THE MANUFACTURING WORKFORCE: EXPLORING NONTECHNICAL SKILLS AND THEIR IMPACT ON WORKPLACE BEHAVIOR

by
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Abstract

The competitiveness of manufacturing firms relies on a business strategy that includes adopting advanced manufacturing technologies (AMTs), changing the skills workers need to perform their jobs. Yet employers have found a gap between the skills manufacturing technicians (MTs) need and those they possess. An exploratory sequential mixed methods needs assessment of 28 aerospace and defense manufacturing employers explored their level of AMT adoption, whether their MTs have the skills employers needed, and employers' training preferences. The findings indicated that while employers were satisfied with the level of MTs' technical skills, they were not satisfied with their nontechnical (NT) skills and had no strategy for addressing this gap. According to the literature, the NT skills most relevant to manufacturing are communication, critical thinking, and self-management. Attribution theory helps explain MTs' workplace behavior in terms of locus of causality, controllability, and stability. An intervention study of NT skills used attribution theory as a framework to examine:

RQ1. To what extent was the intervention implemented as designed?

RQ2. How has the MTs' participation in the intervention developed their NT skills: communication, critical thinking, and self-management?

RQ3. How do the MTs' NT skills affect their understanding of expected workplace behavior?

The 10-week convergent, parallel, mixed-methods study used error management and spaced learning online, combined with problem-solving and experiential learning, to teach NT skills to seven MTs. Qualitative data from a focus group, researcher's notes, and individual interviews were analyzed to assess the intervention's effectiveness, while quantitative data from session attendance, experiential learning assignment completion, online lesson completion, and schedule

adherence were analyzed to evaluate participation and dosage. The intervention revealed that participants improved their understanding of NT skills and expected workplace behavior. However, they were inhibited from using their NT skills when concerned about a negative result and were enabled to utilize them only when they felt psychologically safe. Workforce development non-government organizations that prepare under-skilled adults for the workforce are potential providers of NT skills training, leveraging existing education providers and bridging the divide between education providers and employers.

Keywords: workforce, soft skills, manufacturing, training, leadership, attribution theory

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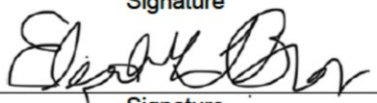
Elizabeth Brown		04/17/2022
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Dedication

I dedicate this dissertation to my husband, Drew, who believes in me more than I do in myself, who gives me strength, who stands by my dreams, and who reminds me to have fun along the way. You, as only the greatest husbands can, bring out the best in me. And to my sons, Joaquin and Luis, whose dedication, tenacity, and hard work make me proud as a mother and whose encouragement has meant the world to me throughout this journey.

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My father taught me that if you love what you do, you'll never work a day in your life. His words inspired me to help others find that passion in their own lives. My mother fostered my deep curiosity and taught me to value learning. I thank them for my upbringing, which motivated my research and instilled in me the responsibility to help make the world better for everyone.

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Executive Summary

The fourth industrial revolution is accelerating technology adoption, changing the skills workers need to perform their jobs (Soares, 2013; World Economic Forum [WEF], 2016). Technology advances have enabled higher quality, improved production, and customization in manufacturing, potentially aiding employers' competitiveness (Congden, 2005; Kotha & Swamidass, 2000; U.S. Government Accountability Office [GAO], 2019). Bronfenbrenner's ecological systems theory (EST; Bronfenbrenner, 1977) provides the theoretical framework to analyze the impact of accelerated technology adoption by aerospace and defense manufacturers on their workforce, with focus on the implications for each system level. Workforce education has evolved, serving different populations and focusing on continually changing skillsets (Peddle, 2000; Li & Kennedy, 2018), with community colleges as the foremost purveyors of technical education (Blume et al., 2019). However, increased use of technology has made technical education more expensive (Grover & Miller, 2018), while funding models have not adapted to incentivize colleges to make the needed investments (Cox & Salle, 2018; Mullin & Honeyman, 2008). The rapid pace of technology innovation and adoption bear on all aspects of work, notably changing the skills people need to perform in manufacturing roles (Soares, 2013).

Problem of Practice

The competitiveness of manufacturing firms relies on a business strategy that increasingly includes the adoption of advanced manufacturing technologies (AMTs; Kotha & Swamidass, 2000). Adults continue their education to stay relevant in the workforce (Soares, 2013), yet employers have found a gap between the skills manufacturing technicians (MTs) need and those they possess (Resnick, 1987; Soares, 2013; WEF, 2016). Ensuring aerospace and defense supply chain manufacturing employers have the skilled workforce they require starts

with a better understanding of the skills gap followed by development of a strategy to addresses it.

Background and Context

The accelerated rate of technological change brought on by the fourth industrial revolution has altered the need for education delivery to a just-in-time model that allows workers to update their skills throughout their entire lives (WEF, 2016). This is especially true for manufacturing firms that must continually adopt AMT to remain competitive (Congden, 2005), requiring workers with higher skill levels (Peddle, 2000). The impact of employers adopting new AMTs at a faster pace, to both students and educational institutions, requires understanding the experience of post-traditional students who manage family and work obligations while attending school. Post-traditional students differ from adult learners in that their educational goal is directly related to career advancement (Soares, 2013). They experience education differently from traditional recent high school graduate students (Bowl, 2001; Fielstein et al., 1992; M. L. Johnson et al., 2016; Wolfgang & Dowling, 1981), taking fewer classes at a time while balancing school with other priorities such as family and jobs (Gagnon & Packard, 2012).

To truly welcome post-traditional students and effectively support their success, education providers must recognize how they differ from their traditional counterparts and provide services appropriate to the circumstances of each (Ben-Yoseph et al., 1999). Community colleges, one of the primary sources of workforce education for adults, face external pressures from decreasing enrollment (Ma & Baum, 2016), and state funding (D'Amico et al., 2014; Hillman et al., 2014; Mullin & Honeyman, 2008), even as the cost of providing technical education increases (Grover & Miller, 2018). Additionally, community colleges face growing competition from for-profit schools (Soliz, 2018) and unaccredited training providers (White et

al., 2018). With manufacturing competitiveness at the forefront of national strategy (GAO, 2019), addressing the education needs of the fourth industrial revolution post-traditional student and ensuring employers have the workforce they need is essential.

A Needs Assessment Investigation

Past research has focused on the process of a firm's adoption of new AMT equipment to their manufacturing processes (Desplaces et al., 2019; Lanzolla & Suarez, 2012), the impact of new technology on the labor force (Aaronson & Phelan, 2020; Gvaramadze, 2010), and the need for technology training for workers and job seekers (Osterman & Weaver, 2016; Rishel & Burns, 1997; Soares, 2013). This needs assessment expands on past research to explore the factors that impact employers' technology-driven need for training and how education providers can address this need.

The exploratory sequential mixed methods needs assessment explored aerospace and defense manufacturers' level of adoption of AMT, whether their manufacturing technicians have the skills employers need, and employers' preferences for addressing their training needs. In the study's first phase, 343 aerospace and defense manufacturers in Dorado County were invited to complete a survey; 28 responded. The survey responses indicated that, while employers were satisfied with the level of technical skills of their employees, they were not satisfied with their employees' nontechnical (NT) skills, especially management, leadership, business communication skills, and appropriate workplace behaviors. Based on the respondents' level of technology adoption, three companies were selected for semi-structured interviews. Interviews were conducted with the human resources manager and one manufacturing technician from each organization who expressed frustration about employees' NT skills, especially their lack of initiative. The human resources managers felt a misalignment between expectations and

employees' skills led many new employees to leave the company while those with the NT skills stayed with the company for years. Although manufacturing companies have reliable strategies for ensuring employees have needed technical skills, they do not have a plan for training NT skills.

Theoretical Framework

Attribution theory (Weiner, 1972) helps explain MTs' workplace behavior—how workers react and interpret what happens in their environment (Harvey et al., 2014). Attribution theory proposes that people are motivated differently based on whether they attribute outcomes to their own actions perceived within their control or factors in the environment they believe outside of their control (Weiner, 1972). The theory describes three dimensions that explain a person's actions: locus, stability, and controllability (Weiner, 1972). Locus describes an individual's attribution of an outcome to either internal or external factors, stability describes whether an attribute is temporary or permanent, and controllability refers to whether the individual has control over the situation. These three components of attribution theory illustrate the causes that a person assigns to an outcome that motivates their future behaviors (Weiner, 2018). In the workplace, employee behaviors such as motivation, leader/member relationships, conflict resolution, performance, and training are driven by attributions (Harvey et al., 2014).

Interventions to Address Nontechnical Skills

NT skills, often referred to as soft skills, are interconnected, nuanced, contextual (Bender et al., 2014), and difficult to assess (Benbow & Hora, 2018). This literature review identified various studies (e.g., Benbow & Hora, 2018; Burning Glass, 2015; Deloitte, 2017; Gates et al., 2016; Deloitte, 2017) that explore the specific NT skills and abilities considered critical in manufacturing, categorizing them as communication, critical thinking, and self-management.

