acknowledged. The 2021 OSHA 10-hour construction trainer curriculum does not seek to recognize these hazards; however, welders will be in situations that they could impact their workplace safety. Therefore, students and workers must rely on methods that provoke recognition techniques.

Holmes et al. (1999) also noted workers' view of risk is affected by multiple factors, a key factor being the social constructs of workers around them. Research suggests that psychological and social factors are crucial in determining how people perceive and respond to risks (Douglas & Wildavsky, 1982; Rayner, 1992; Slovic et al., 1987).

Using a non-monic energy model, such as Albert et al. (2014), to help workers consider the less frequent exposures has merit and may bridge the gap to help workers recognize hazards in construction and agriculture training programs. The article notes concern for the observer effect. A solution would be the integrated use and review of electronic construction diaries, incident reports, and employee statements to correlate hazard recognition activities.

Hazard recognition training aims to equip students, regardless of the profession, to become aware of their exposure and take appropriate action. There are various delivery systems available that instructors in the industry could utilize to accomplish this. They include, but are not limited to, virtual reality simulators or wearable technologies (Nnaji & Karakhan, 2020).

Utilizing strategies to eliminate hazards should always be the first step to preserving life. Research on confined space entry involving welding (Botti et al., 2018) suggests welding tasks could utilize welding robot technology to prevent humans from the dangers of welding fumes. Barnett (2018) points out that utilization of the hierarchy of controls is essential, and there are other strategies within the design or maintenance stages of work. Barnett (2018) also demonstrated that for anyone employing a hierarchy of controls beyond elimination, the remaining hierarchy still has the presence of risk.

At a recent conference, the idea of utilizing virtual reality within CTE was presented (Anaya et al., 2022). While not directly focused on hazard recognition and the use of virtual reality to do so, the concept of hazard recognition was presented as part of the virtual reality solution. Furthermore, the researchers suggested that the use of such virtual reality technology would improve efficiency and improve faster completion of training within industry (Anaya et al., 2022).

Lagging Strategies to Prevent Future Injuries

In the instruction of welding, lagging strategies must also be considered. Each year the United States experiences a multitude of fatalities in various industries (BLS, 2020). Many of the incidents are chronicled through investigations by the U.S. Department of Labor Occupational Safety Administration. Although these incidents are chronicled, very little root cause examination is presented to the body of knowledge to prevent future incidents. This could be because the professionals investigating them have sought to find a single point of failure. Incident investigation can be a useful tool to prevent future incidents, but it is more reactive than proactive (Al-Bayati et al., 2021; Oakley, 2003; Underwood & Waterson, 2014).

It can be challenging to determine what exactly led to a fatality (McManus, 2009). McManus (2009) pointed out that when others are trying to learn from an incident investigation, many factors may lead to poor or inconclusive incident investigation results. Thus, it is not always easy for researchers to evaluate and point to specific root causes of incidents. This difficulty makes it even harder for practitioners to learn from others. McManus (2009) also pointed out that rule-makers utilize data from these fatality investigations to make rule changes or implement new rules. Failure to do incident investigation well may lead to unnecessary rules and added costs of doing business.

In a recent review of occupational injuries, Al-Bayati et al. (2021) evaluated fatalities involving arc flash. The review of results demonstrated that inadequate training was a potential workplace factor that led to death in the workplace. Inadequate training could mean a variety of things, such as training that did not teach hazard recognition, the proper steps to handle arc flash, or training that did not outline the procedures to prevent arc flash from occurring.

The activity of welding also occurs in other professions. A review of such incidents by Rani et al. (2005) listed several instances of occupational fatalities that occurred by employees performing welding activities. Although the report does not address fatalities in the United States, it provoked the reality that welders trained in different countries may weld wherever they choose. Therefore, students learning to weld must understand that each country has different production standards for torches, gas cylinders, and other equipment vital to a welding activity.

An epidemiological review published in 1981 found that welders who worked between 1951 and 1977 experienced a higher death rate due to respiratory conditions (Beaumont & Weiss, 1981). This, in large part, could be attributed to the lack of epidemiological information regarding exposures. It highlights why workers must train to recognize hazards from the beginning. The lack of knowledge and protection led to the suffering of many welders.

There may be times when welders are asked to perform welding tasks inside confined space locations. A confined space is defined by OHSA as a space not meant for sustainable living and which has limited egress. Welders may be brought into the space to repair a pipe or some other structure inside the space.

Instructional strategies to teach welding safely have been limited and challenging until recent years, when new forms of technology have emerged. Extended-based realty practices have shown that students can learn to weld using the new state of technology safely, without much of the exposure that they would typically face during regular classroom instruction in the past (Doolani et al., 2020).

Teaching Safety in Welding

Safety can be taught in several different ways in postsecondary welding classrooms. The instructor has specific techniques that be used in instruction; however, the classroom and lab settings are also workplace setting that require the instructor to recognize hazards, just as other workplaces. This topic is so important to the profession, the AWS offers training within their website free of charge to the public. Additional emphasis on safety is then promoted within their periodicals.

There are multiple learning modes through which students can learn hazard recognition. Instructional methods could include lectures, computer software, virtual reality, learning by doing, and work-based learning. Learners do not all learn the same way and it is critical that safety as a topic must be mastered. If multiple means are not used to deliver instruction, it is less likely they will learn and transfer these skills to the workplace (Sims & Sims, 2006). Some learners are auditory, some are visual, some learn by doing, and others learn through lectures (Fazarro, 2005). For this reason, instructors must have a variety of techniques to teach new students hazard recognition concepts. Additionally, instructors must consider that learners may speak English as a second language and adapt their pedagogical approach to meet those students' needs. "Instruction offered in learners' primary language has driven quality, worker safety, and productivity" (Brooks, 2009).

Maul and Wallace (2007) explored the use of computer software to teach workers the hazards of using industrial presses. Workers were consulted to evaluate presses for hazards. The software would then direct them to the appropriate occupational safety standard to demonstrate if a risk existed. Workers who used this learning strategy performed better than workers who experienced other training forms.

Chakradhar et al. (2022) examined applications of augmented reality within the welding classroom. Within the study, students were provided with tools that allowed them to perform tasks in augmented reality with full instruction and correction at the time of practice. The study noted that students were not exposed to harmful welding fumes, ultraviolet light, or other occupational health exposures, and ultimately enhanced student safety within the welding laboratory.

Johnson (1989) described a series of strategies that agricultural laboratories and classrooms could utilize to prevent incidents from occurring in the laboratory. At least 15 of the management strategies that Johnson pointed to were safety related. These items were many things that students could perform as part of the process that emphasized learning safety. These items included housekeeping, incident management, first aid, safe operating procedures, and more. These management strategies were clearly developed to build on safety culture within the classroom and reinforced by the instructor as part of classroom management.

American Welding Society Online Safety Training for Everyone

The American Welding Society has created an 11-module safety training program to introduce students to safety within the welding profession. The modules consist of basic safety training and is presented in conjunction with the ANSI Z49 (21012) standard. The training has not been updated since the implementation of the latest 2021 version of the standard but provides emphasis on the management of welding activities. The roles of these groups have not changed between the old and the new version of the standard and managers are the final authority to allow welding to occur.

Advantages

The AWS safety training program does have some advantages to its delivery and format. The modules are designed to be taken in any order needed. Therefore, if an instructor sought to teach specific aspects of welding safety at various times, they could use this training to supplement the lessons learned and allow students the opportunity to take them at their convenience.

Each module is about 20 minutes in length. The material felt a bit dry at times and, in some instances, veered into the territory of over-explanation. For example, it is good to know how the eye may be affected by exposure, but at one point, they explain how the eye works. The information is good but not needed for training and would not be the value-add that it could be if they had presented some statistics about eye injuries. Documentation of cases shared as facts emphasize the importance of using engineering, administrative controls, or personal protective equipment when performing high-risk activities. The training provided is accessible to everyone regardless of whether they are trained welders, instructors, or students. One need only have access to a computer that can connect to the internet. The training course can be completed at any time.

Radiation safety is discussed within module two of the training. Module two covers items such as what is radiation, the types of radiation, or the harm that may be generated to the eyes because of exposure to electromagnetic radiation. Some tools produce damaging light that can potentially expose welders to eye damage and burns to the skin. Disorders from over-exposure to radiation include photokeratitis and skin cancers (American Welding Society, 2022). According to the American Welding Society, sparks can travel great distances. In some cases, sparks can travel as much as 35 feet or more if flames fall from surfaces of elevation (American Welding

Society, 2022). Almost all the modules stressed the potential for fire and explosions. Stressing this type of recognition is good reinforcement of common exposures that welders may experience frequently, given the nature of their profession.

Disadvantages

Much of the training presented by the American Welding Society is not a complete substitute for hazard recognition training. Based on the review conducted for this study, the training has many things that are of interest, but in other areas it felt rushed. For example, the three types of burns are covered in the Burn Module. The training spent more time on how to recognize injury than it did discussing methods to prevent the burns from occurring.

The fifth module does an incredible job at covering the various exposures that may be found in the air but does not address how workers or students should protect themselves. The information is supplemental and could be useful to welders trying to understand exposures. These exposures include toxins from things such as lead and a lack of oxygen particles in a space that may be entered for welding.

The training focused on personal protective equipment as opposed to any discussion of engineering controls and administrative controls. In some cases, the training discussed hazards that may be created by using personal protective equipment. Furthermore, the training emphasized using other organization standards such as NFPA. While these are good references, it is unrealistic to think that anyone would seek out an additional specific standard that may require additional technical knowledge or funding.

The training failed to spend adequate time reinforcing the importance of hazard communication or using hazard communication strategies through safety data sheets. If welders are taught to start with the safety data sheets, they would have a better understanding of the risks they may face, and thus be better prepared when hazard recognition activities present themselves through chemical exposure, physical hazards, and health hazards.

Laboratory Culture – Managing and Leading Instruction

When teaching welding, the laboratory is a large component of hands-on instruction. The welding instructor is the leader of this classroom environment. Leadership, according to Northouse (2019), is defined as "using influence to influence others to accomplish a common goal" (p. 5). The perfect example of an instructional leader is not easily conceptualized or replicated so that everyone would yield the same results, therefore the question remains of how leadership affects the safety climate in a welding classroom.

There is no aggregated data in the North Carolina Community College System (NCCCS) to demonstrate the exposures from the current technical labs. Furthermore, no national database reports this data for the United States. Instead, researchers seeking information about injuries in technical labs are presented with horrific stories of injuries that have taken place and found their way to news media organizations. While studies like Chumbley et al. (2018) present the perceptions of student safety among agricultural faculty members in Texas, this does not provide actual data on the practices and behaviors. This research highlighted the importance of student safety in career and technical education labs. However, to be an effective leader within any college technical learning lab requires leadership and technical safety knowledge to promote students' ability to recognize potential exposures in these dangerous environments. Chumbley et al. (2018) observed teachers in South Texas felt prepared to teach safety which was in direct opposition to earlier studies (Dyer & Andreasen, 1999; McKim & Saucier, 2011; Swan, 1992). Variance in research outcomes suggests that some instructors may not feel as confident in delivering adequate safety training. Furthermore, none of these studies mentioned an actual test of safety knowledge, only a perception of proper safety knowledge.

Instructors and Leaders and Communication Styles

Leaders communicate in various ways: verbal, body language, and writing. Morris et al. (1996) discussed the students' perceptions of college instructors' dress. The study concluded that the perception of instructors that wore dress clothes and were male were significantly statistically more positive than those who dressed more casually. This statistical significance may indicate that the use of a certain type of dress within student labs may indeed impact a student's willingness to comply with the safety rules. Instructors who recognize the physical hazards and health exposures and practice donning and doffing safety equipment may send a message to students that the activities they are participating in present elements of danger. Additionally, it may set an expectation that protecting yourself is a requirement (Zajac & Lane, 2020).

Leader membership exchange theory examines the relationship between leaders and followers (Northouse, 2019). Earlier research suggested that the more the leader communicated with the follower, the better the relationship was for both the leader and the follower (Hill et al., 2014). This may suggest that instructors that communicate more frequently with students may have a deeper relationship. This relationship may lead to students' willingness to accept safety guidance from instructors in career and technical labs.

Safety Leadership Ethics in the Laboratory

Leadership ethics have been shown to influence worker safety and leaders may promote safety through their actions (Shafique et al., 2020). Similarly, instructors who practice ethical leadership in the technical lab may also encourage positive safety outcomes for students. Lindholm et al. (2019) noted that instructors must be convinced that safety training is important.

This would suggest instructors lack safety technical knowledge, which would allow them to recognize and demonstrate strong ethical leadership.

Teaching safety in hazardous environments is not only an ethical or legal requirement; it is also a moral obligation, according to Chumbley et al. (2018). Therefore, instructional leaders, just like workplace supervisors, have a responsibility to lead students and workers in a manner that protects them. Failure of instructors to adequately protect students has resulted in criminal charges such as those brought against a professor in 2015 following a lab explosion which resulted in a student fatality (Skvorc & Wilson, 2015).

Instructional Leadership and Follower Knowledgeability to Recognize Hazards

For instructional leaders to manifest attitudes within the classroom, they must first understand with what they are coming into contact. Many instructors from career and technical fields have experience working in the industry. However, their experience and training may be limited by a lack of professional safety instruction. Therefore, while they may inherently recognize hazards to which they are being exposed, they lack the ability or foresight to adequate explain or prepare their students for similar scenarios. For example, stainless steel welding rods have been used for decades, but it was not until the late 2000s that it became a regulated carcinogen that required shipyard welders to be provided additional protection through engineering controls and personal protective equipment.

Instructors who were skilled tradespersons may not have the time or technical knowledge to know when new epidemiological information on exposure becomes available. Lack of instructor safety knowledge and the ability to know when new exposures are recognized are systemic burdens that instructional leaders must be taught. Just as instructors find themselves learning to provide career and technical training, they must also be given the knowledge to help recognize hazards in the technical labs (McKim & Saucier, 2011). This new knowledge can be used to set new norms and greater expectations in the technical labs. Once instructors of labs have been taught to identify safety hazards and health exposures, students should also be taught to recognize them. As noted, earlier workforce development and apprenticeship programs bring students into technical labs and the real work environment where they may be exposed to hazards that could cause them health and physical problems.

Instructional leadership within their courses and curriculum should be working on occupational safety skills to advance young people (Guerin et al., 2020). Welding labs within many of the community colleges in North Carolina are small workstations that include welding equipment, ventilation, and welding curtains. Safety equipment is noted as being assigned, but no time to explain or fit is demonstrated within the published curriculum. The text describes safety in hazard recognition and mitigation strategy. The text does not seem to describe or recommend important topics such as hazard communication (the Right to Know Act), respiratory protection, shop safety inspections, or safety equipment such as portable fire extinguishers. Samson (2019) believed instructors should seek training to improve their knowledge.

Professional Development of CTE Instructors

The professional development of career and technical education instructors was included in the Perkins V legislation (1984). The 2018 Perkins V legislation puts additional emphasis on strengthening CTE instruction (Strengthening the Career and Technical Education for the 21st Century Act 20, USC 2301, 2018). Part of the act provides funds to improve the quality of teachers, faculty, and administrators. There is a significant amount of research on CTE teachers which, in general, states they would like additional training related to planning instruction, delivering instruction, managing their classroom, and the utilization of teaching technologies

(Baker et al., 2016; Bartlett, 2002; Bussey et al., 2010; Cannon et al., 2011; DiBenedetto et al., 2018; Drage, 2010; Latz & Mulvihill, 2011; Mosterdyke, 2014; Murray, 2002; National Research Center for Career and Technical Education, 2010; Ruhland & Bremer, 2003; Sanford & McCaslin, 2004; Sass, 2011). At the postsecondary level, Bartlett (2002) stated that there were differences by states, governing bodies, and institutions on the requirements and professional development for CTE instructors for licensure or to strengthen their instructional abilities. Since these programs vary in length, time to completion, content, and audience, it was noted that there was little commonality in requirements. Bartlett (2002) found that most of the work on teacher preparation policies was for high school teachers, not community college educators. A recent study of 12 CTE instructors in Tennessee by Hudson (2021) reported that none had formal training before beginning work as a CTE instructor. This aligns with the historical perspectives on the preparation of CTE instructors, as many of the instructors stated they had on-the-job training, shadowing experiences, or an opportunity to start as a part-time or contract-based instructor.

Hudson (2021) found that instructors in the Tennessee Community College System needed support from external partners such as universities. Hudson's findings suggest that instructors in CTE programs need assistance in “instructional planning, course management, and technology training to name a few” (p.164). Furthermore, Hudson (2021) outlines the importance of training for new instructors within CTE.

The limited curriculum availability for training and no professional development for instructors will lead to continued subpar education (Samson, 2019). The literature review revealed a lack of research on the amount of professional development in student safety that has been conducted to improve instructors' understanding of occupational safety exposures. Lack of development in teachers and students would suggest that although teachers may perceive themselves as adequately providing safety training in a laboratory setting, they most likely have further opportunities to improve.

Pate et al. (2012) suggested that teachers within the agricultural mechanics profession should focus development skills on items such as lab safety plans to ensure that shops are safe for students, among other pedagogical skills. Pate et al. (2012) found that agricultural teachers learning to weld need strong technical skills within welding equipment setup.

The need for other professional development within colleges and universities is ever evolving with the introduction of "maker spaces." Love (2022) defines the concept of makerspaces as hubs that bring various technical skills, art, science, and engineering together to solve problems. These spaces appear on college campuses, in libraries, dorms, and even residence halls. With their creation, hazards have been created and require robust strategies to prevent injury to students (Love, 2022). This would suggest that anyone supervising activities that generate hazards should be trained to identify and remedy hazards created in any learning environment. Mayfield (2021) also illustrates the need for safety within the agricultural lab, pointing out that many studies have suggested that professional development is a fundamental part of instructor development.

Prevention of Student Injuries

No solitary theory explains or seeks to understand why accidents happen. However, that has not stopped researchers from developing theories around behavior, accident causation, and prevention through design. The theory of planned behavior discusses the behavioral approach to understanding incidents (Ajzen, 2002). The American Society of Safety Engineers (2016) suggested the key to preventing incidents is through the Design Process, while others have multiple theories around accident causation, which seek to look at a variety of factors that led to the accident occurring. Additional research from Albert et al. (2014) shows that hazard recognition is a key component in helping workers prevent construction injuries.