Economic development models were reviewed to identify those that feature workforce education. Triple bottom line (Hammer & Pivo, 2017) and place-based leadership (Beer et al., 2019) strategies facilitate educational institutions' alignment with economic development efforts (Benneworth et al., 2016; Lowe & Feldman, 2018) that could include addressing the NT skills gap. Models for employer-provided training focused on upskilling existing workers (Behaghel et al., 2012; Henriksen & Rolstadås, 2010) and models for training driven by employees addressing their own motivations and needs (Harlow & Bowman, 2016; Schaberg, 2019) were also explored. Finally, various intervention options and methodologies were examined to determine the best approach to address the NT skills gap, including online (Garza Mitchell, 2017) instruction using error management (Heimbeck et al., 2003) and project-based (Musa et al., 2012) and experiential (Joplin, 1981) activities.

Research Purpose and Objectives

The goal of this intervention was for participants to understand better the NT skills identified in the needs assessment and relevant literature (Börner et al., 2018) and how NT skills could impact job performance. This researcher addressed three research questions. The first relates to the intervention process, and the last two relate to the intervention outcome:

RQ1. To what extent was the intervention implemented as designed?

RQ2. How has the MTs' participation in the intervention developed their NT skills: communication, critical thinking, and self-management?

RQ3. How do the MTs' NT skills affect their understanding of expected workplace behavior?

Research Design

A 10-week intervention proposed to teach communication, critical thinking, and self-management skills. The convergent, parallel, mixed-methods study consisted of daily 10-minute lessons on an online platform, four virtual synchronous sessions, and four asynchronous experiential activities participants completed between sessions. Seven manufacturing technicians from a local aerospace and defense employer participated.

Data and Date Analysis

Qualitative data were collected during a focus group before the intervention commenced, along with individual interviews conducted at the end, and the researcher's reflective journal, featuring documentation of participant interactions and details of the intervention implementation. Quantitative data from session attendance, experiential learning assignment completion, the online platform, Skillsline, and schedule adherence were analyzed separately for each participant to assess their level of participation and dosage. The researcher conducted a thematic analysis of the qualitative data in the order collected. The researcher first coded for the a priori themes of communication, critical thinking, and self-management, then reviewed again to identify subthemes. Quantitative data from session attendance, experiential learning assignment completion, Skillsline completion, and schedule adherence were analyzed to assess participation and dosage.

Findings

The intervention revealed that participants improved their understanding of NT skills and expected workplace behavior. Further, the intervention uncovered that participants were inhibited from using their NT skills when they felt it led to a negative result and were enabled to utilize them only when they felt psychologically safe. Attribution theory recognizes

intentionality in the individual's ability to act according to their interpretation of factors in the environment (Harvey et al., 2014). The participants expressed that knowing NT skills and the expected workplace behaviors were the first factors that either enabled or inhibited their use of NT skills. Participants identified two additional factors that impacted their use of NT skills: the type of leadership they work under and having the time needed to deliberate and acquire resources. The intervention demonstrated a method that uses error management (Heimbeck et al., 2003) and spaced learning (Rischke et al., 2011) in online teaching (Garza Mitchell, 2017) combined with project-based (Musa et al., 2012) and experiential (Joplin, 1981) instruction effectively teaches NT skills.

The recruitment process revealed that employers were not willing to invest in training for technician-level employees, suggesting that employers may not be the best entity to provide such training. Workforce development non-government organizations that prepare under-skilled adults for the workforce leveraging existing education providers bridge the divide between education providers and employers. These could be potential providers of NT skills training with both the resources and incentives needed.

Future Research

Further research is needed to better understand the relationship (Harvey et al., 2014) between the supervisor and employee, how employers' belief about MTs' attributions impact their decisions about MTs' NT skills training, and how the relationship between supervisor and employee can be altered to make interventions at the supervisory and management levels more effective. Attribution theory has received less attention in the organizational sciences than in the social sciences, leaving gaps in the understanding of workplace behavior (Harvey et al., 2014). This dissertation adds to the understanding of attribution theory in an organizational context by

exploring the role communication, critical thinking, and self-management skills and MTs' workplace behavior.

Chapter 1

The Manufacturing Workforce: Exploring Nontechnical Skills and Their Impact on Workplace Behavior

The rapid pace of technology innovation and adoption influence all aspects of work, notably changing the skills that people need for successful careers. The third industrial revolution has given way to the fourth (4IR) based on the exponential rate of new innovations disrupting every industry across the world and impacting production, management, policy, and government (Schwab, 2015). Competitive manufacturing firm leaders have adopted advanced manufacturing technologies (AMT) in their operations (Kotha & Swamidass, 2000; Lanzolla & Suarez, 2012; U.S. Government Accountability Office [GAO], 2019; World Economic Forum [WEF], 2016), changing the skills that workers need to perform in manufacturing roles (Soares, 2013).

This accelerated rate of technological change has altered the need for education delivery to a just-in-time model that allows workers to update their skills throughout their entire lives (WEF, 2016). The impact of this shift to both students and educational institutions requires understanding the experiences of traditional, nontraditional, and post-traditional students. In research on undergraduate nontraditional student attrition, Bean and Metzner (1985) developed one of the earliest models differentiating between traditional and nontraditional students based on age and enrollment status. Since then, the differences between these two types of students have been further defined to include family responsibilities and employment status (M. L. Johnson et al., 2016).

For this literature review, traditional students refer to students between 18 and 23 years of age who have attended a 2- or 4-year college immediately after high school, who have enrolled full time, and who have few distractions other than social commitments with peers (M. L.

Johnson et al., 2016; Wolfgang & Dowling, 1981). Nontraditional students meet at least one of the following characteristics: a gap between high school and postsecondary education, lack a high school diploma or equivalent, part-time enrollment, full-time worker while attending school, financial independence, and married with dependents or a single parent (Horn & Carroll, 1996). Post-traditional students are a subset of nontraditional students, with a specific combination of characteristics that include working full time to support dependents while attending school, seeking educational goals directly related to their jobs for career advancement, and potentially needing help to reach college readiness (Soares, 2013). Students' work statuses play important roles in their abilities to participate in education, as described later.

This literature review examines the accelerated rate of technological change and its impact on workforce education from three perspectives. First is manufacturing firms' perspectives about responding to demographic and industry shifts by adopting AMT in their operations (Kotha & Swamidass, 2000; Lanzolla & Suarez, 2012; U.S. GAO, 2019; WEF, 2016). Second are the post-traditional students who must update their skills to remain relevant in the workforce but will do so while working and balancing various other obligations (Soares, 2013). Finally, the third perspective is that of community colleges, the institutions most often tasked with providing workforce training (Blume et al., 2019) and preferred by employers (Osterman & Weaver, 2016). The nation's community colleges have navigated changing demographics that have led to decreased enrollment from every student sector (Ma & Baum, 2016), increased pressures from reduced external funding (D'Amico et al., 2014; Hillman et al., 2014; Mullin & Honeyman, 2008), increased competition from for-profit colleges (Soliz, 2018), massive open online courses (MOOC; Soares, 2013), and other innovative education providers. These

situations have left college leaders to search for new business models to add renewed relevance today.

Historically, community college leaders have provided education to adults as they did for soldiers returning from the Vietnam War (Bishop & Van Dyk, 1977) and for displaced workers who needed to find a new occupation (Ghilani, 2008). However, in both of those instances, students enrolled full time, eliminating some external pressures that impact today's post-traditional working adult students (Wyatt, 2011). Post-traditional students experience education differently from traditional students (Bowl, 2001; Fielstein et al., 1992; M. L. Johnson et al., 2016; Wolfgang & Dowling, 1981). They take fewer classes simultaneously and must balance school with other priorities, such as family and jobs (Gagnon & Packard, 2012). College leaders must recognize the differences between post-traditional students and their traditional counterparts to provide services appropriate to the circumstances of each while welcoming and effectively supporting their success (Ben-Yoseph et al., 1999). However, accommodating post-traditional students' needs may place financial pressures on community colleges' business models.

In an effort to balance the state budget, the state of Arizona permanently eliminated funding for its two urban community colleges in 2016, including Sahuaro Community College (SCC; name changed to maintain anonymity). Additionally, SCC has experienced declining enrollment from traditional students since 2011. With decreasing birth rates in the state (Arizona Department of Health Services, 2018), the traditional pipeline of high school graduates is not expected to contribute to SCC's enrollment recovery. In response, SCC has identified an opportunity for increasing enrollment by addressing the training needs of working adults. SCC believes Dorado County's manufacturers have adopted technology at a similar pace as the rest of

the country and anticipates this process will lead to a need for upskilling and reskilling of the local workforce. This literature review will use ecological systems theory (Bronfenbrenner, 1977) as a framework to explore the factors around the technology-driven need for training the manufacturing workforce by reviewing how firm leaders adopt AMT, the impact on community colleges and workforce education, and the needs of the post-traditional student.