The theory of planned behavior presents the most widely used explanation to describe why people commit unsafe acts and seeks to explain why people behave as they do (Ajzen, 1991). The TPB consists of three components, including subjective norms, attitudes to norms, and perceived behavioral control (Ajzen, 1991) and is quite relevant to leadership. As noted by Su et al. (2019), the subjective norms are presented by both leaders and coworkers. Just as teachers are leaders and other students are coworkers, their perceptions and behaviors may also influence how students conduct themselves in technical labs. Owusu, Danso, et al. (2022) found that other cultural norms may also influence employees' willingness to accept risk on construction work sites. Leadership influences students in the classroom as it influences workers in the workplace. Therefore, it is reasonable to suggest that supervisors in the workplace are seen similarly to classroom instructors in the labs regarding their effect on a worker or student’s perception of safety risks. Rubenstein et al. (2014) noted that role-playing and visual instruction were among the most effective ways to teach students safety skills. This would further illuminate that instruction specific to safety in the laboratory setting is crucial to preventing student injuries.

There have been several instances of fatality of students working in labs. Two of the most widely published instances of tragic fatalities occurred in chemistry departments. The first occurred in 2011 at Yale University when a 22-year-old student got her hair caught in a lathe while making lenses for a senior project (Benderly, 2015). A lathe is a machine commonly used in many CTE programs; the purpose of the machinery is to shape metal. Students seeking to become machinists would be exposed to the unguarded moving parts of a lathe. Additionally, suppose the machine were to malfunction, in which case students must recognize industrial safety protocols such as Lock-Out Tag-Out, which teaches persons that may interact with equipment not to energize it while someone else may be working on it, so that they do not attempt to operate machinery that may not be functioning correctly and injure themselves or someone else.

A widely publicized and controversial incident took place in California, in which a graduate student was handling a highly reactive chemical that caught fire, eventually leading to severe burns and death. The faculty member overseeing the lab was charged with four felonies, but charges were eventually dropped (Skvorc & Wilson, 2015).

In the situations described, tragedies arose that resulted in the loss of life, threats to the schools' reputation, and positional leaders facing pushback both internally and from external stakeholders. Instructional facilitators and leaders have a vested interest in promoting safety within the classroom. Further investigation would most likely show that leadership failed to protect students and faculty from these situations.

Gillen et al. (2013) noted teaching students about safety in a lab setting at the beginning of their experience was crucial to preventing injuries. Parker and DeRung (2019) examined the safety and health training standards within career and technical education. One finding by Parker and DeRung (2019) was that colleges should not assume that just because an instructor has technical knowledge in their field that they necessarily have the skills needed to appropriately deliver safety and health training to students.

A considerable number of research articles present leadership and its effects on the safety of followers in the workforce. Barling et al. (2002) note that transformative relationships influence employee behaviors and values. Clarke (2013) further expanded on the idea by performing a study that demonstrated that leader-member exchange impacted employee perception of safety and willingness to follow work rules for compliance. The significance of this can be seen in its application in today's workplace, and by extension in the technical laboratory settings. Caterpillar has developed safety leadership training to foster leader-member exchange. The significance is that Caterpillar has set up training opportunities in North Carolina's Community College Career and Technical Program. Johnston County Community College currently offers educational opportunities for working on equipment that may lead to permanent employment.

According to Hardison and Gray (2021), Lingard et al. (2013), and Su et al. (2019), supervisors are responsible for addressing technical issues that arise from the projects with which their employees work. These interactions primarily occur with the employee's direct supervisor and occur less frequently with top managers and safety subject matter experts (Fang et al., 2015; Lingard et al., 2013). Supervisors are responsible for assigning tasks that employees complete for compensation. Instructors also assign tasks to students to compensate them through knowledge. Therefore, just as managers supervise employees, so do instructors manage the activities of students, and they are equally responsible for the environment in which the tasks are completed.

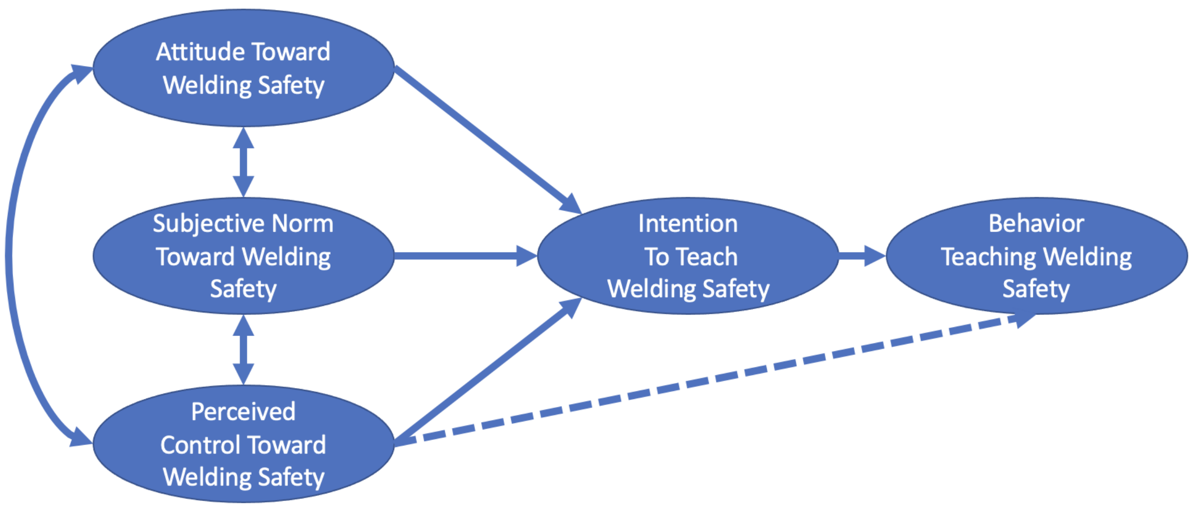
The use of leadership management exchange is explicitly utilized for safety. Safety expectations are enhanced to promote good behaviors among the workers, supervisor, and the organization (Su et al., 2019). This further illustrates that instructional leadership in students' careers and technical labs could present the same outcomes.

The Theory of Planned Behavior

In the late 1960s, psychologists began to develop the theory of reasoned action. The theory was later expanded and renamed the Theory of Planned Behavior (TPB). The theory of reasoned action was first published in 1975 and only included attitudes toward behavior and subjective norms (Ajzen & Fishbein, 1975). The theory was used to help understand why individuals took specific action. It was later expanded by Ajzen to include perceived behaviorist control.

Figure 3

Theory of Planned Behavior in the Context of Teaching Welding Safety



The theory has been tested in many ways to help individuals understand why they are doing specific things and what steps can be taken to optimize the outcomes of any intervention. Studies have been conducted on weight loss, smoking, and educational environments to help participants reach their goals.

The theory is not without academic critique, as some have pointed out that parts of the theory lack consistency in the weight of the variables' effect (Lee et al., 2010). Lee et al. pointed to studies where only two of the three variables were statistically significant in veering manners.

For example, Czerniak et al. (1999) suggested that only perceived control and subjective norms affected outcomes, whereas Sugar et al. (2005) found that subjective norms only affected results.

While no factor within the theory has been shown to have the greatest effect on the outcomes of interventions, studies continue to demonstrate that TPB is a valid solution to understanding why people take the actions they do when presented with novel situations. The TPB demonstrated that outcomes could often be predicted, with studies involving breastfeeding, how people spend their leisure time, and others concerning technology adaptation among those which have shown to contain empirical data supporting the theory.

The intentions of instructors and the level of perceived behavioral control create an impact on how instructors emphasize curriculum within the classroom (Martin & Kulinna, 2004). Furthermore, within the application of TPB in classrooms, Martin and Kulinna (2004) concluded that instructors with strong behavioral attitudes were much more likely to teach classes with the intention to promote health, while instructors with negative intentions were less likely to emphasize health in the classroom. This would demonstrate that welding instructors that rely on an unprepared management team will likely find themselves less desiring to provide an emphasis on welding safety.

According to Pisaniello et al. (2013), the use of certain training aids can help shape the attitudes and beliefs of students. An instructor's inability to find these resources due to a lack of knowledge may further influence outcomes for students and affect an instructor's ability to prioritize aspects of safety in the classroom. As noted by Krosnick and Alwin (1989), safety training has an influence on attitudes and behaviors. Thus, the impact of the teaching and materials used have a direct correlation with the TPB.

Chapter Summary

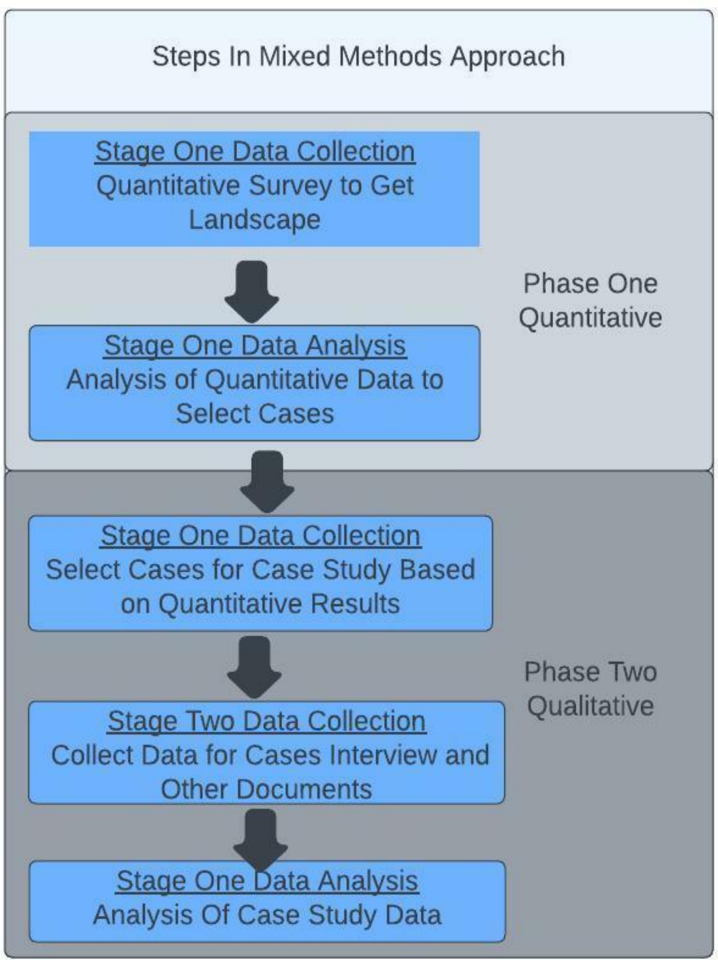
This chapter has provided and overview and synthesized the literature associated with the topics of this study. The literature review then summarized safety principles in vocational education, welding training, teaching welding safety importance to hazard recognition, and concludes by examining the theoretical framework of this study through Arjun's theory of planned behavior.

CHAPTER 3: METHODOLOGY

This chapter provides an overview of the research design, describes the research setting, and provides my positionality statement. The methods are detailed in a two-phase sequential explanatory case study approach that is depicted in Figure 4. This mixed methods approach gathered empirical data for the case studies, with primarily quantitative data in Phase 1 and qualitative data in Phase 2.

Figure 4

Steps in this Mixed Methods Study



When discussing Phase 1, I present the methods used to select participants, collect data, and analyze data. In Phase 2, I include the methods for the selection of cases, data sources, interview protocols, document collection including interviews and documents, transcribing, data coding, and data analysis. In Phase 1, the data collection used survey data to understand the welding landscape at NC Community Colleges and provide data for the purposeful selection of the 32 welding instructors who were interviewed. Phase 2 included the interviews and the collection of documents such as syllabi and job postings to provide further details into the research setting and enrich the description of the case studies. As Yin (2018) states that multiple artifacts will strengthen the validity of the case study, other appropriate artifacts that provide insight into these cases were collected when offered by the participants and found to be valuable and relevant additions to the research. This chapter will conclude with a summary of the methods.

Research Design and Rationale for Design

For this study I implemented a mixed methods approach. According to Johnson et al. (2007):

> Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration. (p. 123)

The research design uses a multiple case study method to generate empirical evidence to enhance the reliability of the findings (Gustafsson, 2017). Based on the strength of the participants' perspective on safety, the welding instructors were placed into two cases, those with strong safety perspectives and those with weak safety perspectives. These two cases are presented to examine safety perspectives within the welding laboratory. The sample of instructors is from the 57 NC Community Colleges that offer welding through certificates, diplomas, or degrees. Additional data collection to provide a deeper understanding of the context of the NCCCS in relation to welding includes the recommended course offerings from all NC community colleges offering welding programs. The information collected through surveys, interviews, syllabus reviews, and course offerings serve as evidence to strengthen the cases presented at the conclusion of this study. Strong evidence such as interviews, surveys, and artifacts are used to generate a high-quality case study (Yin, 2018).

Mixed methods research was selected for this study because it provides a logical approach to producing case studies rich with perspective and further validated through quantitative methods (Yin, 2018). According to Yin (2018), case studies rely on artifacts, interviews, and observations to produce quality research. When examining a previous study conducted by Tammar in 1997, qualitative research was used to describe the perspectives of welding instructors in Texas. Interviews were conducted, but no quantitative data was presented to improve the study's validity. Case studies with a mixture of qualitative and qualitative data improve the study's validity (Yin, 2018). Data sources that will be used to examine multiple case studies include real time job postings from JobEQ, a voluntary written survey, zoom interviews, and supplied curriculum from classes being taught or previously taught. All data were then used to answer the research questions:

1. How do community college welding instructors view the importance of teaching safety in community college welding classrooms and labs in certificate, diploma, and associate degree programs?

2. What are the safety skills taught, and how do community college welding instructors interact with students in relation to teaching safety in the welding classroom and lab?

Utilizing JobsEQ, an individual can conduct a real-time job search. The review first narrows the hiring locations to the North Carolina Community College System. A filter was then applied using "welder instructor" to narrow the results and eliminate high school instructors. Once produced, the job postings were downloaded and saved into a single PDF file. Once stitched together, I conducted keyword searches for words and phrases relevant to this research. These keywords included safety, minimum experience, minimum education, amount of teaching experience, and more.

The written voluntary survey focused on safety-specific topics found in OSHA standards within the construction industry. Questions that gauge the participant's knowledge of fall protection, hazard communication, fire safety, struck by, caught between, electrocution, and more will help generalize the backgrounds that have formed the participants' perceived behavioral control and subjective norms.

The Zoom interviews sought to provide the selected instructors an opportunity to provide a broader explanation of how they teach welding in the welding laboratory and explain their perceptions of teaching safety in the welding laboratory classroom, and provide additional context and depth to the narrative aspects of the research.

Research Setting

The 57 colleges in the NCCCS support many skilled trades offered throughout North Carolina and bordering states. NCCCS produce more than 2,000 welding certificates, diplomas, and associate degree graduates yearly (JobEQ, 2021). The 2019-2020 school year included 1,556 certificates awarded, 275 diplomas awarded, and 184 associate degrees in Welding Technology

(JobsEQ, 2021). Participants in these programs may be certified in MIG and TIG welding. All 57 programs offer a minimum award of a certificate. Forty-seven colleges produced graduates with a diploma and 24 of the 57 with an associate's credential in the 2019-2020 academic year (JobsEQ, 2021). Depending on their program, they may offer these programs to dual-enrollment high school students and adults that have completed their high school diploma or equivalent. These programs may also teach welding as a hobby or as a particular interest program without an awarded certificates diploma, or degree.

Quantitative data obtained through surveys, job descriptions, syllabi, and other artifacts was used to validate findings with the qualitative portion of the research done through interviews. Integrating quantitative and qualitative data has produced rich and helpful case studies. This research design approach is known as explanatory sequential mixed methods. “Explanatory sequential mixed methods is one in which the researcher conducts the quantitative research, analyzes the results and then builds on the results to explain them in more detail with qualitative research,” (Creswell, 2014, p. 33). This mixed method approach provides a rich combination of open-ended questions, and the data will provide valuable artifacts to make generalizations regarding the safety perspectives of welding instructors in the community college system (Creswell & Creswell, 2018).

This study describes welding instructors' perceptions of occupational safety within the NCCCS. The case study of instructors in welding programs is being utilized to share experiences in the context of the workplace that have shaped their attitudes towards teaching and practicing safety in welding programs. This study has investigated how their attitudes toward worker and student safety have formed and how they deliver instruction within the laboratory environment. Types of experiences that this study seeks to explore include exposure to significant injuries on a worksite, student injuries in lab settings, the training they have received before teaching, training received as instructors, employee-sponsored training, or training to improve their skills.

Positionality Statement

According to Coghlan and Brydon-Miller (2014), "Positionality refers to the stance that the researcher holds concerning the social and political context." The researcher provides this statement to advise the audience that there is no conflict of interest. Research bias is an inclination or prejudice toward research that can cause unjust harm to one person or group, especially in a way considered unfair or costly (Simundic, 2013). Participants were not told that the survey presented is linked to student safety, instructor safety, or their perspective, thus removing research bias.

The author of this dissertation is a practicing safety professional. The role of the researcher is only to seek an understanding of the instructor's perspectives. If the researcher were to witness students participating in a dangerous activity, he has an ethical obligation to warn them to reduce the chance of harm. For this research, there were no active observations of student behavior, which removed the possibility of researcher interference in any unsafe circumstance presented inside the actual welding laboratory.

The researcher paid particular attention to the amount of information related to identifying the purpose of this study to the instructors involved to ensure participants will not be influenced in the context of their answers. Furthermore, the researcher has presented results regardless if they are positive or negative to ensure the integrity of the research.

Institutional Review Board (IRB) Approval Process

In the realm of scientific research, ethical considerations are paramount. Researchers strive to conduct studies that protect the rights and well-being of participants while generating valuable knowledge. To achieve these goals, institutions and organizations have established Institutional Review Boards (IRBs) to oversee and approve research projects. This section will delve into the crucial elements of the IRB approval process at North Carolina State University, specifically focusing on informed consent, confidentiality, and data security in the context of this study.

Informed Consent

Informed consent is the process of voluntarily obtaining consent to participate in a research study. In Phase One of the quantitative research the header text of the Qualtrics survey will issue informed consent. The first stage of data collection qualified under exempt status utilizing the Federal Regulation Exemption code 46.101, due to the low risk of harm to participants (See Appendix D). Phase Two of the study involved an informed consent protocol which was approved by the NC State's Institutional Research Board.

Confidentiality

Phase one of this research did not require participants to provide names or personally identifiable information unless they were willing to voluntarily participate in the second portion of the research. Participants were notified that internet IP addresses will not be recorded or linked to the computer or device used due to a secure internet connection and a browser such as Google Chrome.

In Phase 2, the participants were asked to voluntarily provide their names or to select a pseudonym. According to Yin (2018), names should be used to identify participants in cases to improve validity of the study.