Bronfenbrenner's Ecological Systems Theory

Bronfenbrenner (1977) developed the ecological systems theory (EST) model when seeking a more robust explanation for child development to account for the interactions the child had with its environment and people in it. The model describes a series of nested systems offering a disciplined approach to understanding each level of interaction, starting with the chronosystem, exosystem, macrosystem, mesosystem, and microsystem (Bronfenbrenner, 1977; Husen & Postlethwaite, 1994; Neal & Neal, 2013). This review of literature systematically explores the post-traditional, 4IR worker's experience, beginning with the broadest system and ending with their interactions within work and school settings in their roles as employees, parents, and students.

The chronosystem represents changes over time that influence the student's environment (Bronfenbrenner, 1977; Husen & Postlethwaite, 1994; Neal & Neal, 2013). For the post-traditional student, these changes include shifts in the broad economy, industry practices, and educational environments that have impacted workforce education. The macrosystem is made up of societal factors, such as culture, customs, laws, and ideologies, that permeate the other lower-order systems. These societal factors include the dynamics of the labor market and forces that drive technology adoption. The exosystem encompasses events and relationships that affect two or more settings. In this problem of practice (POP), the settings include the manufacturing

industry, various levels of government that determine funding policies, and the education sector. The mesosystem represents the interrelation between settings with which the worker directly interacts. This interrelation includes the post-traditional worker's professional environment, various stakeholders in the community college setting, and family who can play a supportive role or can be an obstacle.

At the core of the EST framework is the post-traditional student who needs to update their skills continually to stay relevant in the workforce (WEF, 2016). The microsystem around this worker represents the roles they must play as employees, students, peers, and family members. The diversity of roles and levels of responsibility attached to each makes participating in education both a need and challenge captured within the microsystem (Horn & Carroll, 1996; Philibert et al., 2008; Soares, 2013). Each of these systems and settings represents several relationships, activities, and roles that the post-traditional student must balance in their daily lives.

The Chronosystem: The Evolution of Workforce Education

The chronosystem depicts the changes to the post-traditional student's environment over their lives and beyond (Husen & Postlethwaite, 1994; Neal & Neal, 2013). This section describes the evolution of workforce education and the forces that have shaped it into its current form. These forces include changes in industrial practices (Peddle, 2000), educational environments (Li & Kennedy, 2018), and funding policies (Li & Kennedy, 2018).

As the use of industrial technology has evolved over the last two centuries, so has the need for workers to learn the skills required for its use. Welsh businessman Robert Owen is considered a pioneer of human resource development in the industrial age (Hatcher, 2013). As the owner of a cotton spinning business at the height of the British Industrial Revolution in the

late 1700s, Owen understood the connection between keeping up with evolving manufacturing technology and ensuring employees had up-to-date skills to maximize their productivity. In the United States, through the late 19th century, apprenticeships emerged for young workers to gain skills that allowed them access to higher pay. As trade unions gained popularity, they took over apprenticeship training oversight and controlled the number of new laborers that could be trained. By the start of the 20th century, trade schools emerged "run entirely in the interests of the pupils and not for the purpose of profit on the work done" (Massachusetts Bureau of Statistics of Labor, 1907, p. 63). However, the cost of attending these schools was high, and paying for the education fell completely on the student.

Workforce education continued to evolve and the first of the nation's 2-year colleges appeared in the mid-1800s (Geller, 2001). However, not until passage of the Smith-Hughes Act of 1917 (Resnick, 1987) with which industry lobbied did colleges receive public funding to support technical education. Over time, education funding models have evolved in response to changes in technology, economic conditions, and the politics of the moment (Mullin, & Honeyman, 2008). Funding for career and technical education (CTE) offers several examples of policy responses to industry needs, such as the Carl D. Perkins Vocational Education Act of 1984. This act was renewed and updated in 1990, 1998, and 2006, providing funding for classroom CTE instruction (Geller, 2001; M. V. Lewis & Stone, 2013). Another example is the Trade Adjustment Act Community College and Career Training (TAACCCT) grant program, launched in 2011 to fund workforce development programs in a wide range of occupations (Blume et al., 2019).

Between 2011 to 2018, all 50 states, plus Puerto Rico and the District of Colombia, received $2 billion in funding for TAACCCT initiatives. The TAACCCT grant program is a

collaboration between the federal Department of Labor and Department of Education. The goal was to increase college access for working adults, creating a pathway into high-skill, high-wage occupations and providing participants with the skills needed to succeed in a fast-changing labor market. Manufacturing training is one of the sectors with the most program activity. In their meta-analysis of 36 TAACCCT evaluation reports spanning four rounds of funding, Blume et al. (2019) examined four types of outcomes. These types included educational outcomes based on program and credential completion, employment outcomes assessing post-program employment, and the wage change between the start and end of the program. The researchers found that program completion and employment outcomes improved, noting the strongest impact was on education outcomes.

Despite the push from the federal and state governments to support industry-focused CTE initiatives, the standardization of education has led to a disconnect between the skills taught in the classroom and those needed by employers (Resnick, 1987; Soares, 2013; WEF, 2016). In the classroom, students should demonstrate different behaviors than in the workplace (Resnick, 1987). In school, students learn independently and demonstrate competency by taking exams individually. In the workplace, students demonstrate competency by solving problems, not in isolation, but collaboratively in teams. Peddle (2000) conducted a dozen studies between 1992 and 2000 as the principal or co-principal investigator for the Center for Governmental Studies at Northern Illinois University. The individual studies were not publicly available; however, Peddle published a report reviewing the findings from a decade of research. The studies were conducted in Northern Illinois using surveys, interviews, and focus groups with employers from the private and public sectors. The goal was to assess their perceptions of education, job readiness, and skill gaps for recent graduates from local community colleges and universities. The pattern of

employers' perceptions of workers' skills that emerged remained consistent. Peddle found that employers expressed dissatisfaction with employees' and new hires' skills, particularly teamwork, problem solving, communication skills, understanding of the work environment, and attitude. Further, after 10 years of research, Peddle concluded that community colleges should provide the "vocational and applied sciences programs as well as basic skills and general education at the post-high school level" (p. 39) that employers would need. The researcher argued that ensuring the sustainability of community colleges was a matter of economic development that would merit public financial support.

Nevertheless, Li and Kennedy (2018) found that recent funding policies in higher education had not focused on incentivizing the alignment of curricula with employer needs and better labor market outcomes, instead focusing on reward enrollment and completions. Li and Kennedy analyzed the performance-based funding models of 29 states and the impact over the 5 years after the policies' implementations. The researchers used resource dependence theory to assess the relationship between state performance funding and 2-year colleges' outcomes. Performance funding formulas would tie state appropriations to community college outcomes, such as retention and completion. In 26 of the 29 states, the same funding was awarded for completion of a 2-year associate degree as a certificate that would take less than a year to complete. Li and Kennedy selected 1990 to 2013 as the dates to study because that was when most performance funding policies were implemented. The researchers drew college-level data from the Integrated Postsecondary Education Data System (IPEDS) to identify a sample of 751 public 2-year colleges that awarded associates degrees. Li and Kennedy found that performance-based funding incentivized colleges to focus on short-term credential attainment without regard to whether there was an impact on students' earning potential compared to only having a high

school diploma. Similarly, Mehta (2013) evaluated the funding policies of Utah, Michigan, and Maryland between 1989 and 2001. The goal was to assess whether policies meant to incentivize education had led to better economic outcomes for students. Although the state governments acknowledged the link between education and the economy and roles played by students' skills in state competitiveness, the policies that resulted focused on institutional measures, such as test scores, rather than the skills relevant to employability. The future of workforce education would require an emphasis on the alignment between the skills students learn and business needs to realize the potential economic gains from additional education (Krause & Sawhill 2017; Peddle, 2000; Soares, 2013).

The Macrosystem

The macrosystem provides a big picture representation of the world of the post-traditional student (Bronfenbrenner, 1977; Husen & Postlethwaite, 1994; Neal & Neal, 2013). It includes macrolevel factors that permeate the other systems (Bronfenbrenner, 1977; Husen & Postlethwaite, 1994; Neal & Neal, 2013). In the context of this POP, the forces considered are the drivers of accelerated technology adoption (Aaronson & Phelan, 2019), the dynamics of the labor market, and the demand for technical postsecondary education.

Forces Accelerating Technology Adoption

Automation is most likely to impact industries that have increasing labor costs and depend on repetitive tasks and routine operations (Aaronson & Phelan, 2019; Jimeno, 2019; Krause & Sawhill, 2017), as seen in manufacturing (Levy Yeyati & Sartorio, 2008; U.S. GAO, 2019). Adopting AMT as a cost savings measure may help mitigate increasing labor costs, but this strategy does not necessarily lead to higher profitability (Kotha & Swamidass, 2000). Kotha and Swamidass (2000) used a 5-point Likert-type scale survey with 160 U.S. manufacturing

firms that had employed an average of 2,800 workers. Participants indicated the degree of emphasis placed by their firms on three factors of cost-leadership strategy defined as prioritizing business unit efficiency, lowering product costs, and reducing process costs. Participants also reported on their firms' use of product differentiation, which included a focus on new product development, product quality, service capabilities, and a highly trained workforce. Regression analysis on three models examined the relationship between strategy, adoption of AMT, and firm performance. The analysis revealed that companies that adopted AMT as part of a cost-leadership strategy showed lower profitability than firms that adopted AMT as part of a differentiation strategy (Kotha & Swamidass, 2000).

Small firms also benefit from alignment between AMT use and the business strategy (Congden, 2005; Meredith, 1987). In seminal research on small firms, Meredith (1987) conducted a case study analysis of the process of adoption of new technologies and outcomes in two small manufacturing firms in the United States. Although expensive to implement, AMTs leveraged advantages already held by small firms, including agility in production, easier customizations, a wider array of products, and shorter response times to customers. Congden (2005) also researched how the relationship between a firm's strategy and use of technology would influence its performance. The researcher surveyed 399 U.S. tooling and machining firms with an average of 53 employees. The questions addressed 11 dimensions of competitive strategy and five of process technology. The researcher found higher profitability in firms that aligned AMT use to their business strategy. Both Meredith (1987) and Congden (2005) made the case that technology could help level the playing field for smaller firms, creating competitive advantages over large firms. As Kotha and Swamidass (2000) found, firms that choose a strategy based on differentiation will need a highly trained workforce.

Labor Market Dynamics

Ensuring the U.S. manufacturing industry has the skilled workforce it needs to remain competitive has been a national policy priority, yet the country faces a tight labor market; new job growth has outpaced the labor supply (U.S. GAO, 2019). The slowdown of population growth (Vespa et al., 2020) and high retirement rates of the baby boomer generation (Jimeno, 2019) exacerbated by a noncyclical decline in employment of less educated men and women (Krause & Sawhill, 2017) have added pressure to the workforce's talent pool. Increases to the minimum wage have led employers to substitute low-skilled jobs for AMT, further reducing the jobs available to the unskilled population (Aaronson & Phelan, 2019).

Krause and Sawhill (2017) compiled research from various government and academic sources to report on the factors that would impact men's and women's participation in the labor force, during the prime working ages of 25 to 54 years old. In reviewing data from the Bureau of Labor Statistics, the researchers found that women's labor market participation had risen steadily between 1948 and 1990, plateauing through 2014. Conversely, men have consistently decreased their participation in that time. Overall, men's participation between 1948 and 2014 fell by 8%, with the sharpest decline for Black men of 11% and men without a college degree. Health problems and increased incarceration rates were the main factors keeping men out of the workforce, as was less-education and men's lack of in-demand skills. These findings showed that workers displaced from highly routine manual jobs had a lower probability of subsequent employment.

Policy-driven minimum wage hikes have contributed to the high cost of labor due to the low supply of workers discussed above (Aaronson & Phelan, 2019). Aaronson and Phelan (2019) studied whether increases in the minimum wage had led to substituting technology for low wage

jobs. The researchers selected 17 measures from the Work Activities and Work Context Importance scales from the Occupation Information Network (O*NET) database of knowledge, skills, and abilities associated with each of the standard occupation classifications. From those measures, the researchers developed six indices that specified the degree to which a task was cognitive or manual. Aaronson and Phelan used occupation employment and hourly wage data (Occupation Employment Statistics [OES], 2009) from 1999 to 2009, when the enactment of new minimum wage policies became less frequent. Using state minimum wage histories together with the OES data, the researchers assessed the relationship between changes to the minimum wage and employment changes by each occupation's routineness according to O*NET. Aaronson and Phelan found that increases in the minimum wage raised the cost of labor and decreased the number of the lowest wage jobs. Minimum wage hikes did not seem to impact more highly skilled occupations that pay more than minimum wage. The researchers cautioned that as the cost of labor would continue to rise and the cost of technology falls, employers would increasingly automate tasks done by minimum wage workers, leaving unskilled workers vulnerable to losing their jobs. The impact of minimum wage increases and employers' responses of accelerating their adoptions of automation have increased their need for skilled workers (Aaronson & Phelan, 2019). Unskilled workers see their opportunities to participate in the workforce reduced further (Krause & Sawhill, 2017). Under-skilled workers need to acquire new skills to rejoin the workforce and fulfill employer demands for higher skilled workforce needs.

Postsecondary Technical Education

Although there are not enough data and research yet available to quantify the amount of reskilling the nation will need as technology adoption expands, community colleges will have an

opportunity to play an important role in that endeavor (U.S. GAO, 2019). Community colleges are well positioned to provide workforce developmental training (Osterman, 2011), and manufacturing employers community colleges as providers of technical training (Osterman & Weaver, 2016). A nationally representative sample of randomly selected manufacturers that employed 10 or more workers from Dun and Bradstreet's database asked about worker skills, training, and hiring policies, as well as about the firm's relationship with local community colleges (U.S. GAO, 2019). U.S. GAO (2019) found that fewer than half of the employers had discussed workforce issues with their local colleges, but those who had discussed issues reported being highly satisfied with the training their employees received.

Adults also prefer community college over universities as their education providers (Cummins et al., 2018). Cummins et al. (2018) used IPEDS data to analyze 115,000 working adult learners enrolled in Ohio public postsecondary institutions from 2006 to 2014. The researchers found that older students, ages 25 to 64, were more likely to work while going to school and were motivated to learn technical and vocational skills with direct applicability to their job. However, increasing enrollment from this segment would require community colleges to be more flexible to accommodate that most students had already attained employment.

Over the history of community colleges, high unemployment and large influxes of soldiers returning from war have positively impacted enrollment (Geller, 2001). After the Great Recession of 2008 to 2009, demands for community college educations increased until 2011, followed by the current trend of decreasing enrollment (Juszkiewicz, 2019). However, as the number of traditional age students has decreased, the proportion of students considered post-traditional has increased (Cummins et al., 2018). In 1972, 20% of students enrolled in a 2-year college were 24 years old or older (Bishop & Van Dyk, 1977); by 2012, that number had more

than doubled to 44% (Ma & Baum, 2016). Cummins et al. (2018) highlighted the importance of providing educational opportunities to nontraditional students to fulfill the nation's workforce needs but cautioned that community colleges must change education delivery to attract and retain nontraditional students.

The Exosystem

The exosystem represents the overarching institutions that delineate the life and interactions of the post-traditional student (Bronfenbrenner, 1977; Husen & Postlethwaite, 1994; Neal & Neal, 2013). These institutions include the manufacturing industry, education sector, and various levels of government that determine funding policies. Each of these institutions acts as a backdrop for the settings in which post-traditional students act on a regular basis.

Technology Adoption in Manufacturing

Although technology makes innovation possible and brings efficiencies to firm processes, adoption of technology displaces jobs (U.S. GAO, 2019). E. Lewis (2011) researched the relationship between the education level of a community's workforce and the technology adoption of area manufacturing firms. The researcher found that cities with lower levels of education also had lower levels of AMT adoption. The researcher selected 143 metropolitan areas with high rates of immigration to study the impact of the influx of low skilled labor on manufacturing firms. The 1988 and 1993 Surveys of Manufacturing Technology (SMT) polled a random sample of approximately 1,000 manufacturing firms with 20 or more employees on their use of 17 categories of AMT. E. Lewis supplemented the SMT data with data from the 1987 and 1992 Census of Manufacturers to compare the change in manufacturers' use of five AMT technologies. The researcher used U.S. Census data and Current Population Survey micro data for non-census years of 1988 and 1993, considering levels of education in four categories:

dropout, high school, some college, and at least 4 years of college. E. Lewis found that regions with a larger proportion of workers with at least a high school education also had more automation in their manufacturing plants, concluding that the AMT substitution effect was higher for workers with less education.

A decade later, Aaronson and Phelan (2020) conducted similar research corroborating E. Lewis's (2011) findings that low skill jobs were most susceptible to technology substitution. The researchers considered state-level occupational employment data from 2010 to 2018 and occupational employment and wages for 328 metropolitan areas in the Bureau of Labor Statistics' OES survey, supplemented by state-level employment data from the American Community Survey from 2010 to 2017. Using regression analysis, the researchers examined the relationship between employment, changes in minimum wage, and changes in minimum wage with the routineness of occupations. The researchers found that increases in labor costs in recent years had compelled firms to increase the rate at which they adopted AMT to perform routine low skill tasks (Aaronson & Phelan, 2020).