Data Security

The data compiled in Phase One utilizing the Qualtrics website was limited to only the research team. Devices used to access the data adhered to the NC State's information security policy and no failures were reported as they did not occur. The data compiled in Phase Two which utilized Zoom and was transcribed were considered moderately sensitive. The security policy set forth by NC State Office of Information Technology was strictly adhered to.

Methods

The methods section for this study provides the techniques of selection of the participants, develop instrumentation, collect data, and conduct data analysis. This study used a two-phase approach that included the collection of quantitative survey data in Phase 1 and primarily qualitative data using interviews and documents in Phase 2.

Creswell (2014) points out that the strategy for two-phase sampling, also called multistage sampling, is when the researcher seeks to identify participants in phase one and then samples the participants directly in phase two (p.158). This study proposed this two-phase sampling process to first identify the instructors knowledgeable about occupational safety programs and then to identify common attitudes towards safety within the classroom.

Phase 1 Quantitative Survey

In phase 1, the methods included the selection of the participants for the survey, the instrumentation including reliability and validity, data collection, and data analysis.

Participants.

The population for this study were welding instructors in the NCCCS. The sample of participants for phase 1 of this study included a census of 17 welding instructors in the NCCCS who attended a state-wide meeting for welding instructors and instructors that were asked to participate via email Each of the attendees was provided a link to complete the Phase 1 survey through Qualtrics.

Instrumentation.

The written survey questions were created using Qualtrics to examine the current confidence level that welding instructors have in teaching technical safety subjects in the welding laboratory. Additionally, there were questions regarding accidents experienced in the classroom and the instructors' confidence level in handling emergencies that may arise. Finally, there were questions related to engineering controls, such as virtual instructional methods, to determine if participants in the survey access to this technology must help acclimate students to safe practices while welding. The Qualtrics Survey is available in Appendix E. Many of the questions used in the survey represent questions used by Tammar's 1993 study of welding. The questions presented in Tammar's study were grounded in Suchman and Jordan's (1992) Validity and the Collaborative Construction of Meaning in Face to Face surveys. Tammar (1993) asked safety instructors in the state of Texas the same questions asked of the agriculture mechanics instructors survey in the 1988 Chumbley study. Questions regarding virtual reality use are new and have not been found in other research studies.

Reliability and Validity.

Surveys allow the generalization from samples to populations (Creswell, 2014). It is critical for surveys to measure consistently and accurately to constructs being investigated. Reliability in education research is estimated using Cronbach's Alpha. Reliability in Tammar's study was reported and appropriate and will be replicated in this study.

Survey questions using technical terms may have been difficult for some instructors with little experience or technical practitioner safety knowledge. The researcher ensured that participants understood that they could ask questions of clarification if requested. Tammar's results will be used to compare generalizations found for welding instructors in Texas. The researcher used the other artifacts to seek to construct validity. Construct validity asks if hypothetical constructs or concepts are measured (Creswell, 2014). The artifacts used job posting from North Carolina, the recommended curriculum posted on each schools' website.

Data Collection and Analysis for Phase 1

The data collection process for Phase 1 played a pivotal role in gathering initial insights and laying the foundation for the direction of the study. In this first phase, I focused on collecting and analyzing relevant data. The following sections outline the three phases of the case study research project, highlighting the specific methodologies employed in each phase.

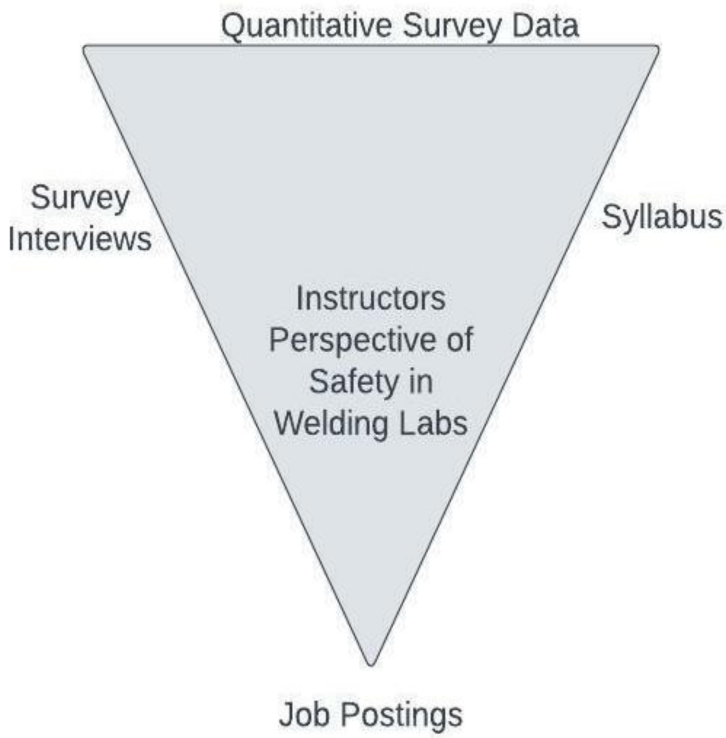
The data was prepared for analysis. In this step, the Qualtrics data was saved as a Comma Separated Value (CSV) file type. That file was then imported into the Statistical Program for the Social Sciences (SPSS) software. The data was cleaned, checking for errors within the entered data or missing responses. A codebook was established for the datasets.

The data was searched following the procedures described by Creswell and Plano Clark (2018). The data was checked for normal distribution and any noticeable trends. Descriptive statistics were checked for major values within the data set.

The data analysis was completed using SPSS to derive confidence levels and inferences. This information will be used to triangulate the cases to make broader generalizations about the participant groups in the findings. Triangulation is the use of multiple sources of data that may generate themes (Creswell & Creswell, 2018). Evidence collected in the quantitative survey in Phase One will be compared to syllabi, job descriptions, and interviews from phase two to generate themes relevant to the instructors' perspectives on safety in the welding laboratory. Figure 5 describes the evidence that will be analyzed to produce generalization for cases.

Figure 5

Synthesizing Cases through Triangulation



Descriptive statistics were used to assess the confidence levels that welding instructors have when delivering safety programs in the classroom. These descriptive statistics show the percentage of instructors who have experienced a laboratory incident with a student and the percentage of participants who emphasized safety when teaching welding. Other descriptive statistics reveal a percentage of instructors that believe an OSHA 30-hour course should be required regardless of the level of education award being sought.

In Phase 1, information regarding the confidence level welding instructors have when conducting classroom facilitation of safety topics such as hazard communication, welding safety, fire protection, and other programs was the primary focus. These standards were selected because they are programs that welders interact with regardless of if they are in the classroom or on the worksite. The OSHA Act requires workers who face these hazards be required to know them (OSHA Act, 1970).

The response rate for this survey was 39.5% which was 32 responses of 81 requests. The response size did not allow a statistical correlation test to determine if there was a relationship between instructors' perceptions of lab safety, course curriculum recommendations, and their perceptions of safety among those respondents that were willing to participate in a virtual interview

Phase 2 Case Studies

The data analysis from Phase 1 and criteria set by the researcher was used to select the cases for Phase 2. The methods for Phase 2 of the study highlights the selection of cases, data sources, instrumentation, data collection, data transcription, data coding, and data analysis. Before beginning the collection of data for the cases, a pilot case was conducted and is described in detail in the following sections. Based on the pilot study, no adjustments were made to the instrumentation for the cases. Additionally, the methods section for the cases covered trustworthiness, transferability including both truthfulness and consistency, limitations, and delimitations.

Selection of Cases for Phase 2.

According to Creswell and Plano Clark (2018), purposeful selection can help explain the views of specific groups. Using descriptive statistics, candidate selections were made from two groups. Group Red were faculty that are meeting a high level of safety understanding and Group White were faculty that were confident in their ability to adequately provide safety within the laboratory. The group names bear no weight in either group; they are simply identifiers using the university school colors.

Results presented in Phase 1 data analysis was used to produce two clustered groups. Group Red participants demonstrated high self-perceptions of safety in the laboratory, and Group White are participants that demonstrated low self-perceptions of safety in the laboratory. Each group has cases presented that provide background information such as credentials, teaching experience, and years of working experience to provide further rich descriptive written perspectives within their group's cases.

Selection of Participants for Two Cases in Phase 2.

The participants for Phase Two of this study were instructors from Phase One that met the criteria listed below and were purposefully selected.

1. They agreed to complete a 45 to 60-minute interview voluntarily.
2. They completed the survey in its entirety in Phase One.
3. They work in the NCCCS
4. They are in the high or low level of perceptions toward teaching safety in classes and the laboratory.

Participants may be of any ethnicity, age, or gender identification. The education of participants may also vary widely; however, they will all met the minimum requirements to teach in the community college. The amount of teaching experience ranged from the first semester to any number of years as an educational practitioner.

The participation group was composed of welding instructors. Welding instructors are individuals that have been hired by the community college to teach welding to a variety of students. They may or may not possess a degree or any formal educational training. However, they may be required to have accumulated several years of welding experience. This was examined during data collection review of job requirements to better understand the cases.

Data Sources for Cases.

Data sources for the cases included interviews, syllabi, and job postings from the NCCCS office for welding instructors listed from June 2021 to June 2022. Yin (2018) recommends various data sources when exploring case studies. The various data sources include interviews, observations, artifacts, onsite observations, and other documentation that assist the researcher in triangulating the data. For this study, documents such as flyers, prospective email invitations, and other student recruitment materials were collected.

Interview Protocols for Phase 2 Cases.

A mixture of questions for the interview were derived from other research within welding and agricultural mechanics education. Other questions were crafted to answer the research questions based on leading change efforts within the educational settings. Leading change questions focused on technologies that may influence the way that safety is taught in the classroom and laboratory. One such change effort will be focused on the use of robotic welding and its impact on student safety.

Interview Collection for Phase 2 Case Studies.

The interviews conducted were zoom interviews that lasted between approximately 45 minutes to 60 minutes and were voluntary. The interview was transcribed using Zoom. Yin (2018) points out that interviews provide strength for understanding the perceptions and attitudes of participants. The review of syllabi were physical artifacts that participants will voluntarily provide for the welding courses they teach. Yin (2018) demonstrated that this type of documentation provides insight into the culture of the organization and provides understanding of technical aspects. Words and phrases related to student safety and laboratory safety practices were searched within the syllabi and other documentation.

Participation in interviews was strictly voluntary and followed the applicable approved IRB protocols of NC State University. The interviews took between 45-60 minutes and were conducted virtually over zoom at the convenience of participants' schedules. Interviews were transcribed using Zoom. A list of interview questions is in Appendix G.

The researcher sought to contact welding instructors using various methods such as email and welding conferences. Emails contained an introduction to the survey and asked willing participants to complete the IRB-required consent form, complete the survey, and if they would be willing to participate in a virtual interview. A copy of the letter can be found in Appendix B. Welding instructors attending conferences were also invited to participate in the survey. Recruitment materials contained a QR code that led prospective participants to the survey. A copy of the recruitment material can be found in Appendix F.

Once contact had been established, instructors were asked to complete a 46-question survey question related to their confidence in teaching technical safety programs and processes that are commonly found within the construction trades. Areas of confidence include fall protection awareness, competent person, hazard communication, control of hazardous energy, caught-between, PPE, fire safety, and respiratory protection. The survey instrument also collected demographic information related to gender, race, and years of teaching welding. The survey was produced in Qualtrics and began by collecting consent utilizing the prescribed NC

State IRB approval process. It then requested the research subject to present their job title. The remaining questions asked participants to rate confidence, disclose experiences, and disclose demographic information. It concluded by asking the participants if they would be willing to participate in Phase Two if selected using the descriptive statistics outlined in the data analysis section. A copy of the questions can be viewed in Appendix E.

Document Collection for Case Studies.

Other artifacts that were used to perform analysis were job descriptions and course syllabi. Job descriptions were retrieved from JobsEQ from July 2021 through June 2022. Syllabi were requested from the most recent courses taught at the institution where the instructor was currently employed. Individual colleges were not identified to protect the instructor identities.

Transcribing of Interviews and Documents for Case Studies.

Transcription of interviews was accomplished by using a software called Zoom. Zoom is a software developed to record video and notes for meetings and is utilized in business, education, and by individuals in various ways. Zoom was used in this study to capture participants' thoughts and later used to conduct pattern matching and theme detection.

Data Coding for Case Studies.

Data coding occurred using transcripts produced by Zoom. Zoom is a software that is primarily used to communicate but also captures video, audio, and transcriptions. The transcripts captured using Zoom was uploaded into Microsoft Word. Then the software was used to print transcripts to provide information for the analysis phase of the study. Welsh (2002) noted that the use of computer enabled solutions may generate the best coding results. Techniques derived from Saldaña will be implemented. According to Saldaña (2021), “Value coding is used to code for participants' beliefs, values, and attitudes” (p. 167). This type of coding further supports the use of the Theory of Planned Behavior to understand why welding instructors conduct safety training within the welding laboratory.

Data Analysis of Case Studies.

Two phases of data collection were implemented to support the strength of the descriptive case study. This two-stage mixed method model is utilized to help the researcher gather data about the welding instructors in general in phase one and to dive deeper in phase two to understand the specific cases. The Phase One survey questionnaire was used to select cases and provide quantitative data to describe the welding instructors in each of the cases. While data was collected in two stages, it was combined to answer the research questions. Documentation, interviews, and artifacts are three pieces of information that strengthen the value of the case, and the triangulation of data is necessary to demonstrate that participants' perspectives are accurately reflected (Yin, 2018). Thus, multiple sources of information were analyzed to present the resulting cases.

The following procedures, derived from Creswell and Plano Clark (2018), were utilized to analyze the information and present the case studies. The combining and presentation of the two phases of data occurred by using the data collected from the Phase One quantitative survey and the Phase Two interviews, syllabi, and job postings as follows:

1. Results of the Phase 1 quantitative study was presented in graphs and charts.
2. Results of the Phase 2 qualitative study was presented in graphs and charts.
3. Results of both the Phase 1 Quantitative and Phase 2 Qualitative was presented in joint displays. This linked the two sets of data together through a statistical theme joint display.

According to Creswell and Plano Clark (2018), explanatory sequential research is not merely comparing data, rather this research design is meant to have the qualitative research portion further explain and support the findings of the initial quantitative section of the research.

The research strategy selected to perform a case study uses theoretical propositions (Yin, 2018). This strategy presents the opportunity to gather data and attempt to answer the following research questions:

1. How do community college welding instructors view the importance of teaching safety in community college welding classrooms and labs in certificate, diploma, and associate degree programs?
2. What are the safety skills taught, and how do community college welding instructors interact with students in relation to teaching safety in the welding classroom and lab?

While Yin has noted that there is no set prescribed method to conduct a case study, the analytic strategy used for analysis is referred to as pattern matching (Yin, 2018). Pattern matching is defined as empirically analyzing patterns to prove a predicted outcome (Yin, 2018). Using pattern matching, I searched for recurring or rival themes and explanations for accomplishing a concise completion of cases.

Each case selected for analysis included the substantive data (Yin, 2018). *Substantive information* are the specific details surrounding the case, including instructor working experience, demographics, etc. (Yin, 2018). Research participants were allowed to use pseudonyms to protect their identities.

Pattern matching to explain the perceptions of welding instructors was generated by reviewing propositions and searching for themes that are occurring among the multiple cases presented through interviews, survey data, syllabi, and job descriptions. Specific inferences were made that provide support to answer the research questions. Case study profiles were drafted prior to data collection to encourage further synthesis of the data (Yin, 2018). Chapters were outlined prior to data analysis and given substance as data is analyzed.

The process of having cases reviewed and commented on by their participants is critical to the validation process. To improve the quality of the case studies presented, participants were sent copies of the case studies they participated in and asked to provide comments and answer a follow-up written questionnaire (Yin, 2018). Once reviewed, the case studies drafts were modified to reflect any new insights that may have been missed during the earlier data collection process (Schatzman & Strauss, 1973). Competing perspectives were acknowledged during the case study write-up. This includes groups not being given the opportunity to share their perspectives.

Pilot Case Study

Using the data instrumentation and data collection procedures outlined above, a pilot case study was conducted. A case study pilot program was necessary to ensure that instrumentation is correct and make necessary revisions to the surveys and interview questions to strengthen the quality of the case study (Yin, 2018). The pilot case study was conducted using the Department Chair of Manufacturing at Guilford Technical Community College who is currently instructing welding students. The Department Chair completed the initial screening and conducted an interview. Data was collected using the interview protocols and tested and results were utilized to refine questions and the case study process. No changes to the protocol or procedures were made. The study proceeded subject to the procedures outlined above for each case.

Trustworthiness

The trustworthiness of the research was ensured through a mixture of processes. According to Creswell (2014), multiple strategies can help ensure the researcher validates the results of the findings. These strategies include triangulation, member checking, presenting rich perspectives, and sharing the positive and negative findings as they reveal themselves.

Triangulation was used between surveys, interviews, syllabi, and job descriptions to create the appropriate theme for the research. As noted by Creswell (2014), "Converging themes that are sourced from both participants and data sources add to the validity of the research" (p. 201).

Member checking was concluded after each interview. The researcher sent a copy of the final case study analysis to each participant and allowed them a two-week time frame to respond with corrections that they felt were necessary to their portion of the research.

Rich perspectives were shared throughout each case. Well-detailed descriptions of the settings in which the instructors work were provided to help readers have a greater sense of the everyday conditions and challenges that instructors experience. This improved the study's validity (Creswell, 2014).

The negative and the positive findings are presented alongside the themes discovered. Sharing the positive and negative is intended to continue to provide the reader with both the themes identified and evidence that may contradict the theme and improve the study's validity.

Transferability

According to Lincoln and Guba (1985), transferability should be used in qualitative research because of the way that subjects are selected and that the research outcomes are often applicable to other locations. According to Slevin and Sines (2000), transferability through truthfulness and consistency can be assured if the research employs multiple strategies to improve them.

As suggested by Slevin and Sines (2000), to improve transferability, the use of multi-site investigation and providing rich and dense amounts of data are provided. The multi-site investigation occurred through the interviewing of multiple welding instructors from various community colleges across North Carolina. Any statements of transfer only focus on the NCCCS and no other educational group. The cases presented themselves will provide a rich and dense amount of data that will be connected to other artifacts.

Truthfulness

Truthfulness in qualitative research is critical to ensuring that the study meets reliability in the research setting (Slevin & Sines, 2000). To improve the truthfulness of the research, participants were given the opportunity to review the cases presented and provide comments on the findings presented. Participants were given two weeks to respond with any comments or corrections.

Consistency

To improve the consistency of the research, the researcher utilized strategies discussed by Slevin and Sines (2000). These strategies include the researcher looking for inconsistencies within answers provided by interviewees. The researcher flagged words transcribed in interviews such as “never” as they may not represent the phenomenon.