As reviewed above, firm leaders adopt AMTs to mitigate increased labor costs or gain a strategic competitive advantage. Firms' selection, adoption, and implementation of new technology into operations are "lengthy, complex, and iterative" (U.S. GAO, 2019, p. 34) processes. Desplaces et al. (2019) conducted case study of in-depth interviews with three U.S. manufacturers that had fewer than 500 employees to explore the characteristics that would show the process of adopting an AMT. The researchers developed a model describing five stages of adoption: knowledge, persuasion, decision, implementation, and confirmation. Lanzolla and Suarez (2012) added to the understanding of the adoption process by studying how adoption would spread internally within the various levels of employees in a firm and differentiating

between adoption and use. The researchers studied user data provided by the software firm from 3,158 firms that had recently adopted new computer technology. After tracing the adoption process over a 3-year period, Lanzolla and Suarez demonstrated that different actors within the company varied in their use of the new technology, potentially causing delays in its full implementation and the materialization of expected benefits. More recently, U.S. GAO (2019) assessed the technology adoption processes of different size firms focused on diverse activities, ten of which were manufacturers. U.S. GAO interviewed the 16 participating firms multiple times between 2017 and 2019. Aligning with Lanzolla and Suarez (2012), U.S. GAO (2019) found that purchasing and installing a new technology did not equal its full implementation and use.

Meeting the Demand for Skilled Workers

Another finding from Lanzolla and Suarez (2012) and U.S. GAO (2019) was that the skill levels of employees were factors in the success of a firm's technology implementation. Rishel and Burns (1997) studied the impact of AMT on small manufacturing firms. The researchers created a survey using data from small manufacturing firms, then distributed the survey to 500 metal fabrication firms with less than 150 employees in Georgia and Pennsylvania. Using standard parametric statistical techniques, Rishel and Burns found that 66% of the 140 respondents had at least one piece of AMT equipment. The researchers also found that firms using AMT required 1.7 skilled workers for every skilled worker in a firm not using AMT. Rishel and Burns concluded that the demand for skilled employees would increase as more firms adopted AMT. Peddle (2000) conducted research during that same period and found that employers did not feel workers had the AMT skills they needed, and 20 years later, the gap seemed to be widening (Krause & Sawhill, 2017).

Workers and job seekers will need technical training to update their skills throughout their lives to meet demands for skilled labor from the employer, an external provider, such as the equipment manufacturer, or an accredited institution of higher education, such as community colleges (Osterman & Weaver, 2016; Rishel & Burns, 1997). The National Centre for Vocational Education Research in Australia published a report in 2018 citing various studies on employers' use of nonaccredited training (White et al., 2018). The biennial Survey of Employers' Use and Views of the Vocational Education and Training (VET) system was used to examine employers' perceptions of the VET system and how they had used it to meet their training needs. The sample of 8,000 to 9,000 employers were randomly selected from the ABS Business Register. The 2017 Survey of Employers showed that 47% of manufacturing employers had used unaccredited training. The report defined unaccredited providers as structured training programs that did not lead to a formal credential or degree. Overall, 20.9% of employers opted for private training providers, 14.7% used professional or industry associations, and 11% used equipment suppliers or manufacturers. These employers cited high levels of specialization and industry knowledge and most suitable curriculum as the main reasons for choosing external training providers (White et al., 2018).

Employers can also train their employees internally. The 2017 Survey of Employers' Use and Views cited that 54.5% of employers surveyed provided in-house training for their employees. These finding were supported by Baqadir et al.'s (2011) research in Saudi Arabia. They conducted surveys and semi-structured interviews of 20 manufacturers, 71 teachers, and 286 students in Saudi Arabia to learn whether there was a gap between technical education provided and industry needs. The researchers found that a gap did exist. Employers provided their own training for employees who needed new skills, leading to potential inefficiencies

because one employer could not provide the same range of topics as a specialized education provider (Baqadir et al., 2011).

Osterman and Weaver (2016) found that employers preferred community colleges as their training providers. Similarly, Reyes et al. (2019) found that because community colleges were local, they could align with the needs of the local labor market. Reyes et al. examined the relationship between student's choice of postsecondary education provider and its geographic context. The researchers used 2010 U.S. Census data and geographic information systems software to map students' locations, local labor market data, and student attainment information from a Houston area community college. The researchers also interviewed 93 students. Reyes et al. found that the proximity to a community college influenced students' decisions to enroll. Students sought education in fields related to local industry, and many already held jobs in those sectors; thus, closeness to a community college with programs aligned to the local labor market were important considerations in their enrollment decision. Although community colleges are trusted by employers (Osterman & Weaver, 2016) and students (Reyes et al., 2019) to provide the training needed to close the skills gap (Krause & Sawhill, 2017), community college funding models impact schools' abilities to address the needs of nontraditional students.

College Funding Models

Community college funding models based on state government policy and funding priorities have a significant impact on a colleges' operations. Mullin and Honeyman (2008) analyzed the funding formulas from 48 states, categorizing them as the following: (a) those with no funding formula, (b) those with responsive funding addressing differences in operating costs across the state, and (c) those with functional component funding addressing differences in the academic program costs offered at each school. The researchers collected publicly available

documents that included legislative briefs, board minutes, strategic plans, and other higher education reports, referenced state statutes, codes, and laws. Mullin and Honeyman then contacted officials directly when questions remained. The researchers found that each state's funding model had distinct advantages and disadvantages. However, Mullin and Honeyman concluded that each evolved over time, responding to changes in technology, economic conditions, and the politics of the moment and specific to the needs of that state.

Neoliberal policies are based on the principles of market competition and individual rights. Cox and Salle (2018) noted such policies would lead to decreased public funding for institutions, decreased need-based financial aid for students, and policies that would engender competition for resources across all levels of educational institutions. Mullin and Honeyman (2008) offered an example of neoliberal education policies using funding to incentivize colleges to follow the political strategy of the moment. Another example of neoliberal policy that has been widely adopted in the United States and Europe is performance-based funding (PBF; Natow & Dougherty, 2019). PBF policies incentivize alignment with state priorities and needs (Mullin & Honeyman, 2008), leaving community colleges to balance compliance with funding policies and remaining faithful to their organizational missions and students' best interests (Levin et al., 2018).

State policy changes, specifically neoliberalist policies and responses to the Great Recession of 2008, affected community colleges' abilities to focus on serving their students. Levin et al. (2018) studied three community colleges in California, Washington, and Hawaii, reviewing state community college system and state policy documents from 2000 to 2014. The researchers also interviewed 15 faculty and 14 administrators, including the CEO from each college, and conducted campus observations. Levin et al. found that the policies rewarded

performance and efficiency, so the colleges responded by shifting from prioritizing social mobility and equity outcomes to meeting economic and financial goals.

Most recently, community college leaders have seen a conflict between PBF policies and their communities' needs for workforce development-oriented programs (Cox & Salle, 2018; Levin et al., 2018). D'Amico et al. (2014) examined data from the 2012 annual Survey of Finance and Access Issues conducted by the University of Alabama's Education Policy Center. The researchers surveyed members of the National Council of State Directors of Community Colleges. The researchers found that PBF policies designed to reward outputs, such as retention and graduation, did not necessarily align with employers' short-term workforce development training needs. D'Amico et al.'s findings aligned with Grover and Miller's (2018) research that showed that PBF policies had mixed results regarding workforce outcomes. Grover and Miller encountered concerns about funding workforce training in their mixed-methods study, evaluating the issues that could impact colleges' ability to deliver training to adults, especially programs paid for by a student or third party. Ten community college job training experts rated 18 critical issues and identified the decline in state funding as their top concerns impacting their abilities to develop workforce programs.

Current community college business models include a complex mix of external public funding, student tuition, and revenue from other services unique to every state and every college district (Mullin & Honeyman, 2008). Cox and Sallee (2018) posited that a diversified funding model less reliant on public funds and more on student tuition would allow institutions the flexibility to serve its students based on their specific needs. Nevertheless, relying on tuition has its own challenges. Declining birth rates (Vespa et al., 2020) mean fewer prospective students in the education pipeline, while increased competition (Soliz, 2018) is eroding enrollment and

tuition revenue from all student demographics (Juszkiewicz, 2019). Soliz (2018) researched the impact of for-profit colleges on community college enrollment. Using IPEDS data from 2001 to 2012, a period when for-profit colleges proliferated, the researcher considered changes in enrollment at 1,213 community colleges when a new degree granting for-profit institution opened in the same geography. The report showed that for-profit schools had leveraged large marketing budgets to recruit students, as drawn by more robust online course offerings, easier enrollment processes, and better customer service (Soliz, 2018).

For-profit schools are not subject to the same accountability measures and politically driven funding models as community colleges (Mullin & Honeyman, 2008). For-profit schools base operational decisions on local contexts and students' needs. Community college leaders must rely on public funding for sustainability so that they can address social needs (Cox & Sallee, 2018). However, for-profit school leaders need to make a profit, so they operate programs that make money (Soliz, 2018). Community colleges provide a wider array of education opportunities—some that are expensive to provide but valuable to economic strategy (Cox & Sallee, 2018). Although this focus on local social needs stains community colleges' financial sustainability levels, it is why employers and students support the community college model (Reyes et al., 2019).