Limitations

The limitations of this study are the number of welding instructors that choose not to participate in the quantitative portion of the study. The survey was sent to instructors in the North Carolina Community College System Office and the researcher did not have any control over the number of participants who self-selected to participate. The participant sample included a combination of both part-time and full-time faculty. While the researcher had no control over the sample size that participated, the researcher provided a series of emails to be distributed to encourage participation.

Delimitations

This study sought to examine the perceptions of instructors working in the high-risk occupational career and technical education facilities of welding technology programs in the NCCCS. This study did not focus on the perception of the educators at the North Carolina high schools. This study did not focus on chemistry labs, nursing labs, or law enforcement training. These fields also pose a risk to life and health but differ greatly from the common exposures of trades within the construction industry.

Although questions were presented in the survey related to the use of welding virtual reality technology, this study did not seek to understand the benefits or shortfalls of this technology. More research opportunities will continue to be generated as this technology continues to manifest in community college systems in North Carolina and abroad.

Student perceptions of lab safety were not included in this study. The student population is broad, and the amount of safety knowledge that students may have will vary greatly depending on previous work experience and existing knowledge. Student perceptions could add additional value to the body of knowledge about student safety.

The study is delimited in its ability to link occupational injuries to specific programs of study. The very nature of the injury recording system in the U.S. does not link to health or education records to examine these trends. The lack of communication between the education system and the private health system creates a disadvantage to replicate good pedological programs from those that may have opportunities to improve.

Safety culture was not measured as part of this study. Culture plays a role in perceptions, yet the complexity of culture and its variables cannot be measured adequately to report any significant findings. Safety culture has been considered and discussed in the literature review.

Chapter Summary

This chapter presented the research design, information regarding the population to be studied, and data collection stages the researcher undertook to collect, analyze, and interpret the data and information as part of this study. A description of the overall population and anticipated sample size was provided to help the reader understand the defined parameters of the case study. The data collection and data analysis strategy were presented to provide an overview of the instruments and techniques to be used to complete case study research. Additionally, a description of the institutional review process and a statement of positionality were presented that describes the steps taken to protect data and ensure that data will be interpreted through the lens of a researcher and were not influenced by the researcher's professional work experience.

CHAPTER 4: FINDINGS

The results presented in this chapter contain a mixed methods approach to validate the case study of welding instructor perceptions of safety in labs and classrooms. The case study approach to conducting research outlines that artifacts must be collected to reinforce any findings presented. The artifacts collected and reviewed included a review of job postings for a defined period, welding school curriculum, syllabi obtained from instructors, a quantitative survey, and interviews conducted with current educators who currently facilitate welding instruction in the NCCCS. The case study approach was chosen to address the research questions.

1. How do community college welding instructors view the importance of teaching safety in community college welding classrooms and labs in certificate, diploma, and associate degree programs? How does it impact what they teach?
2. What are the safety skills taught, and how do community college welding instructors interact with students in relation to teaching safety in the welding classroom and lab?

To answer these questions, two phases of data collection were utilized. In Phase 1 data collection, welding instructors were first asked to voluntarily complete an online questionnaire. The questions were presented as a five-point Likert scale and included some demographic information. At the conclusion of the survey, respondents were given an opportunity to provide their email address to participate in a later Zoom interview. Phase two of data collection began with a pilot interview and was conducted prior to proceeding with the interview protocol, ensuring question validity and the appropriate completion of post activities, such as member checking.

Participants were asked to provide detailed information about their perceptions of safety in the welding classroom/laboratory. The interviews were transcribed using Zoom and artifacts were also collected.

Phase One: Data Analysis

During Phase One, 32 (36.36%) of the 88 welding instructors who were sampled provided usable responses (Table 2). Of the 32 participants, 31 were male and 31 were employed full-time. The majority of the participants held an Associate's degree (*n*=26, 81.25%). Approximately three quarters of the participants (*n*=25, 78.13%) reported experiencing a classroom incident related to a safety injury, this data is presented in Table 3.

Table 2

Frequency and Percent of Gender, Employment Status, and Education Level

	f	%
Gender		
Male	31	96.88
Female	1	3.13
Employment Status		
Full-time	31	96.88
Part-time	1	3.13
Educational Attainment		
High School	2	6.25
Some college	1	3.13
Associate's degree	26	81.25
Bachelor's degree	3	9.38

Table 3

Frequency and Percent of Those that Experienced Student Incidents in Classroom

	Yes		No	
	f	%	f	%
Experienced Student Injury in Classroom	25	78.13	7	21.88

Note: *n*=32

As shown in Table 4, only a very small minority of the participants held certifications from OSHA (*n*=6, 18.75%) or the National Construction Research Center (*n*=3, 9.83%).

Table 4

Frequency and Percent of Certifications of Participants

	Yes		No	
	f	%	f	%
OSHA Certified Instructor	6	18.75	26	81.25
National Construction Research Center Certification	3	9.83	29	90.63

Of the 32 participants, 14 (43.75%), indicated they would be willing to participate in an interview related to teaching welding safety.

Table 5 presents the loadings from a factor analysis using a 3-factor solution and oblimin rotation. To explore the reliability and validity of the scales, an exploratory factor analysis was conducted.

Table 5

Three Factor Solution for Instructional Confidence

	Factor1	Factor2	Factor3
Q9 I feel confident about teaching students how to properly use ventilation in my welding courses.	**0.903**	-0.045	0.108
Q3 I feel comfortable teaching fire safety within my welding courses, (Use of Portable fire extinguishers)	**0.892**	0.17	0.06
Q7 I feel confident teaching students about PPE such as hard hats, welding gloves, and foot protection within my welding courses.	**0.872**	-0.126	0.17
Q8 I feel confident when teaching students about control of hazardous energy programs such as lock out / tag out in my welding courses.	**0.83**	0.163	0.086
Q15 I believe a safety course such as industrial safety should be a requirement of any welding program regardless of level of completion.	**0.816**	-0.037	0.178
Q11 I feel confident teaching students hazards associated with struck by risks in my welding courses.	**0.805**	0.308	0.01
Q10 I feel confident teaching my students about respiratory protection in my welding courses.	**0.79**	0.381	0.084
Q12 I feel confident in teaching students about hazards associated with caught in exposures in my welding courses.	**0.786**	0.348	0.03
Q2 I feel comfortable teaching emergency response to injuries within my welding. Courses	**0.692**	-0.119	0.05
Q5 I feel confident teaching fall protection competent person training within my welding courses. (Teaching students to calculate fall distance)	**0.654**	0.408	-0.269
Q6 I feel confident training hearing conservation safety within my welding courses.	**0.65**	-0.089	-0.099
Q13 I feel confident in delivery safety training related to welding safe practices in my welding courses.	**0.638**	-0.063	0.051
Q1 I feel comfortable teaching hazard communication within my welding courses - (teaching students to identify chemical exposures)	**0.619**	-0.052	0.277
Q4 I feel confident teaching fall protection awareness level within my welding courses. - (Teaching Students to use fall protection devices, harness, lanyard)	**0.562**	0.46	-0.343
Q14 I feel hazard recognition training such as an OSHA 30-hour course should be taught as a required part of curriculum.	**0.556**	0.028	-0.024
Q26 I am familiar with the occupational safety hierarchy of controls? (Elimination, Substitution, Engineering, Administration, Personal Protective Equipment)	0.098	**0.773**	-0.275

Table 5 (continued)

	Factor1	Factor2	Factor3
Q19 I am confident I can teach a student to understand a safety data sheet in the classroom.	0.003	**0.741**	0.152
Q29 Hazard assessments are shared with factuality, students, and staff.	0.051	**0.733**	-0.091
Q20 I was formerly trained in safety policies and procedures before entering the classroom.	0.009	**0.669**	-0.259
Q16 My institution has prepared me well to handle student injuries in the classroom.	0.369	**0.661**	0.152
Q27 I perform safety inspections within the welding lab?	-0.104	**0.661**	0.162
Q30 There are supplemental training videos for welding lab safety at my institution.	0.12	**0.628**	-0.293
Q25 I am comfortable identifying welding hazards in the laboratory.	0.132	**0.626**	0.111
Q22 Students have access to safety data sheets in the classroom.	-0.159	**0.576**	0.257
Q23 I feel my institution provides enough continuous professional development towards student safety.	0.381	**0.573**	0.093
Q17 My institution has taught me to perform incident investigation for injuries that occur in the classroom.	0.459	**0.467**	0.038
Q21 My institution shares sampling data from air sampling conducted in the welding lab.	0.314	**0.374**	-0.587
Q33 I am comfortable training English as a Second Langue students welding safety.	-0.185	**0.325**	0.036
Q32 If you do not have virtual reality welding simulator: Virtual reality welding simulation should be integrated into your college program.	0.196	0.108	**0.836**
Q24 Virtual reality welding simulation is a proactive means to prevent student injury in the lab?	0.322	0.142	**0.652**
Q31 If your institution has virtual reality welding simulation, I believe that it sufficiently teaches students hazard recognition.	0.23	0.347	**0.568**
Cronbach's Alpha	0.917	0.816	**0.764**

The first step was to run the analysis using eigenvalues greater than one as the criterion to assess the number of scales. Initial analysis identified two items that did not factor into scales clearly. In the first iteration of factor analysis, one item cross-loaded and one item was a single factor. Once these two items were removed, the analysis was conducted again, and the Scree plots and face validity of the items pointed to a 3-factor solution.

The factor analysis table provides the loadings for 32 items that make up three distinct scales: confidence and attitudes toward teaching welding safety, safety actions and preparation, and use of virtual reality (VR). The confidence in teaching welding scale comprises 15 items, with loadings ranging from .903 to .556, indicating a strong positive correlation between these items and the underlying construct. The scale had a Cronbach's alpha of .917. The safety actions and preparation scale included 14 items, with loadings ranging from .773 to .325, indicating a moderately positive correlation, and had a Cronbach's alpha of .816. Lastly, the use of VR Use scale encompasses three items with loadings ranging from .836 to .568, indicating a relatively strong positive association between the items and the construct. The Cronbach's alpha for this scale was .764. Overall, this factor analysis table provides a comprehensive overview of the factor loadings for each scale, allowing for a better understanding of the relationships between the items and their respective constructs. All scales had reliability estimates over .70, which is considered acceptable for the purpose of research (Nunnally, 1978).

Table 6 presents the means and standard deviations for the items assessing welding instructors' confidence and attitudes toward teaching safety in the context of a community college welding program. The instructors indicated a strong agreement and high confidence in teaching various aspects of safety, such as PPE usage (M=4.87, SD=.71), ventilation (M=4.81, SD=.74), and fire safety (M=4.69, SD=.89). They also expressed confidence in delivering safety training related to welding practices (<=4.56, SD=.95) and believed that an industrial safety course should be a requirement in any welding program (M=4.56, SD=.91).

Table 6

Statements Assessing Confidence in Teaching Safety in Welding

Statements Assessing Confidence in Teaching Safety in Welding	Mean	SD
Q7 I feel confident teaching students about PPE such as hard hats, welding gloves, and foot protection within my welding courses.	4.87	0.71
Q9 I feel confident about teaching students how to properly use ventilation in my welding courses.	4.81	0.74
Q3 I feel comfortable teaching fire safety within my welding courses, (Use of Portable fire extinguishers)	4.69	0.82
Q13 I feel confident in delivery safety training related to welding safe practices in my welding courses.	4.56	0.95
Q15 I believe a safety course such as industrial safety should be a requirement of any welding program regardless of level of completion.	4.56	0.91
Q8 I feel confident when teaching students about control of hazardous energy programs such as lock out / tag out in my welding courses.	4.53	0.88
Q6 I feel confident training hearing conservation safety within my welding courses.	4.44	1.05
Q10 I feel confident teaching my students about respiratory protection in my welding courses.	4.41	1.07
Q11 I feel confident teaching students hazards associated with struck by risks in my welding courses.	4.22	1.01
Q1 I feel comfortable teaching hazard communication within my welding courses - (teaching students to identify chemical exposures)	4.13	1.04
Q12 I feel confident in teaching students about hazards associated with caught in exposures in my welding courses.	4.03	1.03
Q2 I feel comfortable teaching emergency response to injuries within my welding. Courses	3.97	1.23
Q4 I feel confident teaching fall protection awareness level within my welding courses. - (Teaching Students to use fall protection devices, harness, lanyard)	3.94	1.34
Q14 I feel hazard recognition training such as an OSHA 30 hour course should be taught as a required part of curriculum.	3.78	1.31
Q5 I feel confident teaching fall protection competent person training within my welding courses. (Teaching students to calculate fall distance)	3.47	1.37

Note. N=32, Five Point Scale (1=Strongly Disagree, 2=Somewhat Disagree, 3=Neither Agree nor Disagree, 4=Somewhat Agree, 5=Strongly Agree), Cronbach’s Alpha = ..961

However, the instructors were less confident in teaching fall protection competent person training, indicated by their neutral response (M=3.47, SD=1.37). The items related to teaching fall protection awareness level (M=3.94, SD=1.34) and emergency response to injuries (M=3.97, SD=1.23) received lower ratings, indicating agreement. In terms of attitudes toward what should be taught, instructors strongly agreed that an industrial safety course should be a requirement (M=4.56, SD=.91), while they only agreed that hazard recognition training, such as an OSHA 30-hour course, should be part of the curriculum (M=3.78, SD=1.31).

Table 7 presents the means and standard deviations for the items assessing welding instructors' agreement with items assessing actions and preparation that can model safety in the classroom and their preparation to teach safety. The instructors strongly agreed that they were "comfortable identifying welding hazards in the laboratory" (M=4.75, SD=0.62), performing safety inspections in the welding lab (M=4.66, SD=0.60), and able to "teach a student to understand a safety data sheet in the classroom" (M=4.50, SD=0.72). Questions that were in least agreement were with “My institution shares sampling data from air sampling conducted in the welding lab. (M=2.03, SD=1.09), “I am comfortable training English as a Second Langue students welding safety” (M=2.75, SD=1.41), “Hazard assessments are shared with faculty, students, and staff” (M=3.31, SD=1.33), “My institution has taught me to perform incident investigation for injuries that occur in the classroom” (M=3.34, SD=1.43), “My institution has prepared me well to handle student injuries in the classroom” (M=3.35, SD=1.50), and “I feel my institution provides enough continuous professional development towards student safety” (M=3.41.SD=1.43).

Table 7

Statements Assessing Safety Actions and Preparation

Statements Assessing Safety Actions and Preparation	Mean	SD
Q25 I am comfortable identifying welding hazards in the laboratory.	4.75	0.62
Q27 I perform safety inspections within the welding lab?	4.66	0.60
Q19 I am confident I can teach a student to understand a safety data sheet in the classroom.	4.50	0.72
Q22 Students have access to safety data sheets in the classroom.	4.25	1.05
Q20 I was formerly trained in safety policies and procedures before entering the classroom.	4.22	1.04
Q26 I am familiar with the occupational safety hierarchy of controls? (Elimination, Substitution, Engineering, Administration, Personal Protective Equipment)	3.84	1.17
Q30 There are supplemental training videos for welding lab safety at my institution.	3.50	1.63
Q23 I feel my institution provides enough continuous professional development towards student safety.	3.41	1.43
Q16 My institution has prepared me well to handle student injuries in the classroom.	3.35	1.50
Q17 My institution has taught me to perform incident investigation for injuries that occur in the classroom.	3.34	1.43
Q29 Hazard assessments are shared with factuality, students, and staff.	3.31	1.33
Q33 I am comfortable training English as a Second Langue students welding safety.	2.75	1.41
Q21 My institution shares sampling data from air sampling conducted in the welding lab.	2.03	1.09

Note. N=32, Five Point Scale (1=Strongly Disagree, 2=Somewhat Disagree, 3=Neither Agree nor Disagree, 4=Somewhat Agree, 5=Strongly Agree), Cronbach's Alpha = .816

Table 8 presents the means and standard deviations for the items assessing the use of VR by welding instructors. Only 3.12% of the individuals reported using VR in welding. Among the participants in the survey, all items related to VR were rated low.

Table 8

Statements Assessing Safety Actions and Preparation

Statements Assessing Safety Actions and Preparation	Mean	SD
Q32 Virtual reality welding simulation should be integrated into your college program.	2.41	1.04
Q24 Virtual reality welding simulation is a proactive means to prevent student injury in the lab?	2.34	1.00
Q31I believe that virtual reality welding simulation sufficiently teaches students hazard recognition.	2.10	1.17

Note. N=32, Five Point Scale (1=Strongly Disagree, 2=Somewhat Disagree, 3=Neither Agree nor Disagree, 4=Somewhat Agree, 5=Strongly Agree), Cronbach's Alpha = .764

Phase Two Data Analysis

Case study methodology was employed for the second phase of this project, utilizing artifacts, job descriptions, and interviews to address the research questions. In Phase Two Data Analysis, the instructors from stage 1 was selected and scheduled for their follow-up interviews. Along with the interviews, multiple artifacts were collected to gain insights into the formation of their perspectives. After transcribing and validating 460 questions and reviewing the collected artifacts, several themes emerged. Tables 9 and 10 presents the five most common themes for each case.

Table 9

Most Common Themes for Case Red

Rank	Theme Name
1	Students should not be harmed
2	Students will be taught from my experience
3	Students learn good habits from me
4	I need more resources to teach more safety
5	I have poured myself out in hopes that students will feel safer when they perform the tasks I have taught,

Table 10

Most Common Themes for Case White

Rank	Theme Name
1	Time and attention are huge factors when teaching safety to inexperienced learners.
2	My experiences may prevent harm, so I will share it.
3	Hazards around equipment are my safety skill focus
4	Burn injuries are part of the job (physical burns or damage to the retina)
5	Students haven't fully recognized the value of safety until something happens

Job Descriptions

A review of job descriptions was conducted using JobsEQ data from positions posted between July 1, 2021, to June 30, 2022, and was done to provide a context to the position of a welding instructor at a community college. The analysis aimed to understand the specific qualifications sought by employers when hiring welding instructors. Initially, position postings from North Carolina were reviewed and then a comparison was made between North Carolina's education requirements and those of the rest of the nation.

To further validate the findings of this study and gain a comprehensive understanding of instructors' perspectives, the review of qualifications provided insights. The job descriptions were examined to analyze the credentials sought by higher education institutions for vacant positions. In the state of North Carolina, a total of 111 job postings were identified, covering various employment types such as full-time, part-time, and temporary positions. The results of this analysis are presented in Table 11.

Table 11

Search Results for North Carolina Certification Requirements

Certificate Name
Certified Welder
Certified Welding Educator (CWE)
Certified Welding Inspector (CWI)
Certified Associate Welding Inspector (CAWI)
Certification in Cardiopulmonary Resuscitation (CPR)
National Center for Construction Education & Research Certification (NCCER)

Note: Table Data from JobsEQ (2023)

A query was conducted using the same dates, encompassing all states in the United States, to determine the credentials that institutions of higher education were seeking in welding instructor positions. The analysis included a total of 1,083 job advertisements, which covered full-time, part-time, and temporary positions. The data outlining the sought-after skills is presented in Table 12. The analysis revealed that states other than North Carolina have a broader range of requirements for employment as a welding instructor. The review of all job advertisements indicated that prospective welding instructors were typically expected to hold certifications in welding, be certified welding inspectors, or have certificates as welding educators.

Table 12

Search Results for United States Certification Requirements

Certified Welder
Certified Welding Inspector (CWI)
Certified Welding Educator (CWE)
National Center for Construction Education & Research Certification (NCCER)
Driver's License
Certification in Cardiopulmonary Resuscitation (CPR)
First Aid Certification
American Welding Society Certification (AWS Certification)
OSHA 10
OSHA 500
Certified Associate Welding Inspector (CAWI)
Craft Instructor
The National Institute for Metalworking Skills (NIMS) Certification (unspecified)
Secret Clearance
Senior Certified Welding Inspector (SCWI)
Certified Clinical Medical Assistant (NHA)
Certified Robotic Arc Welding Operator (CRAW)
Class A Commercial Driver's License (CDL-A)
Commercial Driver's License (CDL)
EPA Section 608 Certification (EPA 608)

Regarding institutional support, the interviewed instructors reported that they did not receive assistance from safety professionals within their colleges. None of the interviews indicated direct involvement of a safety professional in classroom training, although one institution had a safety professional on staff who taught an industrial safety course.

The quantitative data collected indicated varied perceptions of institutional support in preparing instructors for classroom incidents. Some institutions showed more involvement in preparedness activities than others. Similar results were observed in follow-up questions regarding incident investigation and training, with nearly identical responses.

Curricula

The curricula also provides context for the case study. A review of the curricula revealed that among the 57 schools offering an associate degree, all of them required an occupational safety course for graduation. However, only four of the programs offering certificates included an occupational safety course as part of their graduation requirements. While many instructors believed an additional safety course would be beneficial for all levels of completion, they acknowledged that students pursuing certificates often had time constraints, and adding another course could affect completion rates. One institution had already implemented a safety course requirement for receiving a certificate, and the instructor supported this requirement, stating that it aligned with the employment skills demanded by prospective employers in their service area.

Regarding syllabi, responses were mixed. Some institutions mentioned having safety included in their syllabi, while others stated they did not. However, none of the participating institutions provided a syllabus for examination. Many instructors referred to the American Welding Society (AWS) safety standard as the resource covering health and safety within the classroom.

Demographics of Interviews

There are various pathways through which individuals enter the welding profession, each driven by unique motivations and aspirations. Welders possess a visionary mindset, not only executing plans devised by others but also often exhibiting an entrepreneurial spirit in designing their own creations. For example, James, one of the interviewed instructors, expressed his passion for witnessing the transformation of materials into something entirely different. He even pioneered the creation of Eastern-style Bar-B-Q cookers. Michelle, on the other hand, embarked on a welding journey to establish a bond with her family, particularly her grandfather. She recalls how her desire to restore old Mustangs led her to learn welding in high school. During her senior year, she discovered her aptitude for helping classmates grasp classroom concepts, even assisting one of them in achieving a higher test score than her own. While these personal experiences may not directly explain why instructors adopt specific teaching methods, they do provide valuable context and insight into the motivations that led them to pursue careers in welding

There were 10 interviews conducted, with participants having welding experience ranging between 11 and 52 years. Nine of the participants identified as male, while one identified as female. Among the 10 instructors, only one began teaching immediately after completing their education. The instructors had diverse backgrounds, with experience in industries such as nuclear, agriculture, manufacturing, government, and shipyards. Many instructors had worked in multiple industries throughout their careers.

Regarding preparation time, 80% of the instructors reported spending between one and two hours per week preparing to teach. One instructor dedicated a significant amount of time to creating welding videos to supplement their teaching. Two out of the 10 instructors returned to the institution where they learned to weld to become instructors. All 10 participants had experienced minor injuries from burns, while approximately 20% had sustained serious injuries that resulted in more than seven working days of absence.

When it came to how instructors began teaching, word of mouth was a common approach. Program directors or deans often contacted prospective instructors to gauge their interest in teaching as adjunct faculty. The most significant factor in securing the job offer was often the quality of the instructor's welding work and their reputation. Many instructors received a call from their local community college, inviting them to become welding instructors. In many cases, these instructors found themselves taking on multiple roles within the community college, with the Program Director position being the most common additional responsibility.

Case Studies

Multiple case studies were conducted as part of this research to address two specific research questions regarding safety in community college welding instruction. Case Red focused on the first research question, exploring how welding instructors in community colleges perceive the importance of teaching safety in welding classrooms and labs, and how it influences their teaching practices. Case White addressed the second research question, investigating the safety skills taught by instructors and their interactions with students in relation to teaching safety in the welding classroom and lab.

Both cases incorporated data gathered from the interviews conducted with the 10 instructors. Through coding and analysis, patterns and themes were identified to provide a comprehensive and detailed explanation for each research question. Additionally, background information such as credentials, teaching experience, and years of work experience were considered to enrich the descriptive perspectives within each case. The 10 instructors taught welding at nine of the 57 colleges offering welding programs within the NCCCS.

The Theory of Planned Behavior was employed to understand and explain the experiences, attitudes, and norms observed in the perspectives of the welding instructors, as well as how these factors influenced their instructional approaches in these programs.

Pseudonyms Based on Personas of Interviewees

To ensure the privacy and confidentiality of the participants, pseudonyms were assigned to them to protect their identities. These pseudonyms were generated through AI; the researcher took the transcripts, uploaded them to ChatGTP, and asked the program to generate a persona based on the transcript. During the member checking phase of the research, the assigned pseudonyms were shared with the participants for verification and confirmation. This measure was taken to maintain the anonymity of the participants while allowing them to validate the accuracy of their assigned pseudonyms. The assigned personas and pseudonyms are presented in abbreviated form in Table 13, with the full personas available in Appendix I.

Table 13

AI Generated Pseudonyms and Abbreviated Personas

Name	Persona
Ray	experienced instructor who moved into teaching after working in manufacturing
Samuel	knowledgeable and experienced - has worked in the nuclear industry for many years
Wade	background in performance automotive work
James	experienced welding instructor who has been teaching for the past 10 years
Kevin	background in various industries, from automotive and aerospace to oil and gas
Mark	experienced full-time welding instructor who has been teaching for 11 years
Michelle	passionate instructor who discovered her love for the craft in high school
Todd	experienced instructor with a diverse background in nuclear power plants and education
Alex	experienced welding instructor who has a diverse background
Andy	dedicated welding instructor with over a decade of experience in the industry

Case Study Red – The Importance of Teaching Safety

Case Study Red addressed the question: How do community college welding instructors view the importance of teaching safety in community college welding classrooms and labs in certificate, diploma, and associate degree programs? The themes that were generated were as follows:

1. Students should not be harmed.
2. Students will be taught from my experience.
3. Students learn good habits from me and are led by example.
4. I need more resources to teach safety effectively.
5. Went above and beyond job description to teach safety.
6. Literacy standards for graduation.
7. Frustration with teaching safety.

The themes from Case Study Red indicate that these instructors see the importance of teaching safety in the welding classroom and understand the impact of what and how they teach.

Students Should Not Be Harmed.

The first common theme was that students should not be harmed while learning. Almost all instructors reported that they had experienced at least a minor burn due to welding. Many instructors mentioned they had family members who had been injured while working. In fact, these instructors considered burns from welding to be an inherent part of their job. It is important to note that the severity of these burns was not discussed. However, based on the descriptions of the injuries, the burns they experienced were likely first-degree in severity.

Throughout the interviews, instructors expressed their strong commitment to ensuring the safety of their students and not wanting them to experience any harm in their classrooms. Wade shared, "I encourage my students to speak up if they see something that might be harmful to another student or themselves. Safety is always important." James emphasized, "Safety is given utmost importance from day one in every course conducted at our institution." He further stated, "Safety is covered regardless of the type of program a student is enrolled in, including continuing education." Todd emphasized, "The safety of students is our top priority at this college." The instructors’ tone and emphasis on safety was clear in the answers.

The overall pattern that emerged regarding goals and objectives related to safety was the need to protect students from potential harm. Mark emphasized, "We try to prepare them for the workforce the best we can, considering that they may work for large or small employers." James had the expectation that students demonstrate proper execution of procedures as taught. James likened this to a Gordon Ramsay cooking show, where the contestants are shown the proper techniques and then asked to recreate the same dish. Andy simply stated, "No harm to people." Michelle took the goals and objectives a step further by not only considering students' safety but also their health. Michelle indicated that the concern was not only for the short-term in the classroom but also extended into the workforce and longer-term health. Alex emphasized the importance of presenting students with potential risks and preparing them to anticipate the associated risks and consequences. Alex stated, “It was critical that the students were made aware of what could happen so they were prepared and could make better decisions about their actions.”

Participants were asked *what makes a good welding instructor?* Only one of the ten participants identified themselves as holding the certified welding educator certification through the American Welding Society while the other nine held other professional credentials related to a specific skill such as welding quality inspector. The distinction did not appear to really show much of a difference. In fact, the theme that emerged was patience and understanding. Each of the instructors recognized that students all have varying levels of knowledge and different learning styles. Alex stated, “You must be able to communicate well. How well you explain it says how well you understand it.” Kevin then shared that he believed, “You must be able to apply past experiences in the classroom and laboratory.”

Additionally, the diversity within the types of former employer was also examined from a brief regulatory review. Instructors that worked in nuclear worksites were exposed to a great deal of required safety training due to OSHA requirements while instructors that had agriculture experience were tasked with relatively little regulatory compliance as it pertained to welding. Therefore, previous exposure to a workplace culture that required tasks such as hazard assessment were less prominent in agricultural work settings versus nuclear power work environments. Ray brought this phenomenon up when he pointed out that smaller employers may not have provided the same level of required safety training when graduates depart from the program.

Students Will be Taught from My Experience.

The diversity of welding employers impacted the way that safety was emphasized in a welding course. For example, Wade experienced a severe workplace injury, which led him to emphasize the negative repercussions to students, further highlighting the importance of safety on the job. In another instance, Ray shared a devastating experience caused by a former co-worker who accidentally started a fire on the worksite. This catastrophic situation had a significant impact on both Ray and the rest of the workgroup. These life-changing events shared by the instructors illustrate the profound impacts they felt and witnessed, emphasizing the overall well-being of welders.

When examining how safety is taught in today's classrooms, almost all instructors noted that safety is now given much more emphasis compared to when they were students. James shared his experience with Lincoln Electric, stating, "There were many things I did not know until I received welding training at Lincoln Electric." Kevin mentioned that work practices had changed with the introduction of concepts such as mechanical advantage and the hierarchy of controls. Todd also observed significant differences, stating, "Things are much different now than when I was a student." Michelle highlighted the evolution of technology and the increased focus on production in the present compared to when she was in school.

Every interviewed instructor mentioned that each course begins the semester by defining safety rules at the start of class. In some cases, safety topics are taught for several sessions prior to students entering the welding laboratory. However, instructors noted that course syllabi mention very little in terms of safety. Instead, specific safety topics are often associated with the demonstration of specific tasks.

Student Learn Good Habits from Me/Lead by Example.

Instructors were asked how they believed their instructional strategies influenced student behavior. All of them stated, in one form or another, that they serve as examples and that students identify them when they violate the rules of the lab, such as failing to wear safety glasses. Double eye protection is required during welding activities, both in the classroom and worksites. One instructor mentioned that they ask students to leave the laboratory if they forget their safety glasses. This action is not meant to punish the students, but rather to teach them that there is an expectation to follow guidelines. Michelle noted that the students she works with pay extra attention if she appears to be violating the rules, emphasizing the importance of setting a good example. "You have to have thick skin when you are working with these young people," she added.

Instructors were also asked to share their thoughts on whether safety is common sense or something more. The prevailing view among the instructors was that safety is far from common sense. Mark stated, "It is not common sense to someone who has never experienced a certain environment; they don't know what they don't know." Samuel mentioned that welders in the industry are now also being asked to perform rigging activities, further emphasizing the need for proper safety training.

Todd shared, "Good instructors are constantly thinking about how they can reach their students and teach them life skills in the process." Kevin added that instructors must be empathetic and apply their experiences to their teaching delivery, recognizing the importance of connecting with students on a personal level.

While instructors mentioned demonstrating the proper use of safety glasses, hearing protection, and protective clothing, most of them stated that they did not require the use of respiratory protection in the classroom. However, this was acknowledged as a necessary safety skill that students should be familiar with. Ray expressed that it would be good to incorporate respiratory protection training with students but concerns about cost and the burden on students or the institution exist. In a separate discussion with a dean referred to as Scott, it was revealed that the administration had not considered the cost of replacement filters and the frequency of filtration required after renovating a welding lab. This raises the question of the added necessity for students to supply or be supplied with respiratory protection.

Another example of modeling for welding students was described in the context of classroom inspections. Todd mentioned that lab inspections are conducted quite frequently, including in the morning before class and during instructor transitions between classes. Ray and other instructors also conducted lab inspections at least once a day. Some instructors mentioned that inspections might be carried out by a third party, such as a fire marshal or a contracted safety official from a local community college. In one instance, a community college was contracted to perform safety inspections for other community colleges.

Lack of Resources to Teach Safety.

Instructors were asked about the availability and accessibility of audio and video technology. Nearly all of them mentioned using resources such as the American Welding Society, YouTube, and equipment manufacturers to deliver training content to students. However, Todd mentioned that finding materials related to robotic welding applications was quite challenging.

When it came to textbooks, all instructors relied on either the American Welding Society (SENSE program) or textbooks from Lincoln Electric. They found the welding content in these textbooks to be good and relevant to the course. However, many instructors felt that the safety content provided in the textbooks was inadequate. Ray and Kevin specifically mentioned that the texts lacked information on new discoveries of toxins in various welding processes, such as stainless steel, and the utilization of hazard recognition strategies.

During the interviews, multiple instructors mentioned relying on textbooks for safety guidance in the lab and future worksites for students. Two textbooks were utilized: the 9th Edition of Welding Principles and Applications (from the American Welding Society) and The Welding Procedure Handbook (from Lincoln Electric Corporation). Some observations made during the review included:

- The 9th Edition of Welding Principles and Applications provided basic information on safety when using welding equipment and in the worksite environment. The section dedicated to workplace safety spanned approximately 27 pages. However, it had limited information on occupational exposures such as falls, which are the leading cause of fatalities in the construction industry. It briefly mentioned Safety Data Sheets.
- The Welding Procedure Handbook, last updated in 2000, contained valuable insights to consider. However, its age raised important concerns. One primary concern was the absence of more recent prescribed threshold limit values set by the American Council of Governmental Industrial Hygienists. These values include metals like hexavalent chromium, commonly found in stainless steel welding applications. While the procedures in the handbook remained relevant, the age of the material posed limitations.

Went Above and Beyond Job Description to Teach Safety.

Many instructors shared the things they were doing to emphasize safety while teaching proper techniques. James had constructed a shop behind his home where he was going to produce video procedures for specific tasks in the classroom. He said, "I want to make videos to show students good techniques to protect themselves."

Instructors brought industry equipment subject matter experts to cover additional topics outside of welding. Wade mentioned that he brought in a specific subject matter expert for equipment training. Alex shared, "First aid instructors were brought in to help train students, as well as safety specialists to teach active shooter training." Todd brought representatives in from companies such as Kline, a hand tool manufacturer that sells tools directly to employees in multiple skilled trades.

Samuel shared, "I go above and beyond what the curriculum requires to teach students. I try to help them see why I am trying to open their eyes." It is different teaching younger people who may still be completing high school while taking a college class.

Literacy Standards for Graduation.

Many instructors noted that their institution had literacy requirements for graduates who were obtaining a diploma or associate degree. Ray stated, "It is not a requirement for students enrolled in a continuing education program or basic certificate program." Some instructors interpreted this question to be specifically focused on safety literacy and mentioned that their students had to achieve a minimum score of 75% on a safety test before being allowed to participate in welding laboratory activities.

Kevin pointed out, "Welding technology has evolved so much. While my institution has minimum standards for English and mathematics, the advancement of technology now requires a new level of critical thinking. Welders in this day and age cannot be educated enough."

Frustration of Teaching Safety.

Instructors were divided in their opinions when it came to the frustration of teaching welding safety. Some instructors expressed that they did not feel frustrated at all because they were patient with the students they worked with. On the other hand, there were instructors who pointed out that teaching safety to skilled trades students was indeed very difficult. Wade expressed his concern that students often did not take safety seriously, and he felt worried about the potential for them to make life-altering decisions. Ray expressed frustration regarding the fact that not all employers, whom his students would eventually work for, would provide the necessary resources to ensure safety on the job.

Summary of Case Red.

Research Question One: How do community college welding instructors view the importance of teaching safety in community college welding classrooms and labs in certificate, diploma, and associate degree programs? How does it impact what they teach? The themes that emerged from this question were as follows:

- Students should not be harmed: Instructors emphasized the importance of prioritizing student safety and preventing harm in the welding classrooms and labs.
- Students will be taught from my experience: Instructors recognized the value of sharing their own experiences and knowledge to educate students about safety practices in welding.
- Students learn good habits from me/Lead by example: Instructors acknowledged their role as role models and believed that students learn and adopt good safety habits by observing their instructors' behavior.
- I need more resources to teach more safety: Some instructors expressed a need for additional resources and support to effectively teach safety in welding, indicating that they wanted access to more tools, equipment, and materials.
- Went above and beyond job description to teach safety: Certain instructors went beyond their job requirements to ensure that students were well-educated in welding safety, going the extra mile to provide comprehensive instruction.

- Literacy standards for graduation: Instructors mentioned literacy requirements for graduates in diploma or associate degree programs, highlighting the importance of safety literacy as part of the overall curriculum.
- Frustration with teaching safety: Instructors had mixed feelings about teaching safety, with some finding it frustrating due to students' lack of seriousness or concerns about employers not providing sufficient safety resources for future employees.

These themes collectively shed light on how community college welding instructors perceive the importance of safety education and how it influences their teaching approaches and experiences in the classroom and lab settings.

Case Study White - Identifying the safety skills taught and their methods

Case Study White addressed the following question: What are the safety skills taught, and how do community college welding instructors interact with students in relation to teaching safety in the welding classroom and lab?