Employers and workers need ongoing training to keep up with adopting AMTs, and they have various resources to meet this need. This section illustrated the settings where work, education, and training had intersected in post-traditional students' lives (Neal & Neal, 2013; Reyes et al., 2019). Employers in the manufacturing industry (Osterman & Weaver, 2016) rely on community colleges to provide ongoing educations to their workers, yet government funding policies (Mullin & Honeyman, 2008) have not incentivized programs to support workforce

education (Grover & Miller, 2018). The following section illustrates why a community college's ability to support the social needs of students, particularly post-traditional students, is an important component of workforce education critical to student success.

The Mesosystem: Balancing Work, Family, and Education

The settings in post-traditional students' lives include work, home, and school (Soares, 2013). The interactions between the factors in these settings include the relationship between the skills that students need to perform their jobs, that they will learn in school, and that can lead to a financial gain at work (Reyes et al., 2019). Post-traditional students must find a way to finance their educations while reducing hours worked to make time for school, possibly reducing their incomes in the short term (Kim & Baker, 2015). The family that might be the motivation behind the post-traditional student seeking that pay increase or promotion might also take away time and attention from studies (Gagnon & Packard, 2012). The mesosystem represents how those settings interact (Bronfenbrenner, 1977; Husen & Postlethwaite, 1994; Neal & Neal, 2013).

Adult students pursue higher education to reskill for employment purposes (Ghilani, 2008) and the economic benefits of education (Reyes et al., 2019). Seminal research by Tinto (1975) showed that students' perception of the costs and benefits of continuing their educations had driven their decisions to complete their studies. Metzner and Bean (1987) conducted a study based on their previously published model of nontraditional student attrition. The researchers surveyed 624 nontraditional freshmen defined as being 25 years or older, commuting to school, and working part-time at an urban university in the Midwest. Metzner and Bean asked about students' backgrounds, academic characteristics, factors from their environments, and social interactions. The researchers found that having an employment goal was a strong predictor of student persistence. The researchers also found that the more hours a student enrolled, the less

likely they were to drop out. Metzner and Bean posited that if a student took more classes, they had demonstrated a higher commitment to their education. However, an alternate explanation was that students could not take more classes because of other competing priorities that impacted their abilities to fulfill their goals, regardless of intent.

Adults who have a desire to take part in education need to have the time and funds to do so (Geller, 2001; Ghilani 2008). This finding was illustrated by increases in enrollment after wars (Geller, 2001); returning soldiers were not yet employed, so they could attend school full time. Another example was the GI Bill (Bishop & VanDyke, 1977) and other government funding sources that assisted adults in paying for their educations (Ghilani, 2008). Ghilani (2008) surveyed a group of former employees between 35 and 60 years old from a recently closed company to evaluate employees' outcomes and the effectiveness of the college preparing them for new careers. The researcher found that 84% of the participants had found employment 9 months after graduation, 52% had found a job only a month after graduation, 73% said their jobs were in their fields of study, and 80% believed that their educations helped in securing their new jobs (Ghilani, 2008). The students received Trade Adjustment Assistance Act funds to pay for their classes, allowing them to study full time rather than having to balance school with work.

Post-traditional students' time is limited, and there is an economic tradeoff to pursuing additional education while they work (Soares, 2013), which often leads to reducing paid work and a decreased income so that they can make time for their studies (Kim & Baker, 2015). Kim and Baker (2015) considered how adults' enrollments and graduations from a 2-year college impacted their earnings. Kim and Baker used data from the National Longitudinal Survey of Youth composed of 12,686 individuals between 14 and 22 years old in 1979. The sample used by Kim and Baker included 154 workers between the ages of 25 and 55, whose highest levels of

educational attainment were represented by associate degrees completed between 1990 and 2008. A second group of 1,578 workers with high school diplomas and no college experiences was used as a control. Kim and Baker found that students who worked full-time had to forgo paid work or reduce their hours to accommodate classes, negatively impacting their earnings in the short term to achieve the potential increase in the long term.

Despite the potential for economic gains, an important challenge for nontraditional students is the cost of education. Seftor and Turner (2002) considered how adult, nontraditional students were impacted by the availability of federal financial aid when making choices about college. The researchers used data from the Current Population Survey between 1969 and 1990 and analyzed enrollment differences at points when changes to Pell grant eligibility as an independent student had occurred. The researchers found that older, nontraditional students had responded to changes in availability of federal financial aid in their enrollment decisions more so than traditional students. Nontraditional students balancing school with work were often not full-time students (Bishop & VanDyke, 1977; Ma & Baum, 2016), making them ineligible for traditional funding options such as federal loans (Seftor & Turner, 2002). However, Tran and Smith (2017) showed other options might be a better fit.

Employers have recognized the benefits of external training and stepping in to support their employees' education. Tran and Smith (2017) reviewed student demographic and financial data from Beginning Postsecondary Students' Longitudinal studies in 2004/09 (BPS) and the National Postsecondary Student Aid study in 2003/04 and 2008/09 for postsecondary students starting in 2003/04, with updates 3 and 6 years later. Only about 5% of the students in the study had received employer aid; of those who reported working full time, the percentage was just over

9%. Tran and Smith concluded that employees who had received aid from their employers were less likely to have dropped out in the study period and transferred to 4-year institutions.

Juggling the multiple priorities of family, work, and school can negatively impact a working learner's ability to fulfill education commitments (Ben-Yoseph et al., 1999; Horne, 1996; Kim & Baker, 2015) and is a primary source of school-related stress for adult students (Dill & Henley, 1998), especially for female students (Yu, 2015). Family can be a source of support for students (Bergman et al., 2014), as can peers and friends (M. L. Johnson et al., 2016). In a survey of 1,240 undergraduate students between the ages of 25 and 67 at an urban public research institution, Bergman et al. (2014) found that a student's educational aspirations, the institution's responsiveness, and the encouragement received from family were variables that most impacted a student's persistence and completion. However, family could also be a reason behind a student dropping out, as identified by Yu (2015). Yu found that female students would leave colleges more often due to familial obligations and childcare responsibilities.

Traditional and nontraditional students find motivation in different ways. M. L. Johnson et al. (2016) surveyed 88 traditional students and 51 nontraditional students at a school of education at a large, public, urban Midwest research institution to evaluate the differences in motivation and predictors of academic achievement between traditional and nontraditional students. Traditional students were more highly motivated by their perceptions of their academic abilities and the cost-benefits of the program. Nontraditional students were highly motivated by peer support. Thus, student life and engagement activities focused on traditional students were less relevant to nontraditional students (M. L. Johnson et al., 2016).

How an educational institution responds to nontraditional student needs plays an important role in their satisfaction with school (Bergman et al., 2014). The college's faculty and

staff are important sources of relationships for the adult working student, as Clark (2012) found when studying 15 community college career technical education students. These students were between the ages of 20 and 67, deriving from diverse backgrounds and attending a suburban southern California community college holding the Hispanic Serving Institution designation. Through focus group discussions, the researcher explored the students' educational journeys, the factors that students believed contributed positively to their degree attainments, the obstacles they had to overcome in their journeys, and advice they would give new students. The researcher found that students achieved a sense of belonging among their other nontraditional peers because they shared similar struggles usually considered barriers to persistence. The encouragement received from faculty, staff, and other students also contributed to their completion of school (Clark, 2012).

Academic advisors play important roles in the academic success of nontraditional students. Bergman et al. (2014) found that almost 87% of the nontraditional students in their study were satisfied with the support received from their advisors who they believed were knowledgeable about the program requirements. However, Shields (1994) noted that a negative advisor experience could leave students feeling frustrated. Shields interviewed 97 primarily part-time adult students at a large Midwestern urban commuter state university to identify the background, goals, and other internal factors, as well as the institutional and external factors that had influenced students' academic success. The author found that although other factors played a role, the most important one impacting student retention was academic advising. Feldstein et al. (1992) added that traditional and nontraditional students had different advising preferences in a survey of undergraduate and graduate students at a Midwest university. Although traditional and nontraditional students valued prescriptive advising that provided them with the technical

information needed regarding college processes, nontraditional students were more favorable toward advising that incorporated support and encouragement (Feldstein et al., 1992). This finding points to nontraditional students' different contexts that include less time for traditional engagements in school activities due to many other obligations they must balance with school.

Some community college leaders have found ways to support their post-traditional students. Ippolito (2018) studied community college practices favorable to adult learners. The researcher reviewed the websites of over 900 two-year degree granting institutions for keywords associated with adult learning, such as prior learning, adult learner, and career pathways. Using scoring rubrics and iterative cycles, Ippolito narrowed the institutions down to 17 and did a deeper analysis into practices supporting post-traditional learners by interviewing top-level administrators at each school. The researcher found three commonalities among the schools most welcoming to adult learners. The first was a website that was easy to navigate. This source of information was the main source of information for all students, but adults relied on it as guidance. Second, they found ways to ensure students could connect to the institution and have the support needed. Finally, they had an institutional champion that had actively advocated for adult students and an institutional culture that would support them as students.

Post-traditional students pursue education to achieve employment goals (Soares, 2013), contributing to their success (Metzner & Bean, 1987). However, doing so requires adults to balance an array of responsibilities that can even lead them to reducing their paid work to make time for their studies (Kim & Baker, 2015). Paying for college is just one of the challenges they face (Tran & Smith, 2017), as keeping up with family obligations is another leading to added stress (Dill & Henley, 1998; Kim & Baker, 2015). However, education institutions can help alleviate the pressures by making supportive staff accessible (Bergman et al., 2014; Clark, 2012)

and creating interventions that help students navigate their systems easier than before (Ippolito, 2018). The following section details the experience of the post-traditional student's experience in postsecondary education.

The Microsystem: The Post-Traditional Student

The microsystem focuses on the post-traditional student and highlights the many roles they must play as a worker, student, peer, and family member (Bronfenbrenner, 1977; Husen & Postlethwaite, 1994; Neal & Neal, 2013). Post-traditional students experience education differently than their traditional peers and nontraditional students (Horn & Carroll, 1996; M. L. Johnson et al., 2016; Wolfgang & Dowling, 1981). Post-traditional students engage in education for economic and work-related goals (Soares, 2013), and they persist because they see a benefit greater than the cost (Bergman et al., 2014; Kim & Baker, 2015; Tinto 1975). The same factors that motivate students to pursue an education act as stressors that students must overcome, and the many competing priorities challenge their abilities to succeed in school (Ben-Yoseph et al., 1999; Bishop & Van Dyk, 1977; Soares, 2013). This section considers the post-traditional student's efforts to succeed professionally and academically.

Researchers often differentiate between traditional and nontraditional students solely based on the age of the student while attending college. In seminal research, Wolfgang and Dowling (1981) defined traditional students as those between the ages of 18 and 22. In more recent research, M. L. Johnson et al. (2016) described traditional as students under the age of 24, and anyone outside of these criteria was considered nontraditional. However, the context of working adults' lives might involve many factors other than age. In seminal research, Bishop and Van Dyk (1977) reviewed 1970 census data from 57,689 individuals to determine which factors impacted the probability that adults over the ages of 25 would enroll in 2- or 4-year institutions

of higher education. The researchers found that responsibilities, such as having children, facing financial obligations, and holding jobs, negatively impacted students' decisions to attend college. Ben-Yoseph et al. (1999) found similar challenges 20 years later.

A non-binary approach is needed that reflects the complexities of life circumstances of the nontraditional student to understand better the differences between traditional and nontraditional students. Horn and Carroll (1996) developed a more robust set of definitions for both types of students. Horn and Carroll (1996) defined traditional students as "enrolling in college immediately after high school and attending full time until graduation" (p. 13). Nontraditional students are minimally nontraditional, moderately, or highly nontraditional, depending on the number of characteristics they meet. These characteristics consider students' enrollment; whether they are full time or part time; how much they delay enrollment after high school; and their financial and family statuses that include whether they are financially independent, employed, have dependents or are a single parent, and their high school graduation statuses (Horn & Carroll, 1996). Soares (2013) added to the literature reviewing various data sources to show a student with a unique set of characteristics insufficiently described by calling them nontraditional, instead defining them as a post-traditional student. These students work to support themselves and/or their families, simultaneously balancing school and work, seeking education based on the type of credential the employer values and compensates, needing additional help to reach college readiness, and utilizing college support infrastructure to ensure they meet all the milestones to achieve their degrees (Soares, 2013).

Traditional, post-traditional, and nontraditional students have different goals that drive them to pursue post-secondary education. Wolfgang and Dowling (1981) found that traditional-aged students would attend college to develop social relationships and meet external expectations

while nontraditional students were more interested in learning. Clark (2012) stated that college for nontraditional students could start "as a means to an end" (p. 517). Post-traditional students would work close to or at full-time status (Horn & Carroll, 1996), and their education goals were career related, seeking to update their skills or earn industry-recognized credentials (Osterman, 2011).

Once students start their college journeys, the reasons they persist and continue to complete their educational goals are also different. Whereas traditional students drop out because they have difficulty balancing the academic demands of school and social demands from peers (Tinto, 1975), nontraditional students are less concerned about developing a social life at school (Dill & Henley, 1998; Yu, 2015). In a seminal research, Tinto (1975) developed a framework to help predict the factors that had caused students to drop out of college. Tinto's model considers external factors, personal factors, and the institution itself. The researcher found that motivation and commitment would play important roles in a student's decision to drop out. Tinto did not differentiate between 2- or 4-year institutions, nor did he consider students' ages. Yu (2015) considered both of those criteria, as well as other characteristics, such as employment and ethnicity in students' motivations to continue in community colleges. Yu used data drawn from IPEDS and the Beginning Postsecondary Students' Longitudinal study (BPS: 04/09); after merging, the findings resulted in a sample of 1,940 students at 50 community colleges during the 2003 to 2004 school year. The researchers analyzed the data to find why community colleges had lower completion rates than universities. The outcomes showed that community college students were more likely to be nontraditional students who had other obligations, such as work and family, that kept them from integrating socially into the college environment. Academic

integration and social integration were positively related to retention. Thus, post-traditional students need a different strategy to help them succeed.

Post-traditional students find support in relationships developed with faculty and staff. They can find a sense of belonging from sharing experiences with other post-traditional students (Clark, 2012). Intrinsic motivation (Metzner & Bean, 1987) is important to post-traditional students' persistence, and traditional students' persistence is associated with their academic abilities (M. L. Johnson et al., 2016). However, even though post-traditional students may be highly motivated to achieve their goals, they face barriers that can make their educational experiences frustrating (Bowl, 2001). However, institutions of higher education have not adapted to address such challenges faced by post-traditional students (Soares, 2013).

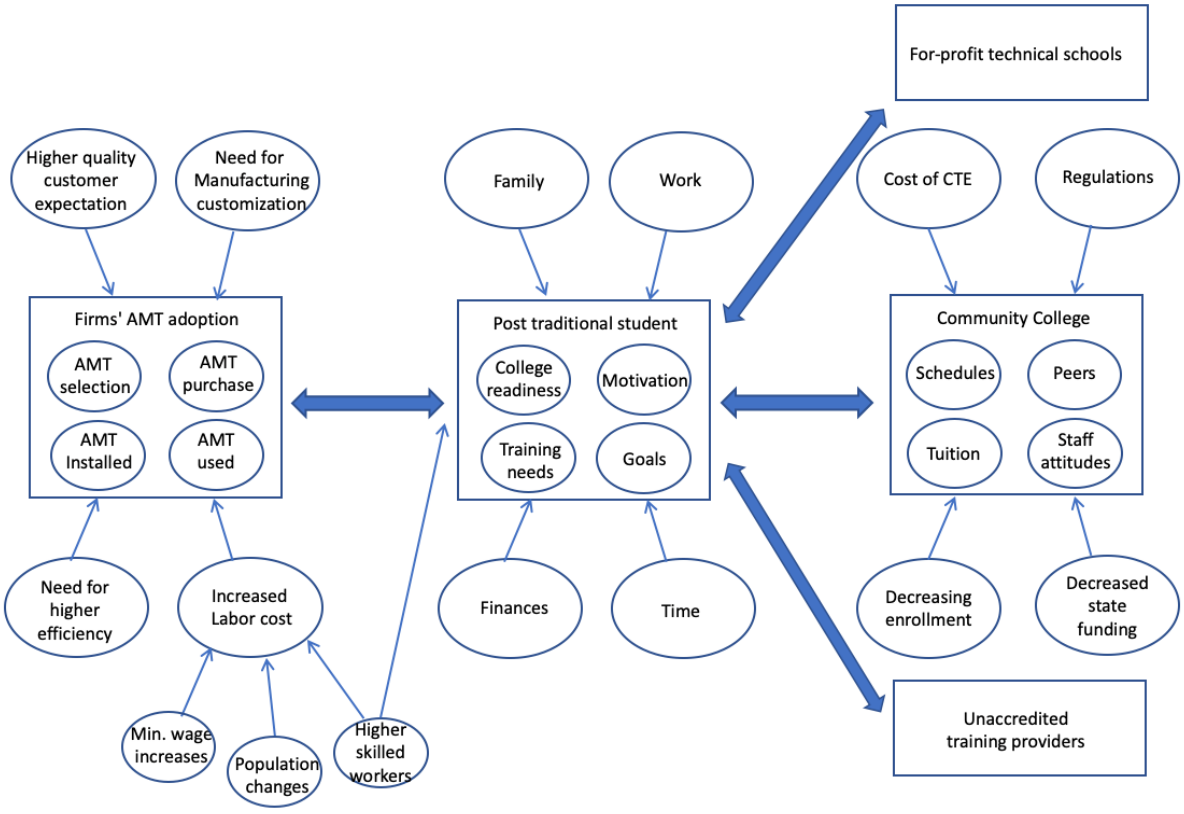
Conceptual Framework

This literature review explored how the accelerated rate of technology adoption brought on by 4IR had changed the need for education delivery from the traditional full-time credit college model to a just-in-time model that would allow workers to update their skills throughout their lives (WEF, 2016). This finding is especially true for manufacturing firms that must adopt AMT to remain competitive (Congden, 2005), thus requiring more highly skilled workers (Peddle, 2000). Figure 1.1 illustrates the interactions between the factors presented in this literature review. First, consider the manufacturing firms adopting AMT as part of their strategies to remain competitive. Such firms undergo the complex process of technology adoption internally (Kotha & Swamidass, 2000; Lanzolla & Suarez, 2012) while externally feeling the impact of higher quality expectations from customers (Kotha & Swamidass, 2000), the need for customization (Meredith, 1987), and higher operational efficiency (Kotha & Swamidass, 2000), as well as increased labor costs caused by minimum wage increases