1. Inexperienced Learners Need for Time and Attention Related to Safety Instruction
2. I Share My Welding Experiences to Prevent Harm
3. Safety Skill Instruction Focuses on Equipment Selection and Work Processes/Scenario
4. Burn injuries are part of the job (physical burns or damage to the retina)
5. Students haven't fully recognized the value of safety until something happens
6. One Course vs. Other Approaches of Teaching Safety in Welding

Inexperienced Learners Need Time and Attention Related to Safety Instruction.

One instructor, Todd, who identified as an OSHA authorized trainer, utilized VR in the classroom. Todd took a different approach when he set out to teach safety using VR technology. Todd said, "We try to teach students the hazards associated with both construction and manufacturing utilizing Virtual Reality environments." Todd had his students complete modules using VR prior to physically welding. Todd also had robotic welding at his school that required a different set of skills to utilize. He noted during his interview that videos and instructional materials to teach this process were limited.

I Share My Welding Experiences to Prevent Harm.

Examples of negative experiences are often used to help students learn and avoid failure from others' misfortune. Throughout the interviews, instructors shared the things that they learned to help reinforce why techniques need to be followed. This was not just for safety but also from a quality perspective. Additionally, instructors passed on information they felt would enhance their students' understanding.

Kevin shared, "To be honest, class case studies and class lectures can coincide directly with the actual workplace environment when teaching a safety class. I use a lot of my own personal experiences of what I've encountered in the field."

Michelle stated that she uses emails from newsletters that discuss safety hazards, reports on accidents, and investigations on how to prevent such accidents. Mark also shared, "I teach from a lot of my own experiences."

Safety Skill Instruction Focuses on Equipment Selection and Work Processes/Scenarios.

Every institution in this study has an advisory board, and, typically, these boards were composed of former students, industry partners, and local welders. The advisory board met at least annually at each campus. These boards shared in-demand skills that they believed graduates of the programs should possess. Samuel mentioned, "Many of my former students and advisory board members have expressed the wish to have been taught rigging skills before entering the worksite." Andy felt that "first aid should be taught as a separate part of a safety course." Other topics, such as confined space entry, were also discussed to help students identify welding hazards in different locations.

Instructors shared the types of demonstrations they believed students should experience in the welding laboratory. These demonstrations varied greatly and were often based on undesirable events that occurred in real worksite situations. Examples of suggested demonstrations included grinding wheel failures, proper placement of pressure vessel gauges, and rigging failures. Instructors frequently demonstrated the proper functioning of ventilation systems, including welding booths and portable fume extraction devices. Alex mentioned, "We teach students a procedure to recognize when the filtration on the ventilation system is not functioning properly and what steps should be taken."

Safety skills taught in the classroom varied, but every instructor emphasized the importance of educating students on the proper setup and use of equipment related to welding to eliminate hazards. Todd mentioned that "certain types of tool safety were demonstrated by vendors such as Kline." Instructors like Andy mentioned "the use of fume extractors during equipment demonstrations."

James shared how Safety Data Sheets (SDS) were also an integral part of a hazard communication program. Ray stated that his program shared SDS information with students and believed they understood how to read them. While many instructors were not aware of every aspect of a hazard communication program, Ray emphasized that "being able to read and interpret safety data sheets is a very important safety skill required in industry." Ray incorporated the use of SDS while teaching various welding processes throughout the courses.

Ray shared, "I demonstrate the hazards of oxy fuel torches. I had a friend who was working under a car one time, and the torch blew up on him. He spent nearly 6 months at the

Chapel Hill burn unit. I think he is retired now." Ray further shared, "I had another friend who struck a torch, and everything went BOOM. Several people died."

Todd shared, "Today, for instance, our students were in the shop learning how to use a track burner. Although they had previously learned how to use it, the instructor went over it again, refreshing their memories, explaining the flame settings, how to use the equipment, and allowing the students to ask questions and seek additional help if needed."

Burn Injuries Are Part of The Job.

Each instructor shared about common injury types that they had experienced. In most cases instructors shared that burns were a common occurrence and that these types of injuries were part of the job. These types of injuries are recognized hazards by the institutions as well as instructors. Michelle shared, "My program has a waiver that students must sign. They know that minor burns are going to be a part of it. We just try to prevent serious burns." While James shared that, “We send a syllabus home for review, which requires a signature. Burns are a normal part of it. I've had burns and spots on me. I have several scars from burns."

Demonstration of safety equipment, such as earplugs, safety glasses, welding aprons, and welding gloves took place in the classroom environment and are required to be utilized in the welding laboratory. Ray demonstrated respiratory protection, but instructors mentioned that they did not require it for students to weld in the laboratory.

Students Have Not Fully Recognized the Value of Safety Until Something Happens.

Ray shared, "Many students don't understand how important safety is until something has gone wrong." The overall instructional practices from lecture to hands-on learning all started with safety. James stated, "We always start with safety regardless of where students are in the program." Ray asserted, "Safety has many topics, and welders play a role. Welders are often part of fire brigades. I once worked at a sawmill where our brigade competed against volunteer firefighters, and we won competitions."

James discussed the integration of safety in tasks, saying, "I demonstrate tasks and expect my students to replicate the exact process that I use." Ray shared that he often demonstrates complex welding processes, adding, "Today, I performed a three-hour demonstration of a task, and I expect each task to be completed as I have demonstrated it, in a specific order."

Demonstration of safety equipment is performed by many instructors. Ventilation was the most common type of safety equipment that was demonstrated. However, many instructors did not have access to the appropriate instruments to test atmospheric conditions within the welding lab. Samuel shared, "It was sometimes hard to select safety equipment because you never know where students might be employed after completing the program."

James explained, "My students should be able to demonstrate the steps that I take when presented with specific scenarios." He also demonstrated to students how to properly approach and activate a welding cylinder, emphasizing the need to come up beside it, not in front of it, due to the high pressure. He mentioned the possibility of regulator blowout (RBO).

Todd discussed the utilization of written tests to assess students' knowledge of safety. "We use a 50-question test that students must score above 75% on to enter the welding lab." Todd also shared, "The first few classes are solely focused on safety."

The lab environment is different from actual work environments, and students may not fully understand that. Nearly all instructors felt that the welding labs students used were in good condition. Many of them mentioned conducting safety inspections with staff to identify any hazards. However, none of them indicated using a specific form or guide for hazard identification. Regarding ventilation systems, many instructors believed they were functioning properly, but they were not on any specific inspection schedule other than visits from the fire marshal. One instructor mentioned that their college had safety staff visit their campus to discuss ventilation. Proper measurement of the filtration system's performance, based on the type of media being filtered and the recommended change interval, was highlighted as important to ensure proper functioning. Manufacturers of the filtration systems could be consulted for the appropriate number of hours before a media change is needed.

One Course versus. Other Approaches of Teaching Safety in Welding.

Instructors were asked about their opinion on whether a separate course specifically focused on workplace safety, such as ISC 110 Workplace Safety, was necessary for welding students. Wade and Todd both mentioned that their programs already required students at all levels of welding completion to take this course, including certificate, diploma, and associate degree programs. This course is centered around the principle of hazard recognition, which is considered a valuable safety skill. However, three of the ten instructors interviewed did not believe that a separate course was necessary. Alex suggested incorporating it into an existing single credit hour course and adjusting the number of hours for the course to two or three credit hours. The concern among instructors who opposed a separate course was related to enrollment and completion rates within the program.

Topics covered in the course would have included training on OSHA, AWS, and other professional organization regulations. Many instructors expressed that the regulations within OSHA standards were too complex for students to read and apply. Instructors were confident in their own ability to apply them due to their extensive experience in the field. Some instructors suggested that additional skills requested by the advisory board, such as confined space entry and material handling, could be included as special items in the course.

In summary, the research question related to safety skills taught and instructor-student interactions in teaching safety in the welding classroom and lab revealed several themes. These included the need for time and attention to inexperienced learners in safety instruction, instructors sharing their welding experiences to prevent harm, safety skill instruction focusing on equipment selection and work processes/scenarios, the acknowledgment of burn injuries as part of the job, students' recognition of safety's value after experiencing incidents, and the range of instructional practices from lecture to hands-on learning.

The term "safety skill" in this research refers to the skills that future welders are expected to be exposed to, regardless of the industry they work in. These skills encompass various areas such as fall protection, hazard communication, personal protective equipment usage, confined space entry, and material handling.

Instructors also highlighted specific skills they felt were in demand from their programs, including rigging and confined space training. Alex emphasized the significance of entering a confined space and how it becomes an even more critical issue when welding within such spaces. During the interviews, instructors also identified additional areas they believed needed enhancement in welder education, which included:

1. Textbooks that provided safety information related to new processes. Many instructors pointed out that new welding processes were not present in many of the textbooks currently in circulation. As a result, they relied on manufacturing information to provide insight into these processes.
2. Most instructors felt that the safety training provided to diploma and associate degree students was adequate. However, many admitted that certificate level students were most likely the least prepared to handle workplace exposures. The primary reasons

noted by one instructor was “that the certificate the institution provided did not require a safety course, and a new welder could go to work for themselves as an entrepreneur and never receive adequate workplace safety training.

3. Personal protective equipment such as respirators was not worn while welding. Some instructors pointed out that the booths provided ventilation systems which may or may not be regularly inspected for proper air flow.
4. Rigging of materials should be demonstrated and trained within the welding laboratory. The reasoning largely was that many welders served in other roles on job sites besides welders. Rigging, they believed, was one of the tasks that some instructors felt was extremely dangerous and required additional attention.

Chapter Summary

In this chapter, the results of various data sources were analyzed and presented to address the research questions related to the importance of teaching safety in community college welding classrooms and labs. The data included surveys from 32 participants, review of 57 curriculum guides, analysis of 1,083 job advertisements for welding instructors in the United States, virtual interviews with 10 welding lab instructors, and examination of textbook chapters used in North Carolina classrooms.

By compiling and coding the data, several themes emerged that were consistent across both Case Study Red and Case Study White. These themes helped to answer the research questions and provided insights into how welding instructors perceive the importance of safety, how it influences their teaching practices, and the specific safety skills taught in the classroom and lab settings.

To ensure the trustworthiness and transferability of the study, triangulation of data was employed, following the techniques suggested by Slevin and Sines (2000). This involved carefully reviewing the transcripts multiple times and looking for inconsistencies in the participants' answers, particularly when they used words such as "never." By weaving together multiple artifacts, the study aimed to strengthen the validity and applicability of the findings.

Chapter Five will delve into the interpretation of the findings, discuss the implications for practice, and provide recommendations for future research based on the insights gained from the data analysis.

CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

This mixed methods multiple case study examined welding instructors' perspectives on safety in the welding classroom and laboratory within the NCCCS. Thirty-two participants completed a 43-question Likert scale survey that addressed safety skills and background information in the first phase of the research. In the second phase of the research, 10 of the 32 participants answered 44 questions during recorded Zoom interviews. The participants in the interviews were from nine different community colleges, with two of the 10 participants coming from the same institution. Each welding instructor delivered a course equivalent to a one-credit course within the NCCCS. The interviews allowed instructors to share their perspectives on safety and the experiences that influenced their viewpoints.

The information collected from the interviews was used in triangulation in conjunction with surveys, curriculum analysis, and job posting analysis. Furthermore, artifacts such as safety in textbooks were analyzed to further understand the perspectives that welding instructors had regarding safety in the classroom and laboratory.

Overview of Study

Welders support numerous fabrication activities worldwide. Welding skills are utilized in various industries, including agriculture, nuclear power, transportation infrastructure, the food and drug industry, manufacturing, and others. According to the U.S. Bureau of Labor Statistics (BLS, 2020), over 4,000 workers die in the workplace each year. In 2020, approximately 21.2% of these fatalities occurred within the construction industry (BLS, 2020).

The NCCCS consists of 57 schools that offer welding certificate, diploma, or associate degree programs. The system produces an average of 1,100 welding certificate holders annually. Currently, most certificate holders are not required to complete a safety skills course before entering the workforce. While the NCCCS provides curriculum guidance for an industrial safety course in welding associate degree programs, it does not address the necessity for welding certificates or diplomas. However, certificate holders face the same workplace hazards as those with an associate degree. Therefore, it is equally important for certificate holders to identify workplace hazards and demonstrate safety skills to ensure the preservation of life and property.

This research offers valuable insights to enhance safety outcomes for both instructors and students within the NCCCS. Although the NCCSC has made progress in improving workforce safety, there is still work to be done. The study shows that instructors have the students' best interests in mind. One way to further enhance safety skills education within the laboratory is by providing instructors with resources. Requiring all students, regardless of their level, to complete safety coursework that focuses on developing safety skills applicable in welding laboratories and future worksites would be beneficial.

Expanding safety skills not only benefits the students personally but also benefits the employers served by the community college. It reduces costs associated with workplace injuries and equipment damage. This research examined welding instructors' perspectives within the NCCS, exploring how they perceive safety within the welding laboratory and how safety skill education is delivered to students.

Both the American Welding Society (AWS) and Lincoln Electric have opportunities to improve their textbooks. The safety sections of these books should be developed with the assistance of certified safety professionals or professional engineers. Many instructors rely on the AWS and Lincoln Electric texts to provide information they may not be aware of, but both texts lack substantial information to ensure that students fully comprehend the risks of their future workplaces.

The American Welding Society established a committee to address improvements in the latest ANSI standard for welding, ANSI Z49.1 (2021), which addresses Safety in Welding, Cutting, and Allied Processes. The standard covers several key elements, including hazard communication and the requirement to inform employees about hazards prior to work. However, the standard does not emphasize the use of action steps utilizing the hierarchy of controls once hazards are identified.

The AWS provides 45 fact sheets that offer valuable information for individuals seeking knowledge about hazards in the welding profession. Incorporating this information into the textbooks used by AWS for its SENSE program, which trains welders about safety as they enter the profession, would be beneficial. The current fact sheets provide information on falling objects and electrocution but lack details about controlling hazardous energy, which may be relevant to hazards in the construction industry. Including more specific information about industry exposures would greatly benefit students as they enter the workforce.

Conclusion and Discussion

This study yielded several significant conclusions when examining the perceptions of welding instructors within the NCCS. The first conclusion is that welding instructors tend to gauge safety based on the severity of negative outcomes. The second conclusion is that instructors require more support from administration, including resources to bridge the workforce gap. The third conclusion is that welding instructors heavily rely on resources in textbooks that may not sufficiently address workplace hazards students will encounter after graduation. During interviews, instructors noted the lack of support from college leadership. Most felt that the administration had no authority to offer guidance on programs they did not understand. However, technical resources are available to support safety within the community college system. Instructors must be made aware of these resources, which aim to assist them rather than infringe on their academic freedom to deliver content.

Furthermore, if the school has a safety officer, they are often viewed as compliance personnel who merely identify issues that need correction rather than as a resource to proactively address problems before students or faculty are harmed. This negative perception likely stems from the job title "officer," which implies enforcement rather than support. Administrations have an opportunity to change the title to coordinator or manager, which may make instructors more receptive to utilizing these services, believing that these individuals will not solely point out problems in the laboratory.

If college programs do not mandate students to take a course in hazard recognition and the utilization of the hierarchy of controls, administrations must invest in instructors to ensure they are fully capable of providing safety skill training while demonstrating equipment. For example, a welder may be hired to weld at heights exceeding 30 feet, where slag and sparks may fly around them. In such cases, wearing the appropriate fall harness, lanyard, and fire-resistant equipment is crucial. Earlier, I mentioned circumstances where smaller employers fail to provide adequate training and knowledge, which exposes young welders to life-threatening situations.

College programs should enforce the use of respiratory protection for all students. Various factors come into play when employees are required to utilize respiratory protection, and their overall health is the initial determining factor. The reality is that some students may not be suitable candidates for welding due to underlying health conditions. Therefore, schools should mandate students to undergo a pre-medical examination before entering a welding program. The exposure to welding can have detrimental effects on the health of young individuals with underlying health conditions. This serves as yet another example where smaller employers may not recognize the extent of exposure their employees face and the need to adequately protect themselves.

Discussion of Findings in Relation to Previous Research

The study conducted by Tammar (1993) focused on the perspectives of welding instructors regarding safety in the laboratory in the Texas Community College System. One of the key findings of Tammar's study, which is also echoed in this current study, is that many instructors felt unprepared to teach safety topics in the classroom. They believed they lacked sufficient professional development to effectively deliver occupational safety skills education, particularly in areas such as fall protection and rigging practices. It is worth noting that these exposures mentioned are more related to the workplace rather than specific to the welding laboratory. Nonetheless, all the instructor participants in this study acknowledged the need for more professional development to teach safety skills that are relevant to worksite conditions. They did, however, feel confident in the safety training they provided regarding equipment operation, considering it superior to their own initial welding training experiences.

Tammar's study also highlighted the need for a standardized curriculum guide or roadmap within the Texas Community College System that outlines the required safety topics to be covered system wide. Similarly, the NCCCS has recognized the need for a safety course and has made it mandatory for associate degree programs. However, it remains optional for diploma programs and is not mentioned as a requirement for certificate completion. Since certificate holders make up most completers in North Carolina, this creates a skills gap without a mandatory safety course. While some institutions within the NCCCS have recognized the need for such a course, the majority have not adopted it, despite the instructors' belief that a separate safety course should be required.

According to Tammar (1993), instructors recognized that hazard recognition is often not as evident to women in the workplace in Texas. This current study also found that some instructors acknowledge that many students, regardless of gender, lack experience and have not encountered the hazards of the worksite.

In terms of new findings from this study compared to Tammar's (1993), while burns were commonly reported in both studies, Tammar described a military man who had been instructing for over 15 years and had experienced eye loss, hospitalization from burns, and near-death experiences. This suggests that he had little to no safety training, like many other participants in Tammar's study. In contrast, the younger generation of instructors in this current study appears to have received more extensive safety training than previous generations.

Tammar (1993) also highlighted the limited use of technology in the classroom environment at that time compared to today. While manufacturers still produce videos, the accessibility and availability of media have greatly increased with online platforms such as YouTube. Instructors in this study mentioned using online platforms to gather and share content in the classroom, and some instructors have even become content creators themselves.

Findings from this study indicates that welding instructors today are more connected and have improved communication and resource-sharing compared to the situation in 1993. Todd mentioned having an electronic contact list of welding instructors across the state of North Carolina, highlighting the increased connectivity among instructors.

Implications for Practice

The implications of this research provide justification for welding instructors to obtain the support they need from institutions to provide a higher level of safety education within the NCCCS welding program framework. Ideally, an industrial safety or construction safety course that will produce a credential for students to demonstrate their knowledge of hazard recognition on a job site to ensure that they not only protect themselves but also others that are near and around them as they compete their daily tasks as part of the certificate, diploma, and associate's degree levels. Furthermore, instructors should be provided with additional opportunities for professional development in occupational safety and industrial hygiene.

The use of safety professionals within the college is an excellent opportunity to utilize the skills and knowledge that the safety professional must improve instructor and student understanding of the hazards in the welding lab as well as the work environment that students may face. Teaching students hazard recognition would be an excellent way to improve students' marketability post certificate, diploma, or associate degree completion. Having students help perform safety audits would also help instructors provide a safer work environment for all as well as train students to set expectations for the workforce they will eventually enter.

Creation of a safety committee that partners students with faculty within the welding lab would be another method to improve safety as well as develop culture within the welding lab that requires safety. Furthermore, it may expose students from other courses to new ways of thinking about safety and change student perceptions of acceptable student behavior while working in the welding lab.

A system is needed to accurately count injuries that occur within the welding laboratory. The current system utilizes an insurance policy, but it is likely that the numbers of injuries are being underreported. While some may only consider injuries as instances where individuals seek medical treatment, it is important to recognize that even burns requiring first aid are considered injuries in the lab and should be actively prevented.

Instructors should be trained to perform accident investigations as part of their professional development plan. Simple techniques such as root cause analysis and the 5 Whys can be easily taught and would demonstrate the college's dedication to improving safety within the institution. Once the information is gathered, it should be shared with the safety committee to enhance communication, reduce injuries, and strengthen the organizational culture.

One of the findings indicated that workers would likely receive additional safety training when being hired by a company. This could be a false premise if individuals work for themselves or as contractors. Additionally, data on the context of injuries indicate that the injuries were occurring at higher rates from non-English speaking workers. Additionally, this could be an issue if they are not hired by large organizations that have the resources to provide the adequate training. The NCCS should update the recommended curriculum for welding technology certificate, diploma, and associate degree programs to include a dedicated course on safety, irrespective of the level of completion. Welders who achieve a single certification are instantly eligible to work as entrepreneurs or for companies that might not have resources to train adequately. However, if they choose the entrepreneurial path, they may never receive additional occupational safety training to protect themselves or the workers in their vicinity.

Instructors are workers within the college. The OSHA act requires that workers be provided testing information, a workplace that is free of workplace hazards, appropriate personal protective equipment, among others. Therefore, the college has a responsibility to protect them as workers. Administrations facilitate the protection of their workers. Care should be taken to ensure that the schools are protecting their workforce.

Implications for Theory

The Theory of Planned Behavior postulates that people's actions are based on three components: subjective norms, attitudes to norms, and perceived behavioral control (Ajzen, 1991). This research has demonstrated this theory through the perspectives shared within the case studies presented. Instructor's experiences with severe injuries that occurred to them, family, or others impacted their level of empathy towards students practicing safe welding procedures as well as day to day protection from hazards on the worksites. Furthermore, instructors recognize that their attitudes towards safety within the laboratory have a direct impact on the way that students present themselves when they enter the laboratory to learn. An example that was used commonly was the wearing of safety glasses by instructors when they entered the laboratory. Instructors also constantly demonstrate safe best practices that further elevate students' understanding of perceived behavioral control. In many instances, instructors share stories of things that went wrong if the proper procedures are not followed and the negative impact that they have seen or experienced from their past.

Recommendations for Future Research

This research explored welding instructors' perspectives of safety in welding classrooms and laboratories within the NCCCS. Several themes emerged for each of the research questions answered. The themes for research question one are:

- Students should not be harmed.
- Students will be taught from my experience.
- Students learn good habits from me and are led by example.
- I need more resources to teach safety effectively.
- Went above and beyond the job description to teach safety.

- Literacy standards for graduation.
- Frustration with teaching safety.

The themes for research question two are:

- Inexperienced learners need time and attention related to safety instruction.
- I share my welding experiences to prevent harm.
- Safety skill instruction focuses on equipment selection and work processes/scenarios.
- Burn injuries are part of the job (physical burns or damage to the retina).
- Students haven't fully recognized the value of safety until something happens.
- Instructional practices range from lecture to hands-on learning.

This study continues to expand the body of knowledge regarding welding instructors' perspectives of safety in welding classrooms and laboratory environments. To date, this is only the second study of these perspectives within community colleges in the United States. Further examination of the perspectives of welding instructors in other states' community college systems should be examined. Welding students' perceptions of safety in welding laborites is an area that has very little research. This study has only examined the perceptions from the instructor's perspective. A study examining how students perceive safety in the lab as well as safety expectations for future employment would enhance the ability of instructors to focus on specific areas that students may have limited understanding of.

A study examining high school instructors' perspectives of welding within the high schools would yield great insights into the challenges that instructors and students face. Many students may learn basic welding in high school and then transition to college. Many of the same challenges may exist. However, the dynamic of funding on the highs school scale may have a greater impact on the outcome.

An examination of both small and large welding employers would be very interesting. Welding presents the same hazards for both groups. This type of study could identify welders that have completed safety courses in college and those that went on to have accidents in the workplace. This information would help college advisory boards, colleges, and students close educational gaps that are on a much broader spectrum.

The limitations of this study include only presenting the perspective of welding instructors within the NCCCS. Future research should also explore documenting students' perspectives on safety in the welding laboratory. This context might also provide strategies that instructors can use to reach students who might seem otherwise occupied or immature when considering the subject matter.

There are also many instructors who teach these topics within the high school system. No research has been conducted to explore high school CTE instructor perspectives within North Carolina. While some community colleges offer classes within the high schools of their geographic service area, the suggested research should focus on those fully supported by the county and local school board.

Employers have a vested interest in hiring students who possess certain credentials, such as welding certificates and OSHA 10-hour or 30-hour cards. An employer's perspective on graduates' safety skills may further help justify or create partnerships between employers and community colleges to ensure that student certificate completers are coming prepared to meet the demands of the worksites in the areas they serve.

Summary and Personal Reflection

Each day, we interact with the very fabrications that welders produce. Some of these are found in the buildings where we work, while others are the bridges we use for transportation.

This research aims to examine the perspectives of the individuals who teach those responsible for creating these structures and ensuring high-quality outputs that we rely on daily to accomplish our tasks. The research addressed the following questions:

1. How do community college welding instructors and program directors perceive the importance of teaching safety in community college welding classrooms and labs in certificate, diploma, and associate degree programs?
2. What safety skills are taught, and how do community college welding instructors engage with students when teaching safety in the welding classroom and lab?

The findings of this study reveal that instructors are deeply concerned about how they teach safety to their students. This concern is particularly evident among instructors who have personally experienced or witnessed severe workplace injuries. As a safety professional who regularly deals with the unfortunate and life-changing consequences of workplace accidents, there is a resounding desire to see more efforts made to preserve life.

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APPENDICES

Appendix A: NC Community Colleges That Require a Safety Course

	Certificate	Diploma	Associates
Alamance Community College	0	0	0
Asheville-Buncombe Technical Comm College	0	0	1
Beaufort County Community College	0	1	1
Bladen Community College	1	1	1
Blue Ridge Community College	0	0	0
Brunswick Community College	0	0	3
Caldwell Comm College & Technical Institute	0	1	1
Cape Fear Community College	0	0	0
Carteret Community College	0	0	0
Catawba Valley Community College	0	0	0
Central Carolina Community College	1	1	1
Central Piedmont Community College	0	0	0
Cleveland Community College	0	0	3
Coastal Carolina Community College	1	1	3
College of The Albemarle	0	0	3
Craven Community College	0	0	1
Davidson-Davie Community College	0	1	3
Durham Technical Community College	0	3	3
Edgecombe Community College	0	0	1
Fayetteville Technical Community College	0	0	3
Forsyth Technical Community College	0	0	0
Gaston College	0	0	3
Guilford Technical Community College	0	0	3
Halifax Community College	0	0	3
Haywood Community College	0	0	0
Isothermal Community College	0	0	0
James Sprunt Community College	0	0	3
Johnston Community College	0	0	1
Le0ir Community College	0	0	0
Martin Community College	1	1	1
Mayland Community College	0	0	3
McDowell Technical Community College	0	0	3
Mitchell Community College	0	0	1
Montgomery Community College	0	0	3
Nash Community College	0	0	1
Pamlico Community College	1	1	1
Piedmont Community College	0	0	3
Pitt Community College	1	0	1
Randolph Community College	0	0	3

Richmond Community College	0	2	3
Roa0ke-Chowan Community College	0	1	3
Robeson Community College	0	0	3
Rockingham Community College	0	1	3
Rowan-Cabarrus Community College	0	0	0
Sampson Community College	0	0	1
Sandhills Community College	3	3	3
South Piedmont Community College	0	0	3
Southeastern Community College	0	0	1
Southwestern Community College	0	0	1
Stanly Community College	1	1	3
Surry Community College	0	1	3
Tri-County Community College	0	2	2
Vance-Granville Community College	0	0	0
Wake Technical Community College	0	0	1
Wayne Community College	0	0	3
Western Piedmont Community College	0	1	1
Wilkes Community College	0	0	3
Wilson Community College	1	1	3
Required safety course on curriculum	5	14	15
Did 0t or listed it as optional	52	42	28
Did 0t have programs	1	2	25
	0.096153846	0.333333333	0.535714286

Coding Legend
0 = Not on Proposed Curriculum
1 = Listed in Proposed Curriculum
2 = Optional in Proposed Curriculum
3 = N/A

Appendix B: Recruitment Email

Hi {NAME}:

I am recruiting for a research study that I'm doing for my dissertation at North Carolina State University. The research study is exploring welding instructor's experiences and I would love for you to participate.

If you choose to participate, you will complete an online survey about your experiences as a welding instructor. The survey should take you approximately 10-15 minutes to complete.

You must be 18 years of age or older, reside in the United States, are a welding instructor working in state of North Carolina, and agree to be in the study to participate. Anyone who does not meet the criteria listed is not eligible to participate in the study.

There are minimal risks associated with your participation in this research. There is no compensation for participating in this research. Participating in this research is not an expectation nor requirement of your job. Completing the survey is voluntary and you can stop at any time by closing your browser.

If you would like to participate, please click here or scan the following code to participate in the research.

If you have any questions about the survey, how it is implemented, or the research study, please contact the student researcher, Jarvis Gray, at jkgray@ncsu.edu and 919-820-7011. You can also contact the faculty advisor for this research, Dr. James Bartlett, at jebartl3@ncsu.edu and 919-208-1697. Please reference study number 24896 when contacting anyone about this project.

Appendix C: JobEQ 2019-2020 Community College Welding Credentials

North Carolina for Welding Technology/Welder. (48.0508)			
Title	Certificate < 1 Yr	Certificate 1+ but < 2 Yr	Associate's
Pitt Community College	152	16	23
Wake Technical Community College	116	4	11
Rowan-Cabarrus Community College	93	8	7
Wilkes Community College	87	6	0
Wayne Community College	71	17	0
Central Carolina Community College	77	2	6
Forsyth Technical Community College	61	9	14
Johnston Community College	68	5	7
Davidson County Community College	60	2	5
Cape Fear Community College	48	17	0
Lenoir Community College	57	5	2
Bladen Community College	39	10	12
Catawba Valley Community College	38	1	10
Cleveland Community College	37	12	0
Surry Community College	41	7	0
Asheville-Buncombe Technical Community College	19	12	13
College of the Albemarle	37	6	0
Alamance Community College	19	6	12
Gaston College	23	13	0
Halifax Community College	33	3	0
Fayetteville Technical Community College	15	20	0
Beaufort County Community College	24	4	4
Coastal Carolina Community College	24	8	0
Blue Ridge Community College	24	0	5
Craven Community College	17	3	8
Southwestern Community College	28	0	0
Piedmont Community College	24	3	0
Stanly Community College	20	7	0
Richmond Community College	18	8	0
Central Piedmont Community College	6	1	17
Vance-Granville Community College	15	1	8
Randolph Community College	11	12	0
Guilford Technical Community College	7	13	0
Mayland Community College	18	2	0
Isothermal Community College	11	0	4
South Piedmont Community College	13	2	0
Haywood Community College	10	0	4
Rockingham Community College	10	4	0
James Sprunt Community College	5	8	0
Mitchell Community College	10	1	2
Southeastern Community College	7	3	2
Roanoke-Chowan Community College	11	0	0
Tri-County Community College	6	4	1
Nash Community College	7	0	3
Robeson Community College	0	10	0
Wilson Community College	8	0	0
Durham Technical Community College	7	0	0
Pamlico Community College	5	0	1
Caldwell Community College and Technical Institute	5	0	0
Brunswick Community College	4	0	0
Edgecombe Community College	4	0	0
McDowell Technical Community College	3	0	0
Sampson Community College	0	0	3
Western Piedmont Community College	2	0	0
Carteret Community College	1	0	0
Martin Community College	0	0	0
Montgomery Community College	0	0	0
Total	1,556	275	184
Source: JobsEQ®			
Data as of the 2019-2020 academic year unless noted otherwise; related occupation data as of 2021Q1.			
Note: Figures may not sum due to rounding.			
1. Data as of the 2017-2018 academic year			
Exported on: Monday, September 27, 2021 7:10 PM			

Appendix D: IRB Exempt Status Approval for Phase One

Bartlett - 24896 - IRB Protocol assigned Exempt status

IO **IRB Administrative Office <pins_notifications@ncsu.edu>**
5/6/2022 4:10 PM

To: jkgray@ncsu.edu

Dear Jarvis Gray:

Date: May 6, 2022
IRB Protocol 24896 has been assigned Exempt status
Title: Yael [meeting scheduled for 5/10/22] Safety Perspectives and Actions of Welding Instructors in North Carolina's Community College System
PI: Bartlett, James E

The research proposal named above has received administrative review and has been approved as exempt from the policy as outlined in the Code of Federal Regulations (Exemption: 46.101. Exempt d.2L). Provided that the only participation of the subjects is as described in the proposal narrative, this project is exempt from further review. This approval does not expire, but any changes must be approved by the IRB prior to implementation.

1. This committee complies with requirements found in Title 45 part 46 of The Code of Federal Regulations. For NCSU projects, the Assurance Number is: FWA00003429.
2. Any changes to the protocol and supporting documents must be submitted and approved by the IRB prior to implementation.
3. If any unanticipated problems or adverse events occur, they must be reported to the IRB office within 5 business days by completing and submitting the unanticipated problem form on the IRB website: http://research.ncsu.edu/sparcs/compliance/irb/submission-guidance/.
4. Any unapproved departure from your approved IRB protocol results in non-compliance. Please find information regarding non-compliance here: http://research.ncsu.edu/sparcs-docs/irb/non-compliance_faq_sheet.pdf.

Please let us know if you have any questions.

****

NCSU IRB Office

Please contact ncsuirboffice@ncsu.edu if an official PDF approval letter with signature is required by your funding source.

Appendix E: Qualtrics Survey Phase One

Safety Perspectives of Welding Instructors Initial Screening

Survey Flow

Block: Default Question Block (45 Questions)

Page Break

Start of Block: Default Question Block

Q44 Initial Screening To ensure your responses remain confidential, please only access this survey when you're in a private location, such as your home, on a private internet connection with your web browser in private or incognito mode.

Title of Study: Safety Perspectives and Actions of Welding Instructors in North Carolina's Community College System
eIRB # 24896
Principal Investigator(s): Dr. James Bartlett, jebartl3@ncsu.edu 919-208- 1697, Student Researcher :Jarvis Gray, jkgray@ncsu.edu, 919-820-7011
Funding Source: None
Collaborating Researchers: North Carolina State University, Dr. James Bartlett
Dr. Michele Bartlett mebartle@ncsu.edu, Dr. Travis Parks travis_park@ncsu.edu , and Dr. Alex Albert alex_albert@ncsu.edu

What are some general things you should know about research studies? Participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate, and to stop participating at any time without penalty. The purpose of this research study is to gain a better understanding of welding instructors' perspectives within your institution. You are not guaranteed any personal benefits from being in this study. Research studies also may pose risks to those who participate. You may want to participate in this research because the knowledge gained through generalized answers may lead to future research. Specific details about the research in which you are invited to participate are contained below. If you do not understand something in this form, please ask the researcher for clarification or more information.

A copy of this consent form will be provided to you. If you need a replacement, you may contact me at jkgray@ncsu.edu. If, at any time, you have questions about your participation in this research, do not hesitate to contact the researcher(s) named above or the NC State IRB office. The IRB office's contact information is listed in the What if you have questions about your rights as a research participant? Section of this form.

What is the purpose of this study?
The purpose of the study is to explore safety programs of welding instructors within the North Carolina Community College System. The aim is to justify future research in the coming year. Research has shown that there are varying opinions among instructors regarding support in the classroom, ability to teach complex safety topics, provide adequate recognition and mitigation of hazards in the workplace.

How many people will be in the study? There will be approximately 150 participants that are asked to provide a survey response. Am I eligible to be a participant in this study? In order to be a participant in this study, you must agree to be in the study and be an active welding instructor within the North Carolina Community College System. You cannot participate in this study if you do not meet the inclusion criteria or you are not a current active instructor within the North Carolina Community College System.

What will happen if you take part in the study?
If you agree to participate in this study, you will be asked to do all of the following: 1. Complete a pen and paper survey 2. Your participation may lead to recommendations for father research and is hoped to generate change in The total amount of time that you will be participating in this study is up to 15 minutes.

Risks and benefits There are minimal risks associated with participation in this research. The risks to you because of this research include use of your name and institution name. However, if you are concerned about the use of your name or institution name, there will be an option to use a pseudonym. There are no direct benefits to your participation in the research. The indirect benefits are that you will be contributing to the advancement of welding safety and that improvements may be made as a result of your willingness to share your experiences. Right to withdraw your participation You can stop participating in this study at any time for any reason. To do so, just stop any research activity that you are doing or contact Jarvis Gray. You can also contact the faculty advisor for this research at jebartl3@ncsu.edu and 919.208.1697. If you choose to withdraw your consent and to stop participating in this research, you can expect that the researcher(s) will redact your data from their data set, securely destroy your data, and prevent future uses of your data for research purposes wherever possible. This is possible in some but not all cases.

Confidentiality, personal privacy, and data management Trust is the foundation of the participant/researcher relationship. Much of that principle of trust is tied to keeping your information private and in the manner that I have described to you in this form. The information that you share with me will be held in confidence to the fullest extent allowed by law. Protecting your privacy as related to this research is of utmost importance to me. There are very rare circumstances related to confidentiality where I may have to share information about you. Your information collected in this research study could be reviewed by representatives of the University, In other cases, I must report instances in which imminent harm could come to you or others. How I manage, protect, and share your data are the principal ways that I protect your personal privacy. Data that will be shared with others about you will be identifiable unless you direct me otherwise. Anonymous. Anonymous data means that at no time can I or anyone else link your identity to your answers on the survey and your recorded audio/video recording. Collected during this research. This means that I cannot identify you at all, even when the data is combined with other information. I will also not seek to identify you using any techniques or technology. Identifiable. Identifiable data is your name and institution name that directly links you to the data. This includes, but is not limited to, your name, e-mail, phone number, or other details that make you easily recognizable to me and others. Identifiable data has your real identity directly on the survey data that are shared with me. And other people.

Future use of your research data Your information, even with identifiers removed, will be stored for future research studies. Compensation There is no compensation for participating in this study. Research collaborations This research project is a cooperative effort between Jarvis Gray, Dr. James Bartlett, Dr. Michele Bartlett, Dr. Travis Porch, and Dr. Albert Albertson the following entities: North Carolina State University.

What if you have questions about this study? If you have questions at any time about the study itself or the procedures implemented in this study, you may contact the Jarvis Gray researcher. You can also contact the faculty advisor for this research, James Bartlett, at jebartl3@ncsu.edu and 919.208.1697 What if you have questions about your rights as a research participant? If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact the NC State IRB (Institutional Review Board) office. An IRB office helps participants if they have any issues regarding research activities. You can contact the NC State University IRB office at IRB-Director@ncsu.edu, 919-515-8754, or fill out a confidential form online at https://research.ncsu.edu/administration/participant-concern-and-complaint-form/ Consent to participate By signing this consent form electronically,

I am affirming that I have read and understood the above information. All of the questions that I had about this research have been answered. I have chosen to participate in this study with the understanding that I may stop participating at any time without penalty or loss of benefits to which I am otherwise entitled. I am aware that I may revoke my consent at any time.

○ Yes, I want to participate in this study (1)

○ No, I do not wish to participate int his study (2)

Q46 Please sign here.

Q45 I am currently a welding instructor within the community college system.

○ Yes, Please continue (1)

○ No, Please do not going any further. (2)

Page Break

Q1 I feel comfortable teaching hazard communication within my welding courses - (teaching students to identify chemical exposures)

○ Strongly Disagree (1)

○ Disagree (2)

○ Neither comfortable nor uncomfortable (3)

○ Somewhat comfortable (4)

○ Extremely comfortable (5)

Q2 I feel comfortable teaching emergency response to injuries within my welding. courses

- Strongly Disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q3 I feel comfortable teaching fire safety within my welding courses, (Use of Portable fire extinguishers)

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q4 I feel confident teaching fall protection awareness level within my welding courses. - (Teaching Students to use fall protection devices, harness, lanyard)

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q5 I feel confident teaching fall protection competent person training within my welding courses. (Teaching students to calculate fall distance)

○ strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q6 I feel confident training hearing conservation safety within my welding courses.

○ strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q7 I feel confident teaching students about PPE such as hard hats, welding gloves, and foot protection within my welding courses.

○ strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q8 I feel confident when teaching students about control of hazardous energy programs such as lock out / tag out in my welding courses.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q9 I feel confident about teaching students how to properly use ventilation in my welding courses.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q10 I feel confident teaching my students about respiratory protection in my welding courses.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q11 I feel confident teaching students hazards associated with struck by risks in my welding courses.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q12 I feel confident in teaching students about hazards associated with caught in exposures in my welding courses.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q13 I feel confident in delivery safety training related to welding safe practices in my welding courses.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q14 I feel hazard recognition training such as an OSHA 30 hour course should be taught as a required part of curriculum.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q15 I believe a safety course such as industrial safety should be a requirement of any welding program regardless of level of completion.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q16 My institution has prepared me well to handle student injuries in the classroom.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q17 My institution has taught me to perform incidnet investigation for injuries that occur in the classroom.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q18 I have learned from injuries that have occurred in the classroom.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q19 I am confident I can teach a student to understand a safety data sheet in the classroom.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q20 I was formerly trained in safety polices and procedures before entering the classroom.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q21 My institution shares sampling data from air sampling conducted in the welding lab.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q22 Students have access to safety data sheets in the classroom.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q23 I feel my institution provides enough continuous professional development towards student safety.

- ○ strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Q24 Virtual reality welding simulation is a proactive means to prevent student injury in the lab?

- ○ strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Q25 I am comfortable identifying welding hazards in the laboratory.

- ○ strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Q26 I am familiar with the occupational safety hierarchy of controls? (Elimination, Substitution, Engineering, Administration, Personal Protective Equipment)

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q27 I perform safety inspections within the welding lab?

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q28 I believe that the design of my institutions welding labs have resulted in injuries to students or other faculty.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q29 Hazard assessments are shared with factuality, students, and staff.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q30 There are supplemental training videos for welding lab safety at my institution.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q31 If your institution has virtual reality welding simulation, I believe that it sufficiently teaches students hazard recognition.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q32 If you do not have virtual reality welding simulator: Virtual reality welding simulation should be integrated into your college program.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q33 I am comfortable training English as a Second Langue students welding safety.

- strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q35 Are you an OSHA certified instructor?

- Yes (1)
- No (2)

Q36 I have certification through National Construction Research Center.

- Yes (1)
- No (2)

Q37 I have you experienced student incidents in the classroom?

○ Yes (1)

○ No (2)

Q38 I teach

○ Part time (1)

○ Full time (2)

Q40 What is your gender?

○ Male (1)

○ Female (2)

○ Prefer not to answer (3)

Q42 Are you of Spanish, Hispanic, or Latino origin?

○ Yes (1)

○ No (2)

Q44 What is the highest level of education you have completed?

- ◯ Some high school or less (1)
- ◯ High school diploma or GED (2)
- ◯ Some college, but no degree (3)
- ◯ Associates or technical degree (4)
- ◯ Bachelor's degree (5)
- ◯ Graduate or professional degree (MA, MS, MBA, PhD, JD, MD, DDS etc.) (6)
- ◯ Prefer not to say (7)

Q47 I would be interested in a private interview requesting my perspectives of safety in the classroom for future research.

- ◯ Yes (1)
- ◯ No (2)

Display This Question:

If I would be interested in a private interview requesting my perspectives of safety in the classroo... = Yes

Q48 Please enter an email address where you would like to be contacted.

____

End of Block: Default Question Block

Appendix F: Recruitment Material

Appendix G: Phase Two Interview Questions

Greetings,

Thank you for your willingness to participate in this research. This research is seeking to understand your perspective of safety in welding classroom/labs as a welding instructor working in the North Carolina Community College System. Before we get into the interview questions, I wanted to ensure that you understood a few things.

- This is a voluntary research process; you are free to end the process at any time.
- You have completed a consent form to participate in this process. You have also signed a broad consent form. Broad consent gives me the ability to share the research with other researchers or journals to publish in the future.
- This interview is being audio recorded so that it may be transcribed. You will be given a copy of the transcript for your records as well as an opportunity to review the research once completed.

Do you have any questions for me? If not let's begin. Feel free to skip any questions that you are not comfortable answering.

Interview Questions

RQ #	Q#	Question
1		There are all sorts of environments in which welding takes place: ranching, manufacturing, construction, maintenance, shipyard, chemical and refinery etc. What kinds of welding environments have you been employed in?
2		How did you become a welding instructor?
2		What Makes a good welding instructor?
1		Have you ever participated in a safety committee?
1		Are you a member of the American Welding Society or other welding professional organization?
1		Have you ever witnessed or been a part of welding incidents on any job?
1		Have you had family or friends experience workplace accidents or illness?
2		How do you think the welding safety and health training you provide in your classes is different from that which you received as a student?
2		Have you ever had to take a test to demonstrate your knowledge of welding health and safety?

1		Do you feel there are any safety problems in your labs? Is adequate ventilation a problem?
1		Are the labs inspected by anyone? If so how often?
2		Some instructors view minimum literacy requirements as a way to help ensure welder's safety. Others don't feel this way. Do you have any feelings in this regard? Is there a minimum literacy standard set for graduating welders set by this school?
1		Some instructors feel that with the advent of new materials and processes, teaching welding safety is more important than ever, while other instructors feel that-welding safety is welding safety; it doesn't change a whole lot" Do you have any opinion?
2		What would you say should be the objectives or goals of teaching welding health and safety?
2		Do you attempt to draw a line between what safety topics should be presented in class, and what topics are best presented at the worksite?
1		Some instructors I have interviewed feel welding safety is largely a matter of common sense. Others disagree. What do you think?
1		As an instructor, how do you feel you influence the safety attitudes of your students?
2		Do you have any established guidelines for health and safety content?
2		Do you have a curriculum guide / syllabus that covers the areas you want to discuss with your students? Would you be willing to share any course syllabus?
2		Do you feel that there are adequate welding safety and health written and audio-visual materials available?
2		Do you feel the safety component of the welding textbooks you use is adequate?
2		Where do you go to look for new welding safety and health materials? Do you have a favorite place to look for these materials?
1		Do sales representative or safety personnel from the college ever come into the class to give safety demonstrations of equipment or procedures?
2		Do you devote blocks of class time specifically to health and safety, or do you teach safety in conjunction with equipment demonstrations?

2		Do you demonstrate any safety equipment such as fume extractors, explosimeters, oxygen sensors, or portable ventilation equipment, in your classes?
2		Do you demonstrate the use of respiratory protection or other PPE such as ear plugs in your courses?
2		Most instructors I have spoken with say they have very little knowledge of OSHA requirements. Some instructors feel these regulations should be covered as part of the safety curriculum, while others disagree. Do you have any opinion on this point?
2		Do you feel that OSHA and AWS safety regulations are written in too sophisticated a language for you or your students?
1		Do you teach your students to expect or request local exhaust ventilation equipment when on the job?
		How many full and part-time instructors are working at the school?
1		Does the topic of teaching welding health and safety come up in department meetings? In other words, is there any attempt to coordinate this aspect of the curriculum? If so, how is this managed?
2		Are you aware of any document from this school administration, that mentions safety instruction? Would you be willing to share it?
2		Is it your feeling that the administration offers any guidance concerning the safety curriculum presented by instructors? Would you welcome such guidance?
2		Do you think that the welding safety and health instruction this school provides is affected by its geographical location? In what way?
1		Is it your impression that most welders graduating from this college receive adequate on-the-job safety instruction?
1		Do you know if the advisory board have any input into safety instruction?
		How often does the advisory board meet?
2		Some instructors I have spoken with feel that safety should be addressed as a separate course, while others don't think so. How do you feel about this?
2		If you were to teach a separate course in welding safety and health, what subjects would you include that are important to you?

1		Would you include OSHA regulations, AWS, NFPA, API safety standards? atmosphere testing, for oxygen, flammable vapors? Management procedures: fire watches, marking containers that have been purged, etc.
2		Is there anything you would specifically like to demonstrate in the laboratory?
1		Do you feel the teaching of welding health and safety poses any particular problems or frustrations for you?
2		Do you have a hazard communication programs in place here in the welding department?
1		Do you have any thoughts about anything we've talked about, that you would like to clarify?

Appendix H: Consent Form placed in Qualtrics

Schedule and Broad Consent

Thank you for taking the time to complete the initial screening survey. You qualify to participate in this study. To proceed, please read and sign the consent form. After the consent form and be routed to a space where you can schedule your interview. You can stop at any time for any reason by closing your browser. If you have questions about this study, please contact the student researcher, Jarvis Gray, at jkgray@ncsu.edu and 919-820-7011. You can also contact the faculty advisor for this research, Dr. James Bartlett, at jebartl3@ncsu.edu and 919-208-1697. Please refer to protocol number 24896 when contacting anyone about this study."

BROAD CONSENT ADDENDUM Title of Study where Broad Consent is Initially Sought: Safety Perspectives and Actions of Welding Instructors in North Carolina's Community College System (eIRB # 24896) Principal Investigator: Jarvis Gray, jkgray@ncsu.edu, 919-820-7011 Funding Source: None NC State Faculty Point of Contact: Dr. James Bartlett jebartl3@ncsu.edu 919-208-1697

This form asks you to make an important choice about the use of your re-identifiable information. It asks you to decide if you are willing to give your consent to the use of your re-identifiable information for future research.

If you agree, researchers in the future may use your re-identifiable information in many different research studies over an indefinite period of time without asking your permission again for any specific research study. This could possibly help other people or contribute to science. If you do not agree to allow your re-identifiable information to be used for future research, your information will not be kept for future use by anyone.

This form explains in more detail what saying “yes” or “no” to this use of your information will mean to you.

If you say "Yes" on this form
The researcher(s) will store, use and share your re-identifiable information, and may do so for the purpose of medical, scientific, and other research, now and into the future, for as long as they are needed. This may include sharing your re-identifiable information with other research, academic, and medical institutions, as well as other researchers, drug and device companies, biotechnology companies, and others.

If you say "yes", there are no plans to tell you about any of the specific research that will be done with your re-identifiable information. By saying "yes," your re-identifiable information may be used to create products or to deliver services, including some that may be sold and/or make money for others. If this happens, there are no plans to tell you, pay you, or give any compensation to you or your family.

The main risk in saying "yes" is that your confidentiality could be breached. Through managing who has access to your re-identifiable information and through regularly updated data security plans, I will do my best to protect your re-identifiable information from going to people who should not have it.

Another risk is that if you say "yes," your re-identifiable information could be used in a research project to which you might not agree to if you were asked specifically about it.

You will not personally benefit from saying "yes" in this form. Saying "yes" in this form is not a condition of participating in the Safety Perspectives and Actions of Welding Instructors in North Carolina's Community College System (eIRB # 24896) study, nor of your enrollment or employment at any institution.

If you say "no" or do not complete this form The researcher(s) and institution(s) identified above will not store, use, or share your re-identifiable information beyond the purposes stated in the previous consent form that you agreed to and signed for the Safety Perspectives and Actions of Welding Instructors in North Carolina's Community College System (eIRB # 24896) study.

If you want to withdraw your consent You can stop participating at any time for any reason by stopping any research activity that you are doing or by contacting the student researcher, Jarvis Gray, at jkgray@ncsu.edu and 919-820-7011. You can also contact the faculty advisor for this research, Dr. James Bartlett, at jebartl3@ncsu.edu and 919-

208-1697. You can expect that the researcher(s) will redact your re-identifiable information from their data set, securely destroy your data, and prevent future uses of your re-identifiable information for research purposes wherever possible. This is possible in some, but not all, cases.

If you have questions Please ask the research team to explain anything in this form that you do not clearly understand. Please think about this broad consent and/or discuss it with family or friends before making the decision to say “Yes” or “No.”

If you have any questions about this broad consent, please contact the student researcher, Jarvis Gray, at jkgray@ncsu.edu and 919-820-7011. You can also contact the faculty advisor for this research, Dr. James Bartlett, at jebartl3@ncsu.edu and 919-208-1697.

If you want to discuss your rights as a person who has agreed to, refused, or declined to respond to an offer of broad consent or believe that your rights were violated as a result of your agreeing to this broad consent, please contact the NC State IRB Director at IRB-Director@ncsu.edu, 919-515-8754, or fill out a confidential form online at ttps://research.ncsu.edu/administration/participant-concern-and-complaint-form/.

○ **Statement of agreement**

I say yes. The future use of my data and this broad consent addendum is clear to me. I agree that my re-identifiable information can be used for other research studies. My participation is voluntary. I can withdraw my consent at any time without any penalty or loss of benefits to which I am otherwise entitled.

○ **Statement of refusal**

I say no. The broad consent addendum is clear to me. I do not give permission for my re-identifiable information to be kept or used for other research studies. **You can still participate in this research if you say no on this form.**

Thank you for agreeing to participate in a semi-structured, audio, video, recorded interview with me over Zoom for research purposes. Please, list at least five times below, outside of working hours, that work for you to do an interview with me, ranked in order of preference. You may list up to 10 date/ties if you wish.

List Option 1: Date and TIme

List Option 2: Date and TIme

List Option 3: Date and Time

List Option 4: Date and TIme

List Option 5: Date and TIme

List Option 6: Date and TIme

List Option 7: Date and TIme

List Option 8: Date and TIme

List Option 9: Date and TIme

List Option 10: Date and TIme

Please provide an email address where you would like to receive confirmation of your interview date/time and further coordination. I will respond with an email confirming your interview date and time as well as providing information about the web-conferencing platform details that I will use for your interview.

Email Address

Confirm Email Address

First Name

Last Name

Please sign below.

SIGN HERE

clear

Appendix I: AI Generated Pseudonyms and Personas

Name	Persona
Ray	experienced welding instructor who transitioned into teaching after working in the manufacturing industry. He believes that effective welding instructors not only need to be skilled in welding techniques but also possess the ability to effectively communicate and teach others, emphasizing the importance of clear and understandable instruction.
Samuel	knowledgeable and experienced individual who has worked in the nuclear industry for many years. He decided to transition to a different job closer to home and currently work as a teacher, specifically teaching welding and safety. He is passionate about going beyond the curriculum and instilling a strong sense of safety in their students.
Wade	experienced welding instructor with a background in performance automotive work. He has been teaching welding for over three years and is known for his patience and ability to mentor students with different learning paces. He is also interested in pursuing further certifications in welding inspection.
James	experienced welding instructor who has been teaching for the past 10 years. He became an instructor because he wanted to give back to young people and share his knowledge and passion for welding. He prioritizes safety and believes that proper training and equipment can make welding a safe and rewarding profession.
Kevin	seasoned welding instructor with a vast background in various industries, from automotive and aerospace to oil and gas production. His passion for teaching and commitment to student success is evident as he combines his real-world experiences with a strong emphasis on safety and the evolving nature of the welding industry.
Mark	experienced full-time welding instructor who has been teaching for 11 years. With a background in oil and gas production, fabrication, and education, emphasizes the importance of adapting teaching methods and prioritizing safety in the welding lab.
Michelle	Is a passionate and determined welding instructor who discovered her love for the craft in high school and pursued it through a dual enrollment program, eventually landing a full-time position as a program coordinator. She prioritizes student safety, fosters a relaxed learning environment, and encourages her students to embrace their potential in welding.
Todd	experienced welding instructor with a diverse background in neutral power plants and education. He is passionate about teaching students proper welding techniques and instilling a strong emphasis on safety, ensuring they are well-prepared for their future careers.
Alex	experienced welding instructor who has a diverse background in the field. He started as a welding inspector and has worked on various job sites, from basic construction to large pharmaceutical facilities. He is passionate about teaching and prioritizes student success, focusing on effective communication and identifying their strengths. He values safety and has noticed a growing emphasis on it in the field.
Andy	dedicated welding instructor with over a decade of experience in the industry. Passionate about sharing his knowledge and fostering a safe learning environment, he emphasizes practical skills development and ensures his students are well-prepared for real-world welding challenges.