(Aaronson & Phelan, 2019), population changes (Vespa et al., 2020; Jimeno, 2019), and the need for more higher skilled workers (U.S. GAO, 2019). Second, firm leaders should consider the post-traditional student, who could become that higher skilled and higher paid worker. Firm leaders should address internal needs, including college readiness (Soares, 2013), motivations, and goals (M. L. Johnson et al., 2016), with external pressures from family obligations (Gagnon & Packard, 2012), work responsibilities, financial limitations, and scarcity of time (Kim & Baker, 2015).

Figure 1.1

Conceptual Framework



The third perspective is that of the community college. Community college leaders must make internal changes to class schedules, tuition arrangements, how they promote peer interactions (Clark, 2012), and the attitudes of staff (Shields, 1994) to serve post-traditional

students adequately. At the same time, such leaders face external pressures from decreasing enrollments (Ma & Baum, 2016) and state funding (D'Amico et al., 2014; Hillman et al., 2014; Mullin & Honeyman 2008), as the cost of providing technical education increases, and regulations still require compliance (Grover & Miller, 2018). Additionally, community college leaders face growing competition from for-profit schools (Soliz, 2018) and unaccredited training providers (White et al., 2018).

College leaders make decisions on the services they will provide students in and out of the classroom based on funding (Levin et al., 2018). Workforce development programs are particularly impacted by funding policies (Grover & Miller, 2018). Additionally, students' needs have changed from those of recent high school graduates whose priorities are school, to the post-traditional student juggling multiple priorities while they update their skills (Soares, 2013). With manufacturing competitiveness at the forefront of national strategy (U.S. GAO, 2019), addressing the educational needs of the 4IR post-traditional student and ensuring employers have the workforce they need are essential.

The following chapter explores whether Dorado County manufacturers have adopted AMT and their training needs as a result. The constructs explored include employers' levels of technology adoption, employers' perceptions of manufacturing workers' skills level, employers' perceptions of the training needs for manufacturing technicians, employers' strategies and preferences in training delivery, and employers' preferences for using formal educational providers and credential attainments.

Chapter 2

Needs Assessment

Community college leaders must provide workforce developmental education; thus, they should embrace serving post-traditional students (Soares, 2013), providing the reskilling and upskilling needed to succeed in today's manufacturing workplace (WEF, 2016). As employers seek to adopt new advanced manufacturing technologies (AMT), the skills workers need and how they acquire those skills become important considerations (Desplaces et al., 2019). Past research has focused on the process of a firm's adoption of new AMT equipment to their manufacturing processes (Desplaces et al., 2019; Lanzolla & Suarez, 2012), the impact of new technology on the labor force (Aaronson & Phelan, 2020; Gvaramadze, 2010), and the need for technology training for workers and job seekers (Osterman & Weaver, 2016; Rishel & Burns, 1997; Soares, 2013). This needs assessment expands on past research to explore whether employers' adoptions of AMT have impacted perceptions of their employees' skills and the roles education and training providers.

Context of the Study

Manufacturing plays an important role in the nation's economy and the workforce development efforts of community colleges that help ensure global competitiveness are at the heart of national policy (Osterman & Weaver, 2016). In Dorado County (name changed to maintain anonymity), aerospace and defense are leading industries that generate innovation, technology, and good-paying jobs. Strengthening the supply chain within these industries and meeting workforce training needs are specific goals in Dorado County's Economic Development Plan (2019). Sahuaro Community College (SCC; name changed to maintain anonymity) has aligned with these priorities, investing $45 million into expanding one of its campuses, which

includes facilities for advanced manufacturing training, with a focus on aerospace and defense (Blivin & Mayo, 2019). According to Maricopa Association of Governments' Interactive Mapping and Analysis Site (2019), 152 manufacturers in Dorado County identify as aerospace and defense focused, and many more are in related industrial sectors.

Today's competitive market requires manufacturers achieve higher levels of quality and leverage operational efficiencies, making investments in AMT necessary to remain profitable (Frank et al., 2019; Kotha & Swamidass, 2000). However, today's employees may not have the skills for tomorrow's technology (WEF, 2016). As new equipment featuring the latest technology evolves, and updated versions are introduced (Lanzolla & Suarez, 2012), workers must continually update their skills to remain relevant (WEF, 2016). Employers have seen that job seekers lack the specialized skills needed when hired, so firms must provide their own educations (Baqadir et al., 2011). Workforce developmental education provided by community colleges can act as a substitute for training that an employer may otherwise provide internally (Osterman & Weaver, 2016).

Post-traditional students have turned to community colleges to increase their earning potentials and stay relevant in the labor market by learning new technical skills or updating existing skills (Reyes et al., 2019). Consequently, in recent years, community colleges have seen enrollment growth of post-traditional learners (Ippolito, 2018). Nevertheless, community college leaders have faced increased competitions from for-profit colleges (Soliz, 2018), MOOCs (Soares, 2013), and other innovative education providers, providing additional choices for employers and learners.

Statement of the Purpose

This needs assessment sought to clarify the extent of technological change in Dorado County and how it had impacted the manufacturing industry's workforce developmental needs. If employers' adoptions of AMT have exacerbated the gap between employers' needs and workers' skills (Peddle, 2000; Soares, 2013), both employers and workers will need to identify a strategy for addressing it. The data collected for this needs assessment helped to clarify the extent and characteristics of the gap in Dorado County and inform possible strategies to prepare workers better for 4IR jobs.

Method

This needs assessment explored the extent of a manufacturing firm's adoption of new AMT, whether their manufacturing technicians had the skills needed, and how their training needs might be filled. A survey was chosen as the appropriate measure to facilitate a larger number of responses and a standardized data set that permitted adequate analysis. Interviews were conducted to add context and additional perspectives. The research addressed three questions, as discussed in the following subsections.

Research Question 1

Research Question 1 (RQ1) was the following: To what extent have Dorado County manufacturers adopted AMTs in their manufacturing processes? Currently, there is little information available quantifying the degree to which local manufacturers have implemented AMT in their operations. Anecdotally, there are well-known examples of specific companies; however, industry organizations, such as the Arizona Technology Council or the Southern Arizona Manufacturing Partners, and government entities, such as the Arizona Commerce Authority, Tucson Office of Economic Initiatives, or Dorado County Economic Development, do

not collect this data. This needs assessment attempted to understand better whether local employers had used AMT or planned to implement it in the next 2 years.

Research Question 2

Research Question 2 (RQ2) was the following: How satisfied are Dorado County employers with their manufacturing technicians' skills? Firms with low adoptions of AMTs may have different needs and expectations of their workers than those with AMTs in their operations. The employers' training needs will depend on their perceived skills gap (Peddle, 2010; Soares, 2013). This RQ was used to address employer satisfaction with an array of skills to assess whether they perceived there was a skills gap that should be resolved.

Research Question 3

Research Question 3 (RQ3) was the following: What are employers' preferences in how their manufacturing technicians receive training? For those employers unsatisfied with their employees' current skills, this RQ was used to identify their preferences for training that would resolve the deficiencies. Employers have many different options to deliver training, including modality, provider, scheduling, and location. The employer's preference depends on a company's strategies, policies, and workloads (Peddle, 2000; Soliz, 2018). If community colleges provide the needed training, it must align with employers' needs and preferences; otherwise, the employer will simply take the business to another training provider whose training aligns with their needs (Seftor & Turner, 2002).

Drawing on the skills gap identified by Peddle (2010) and Soares (2013), this needs assessment explored Dorado County employers' AMT adoptions and resulting workforce needs to understand the role SCC should play in manufacturing workforce development. The constructs explored include

- employers' levels of technology adoption,
- employers' perceptions of manufacturing workers' skill levels,
- employers' perceptions of the training needs for manufacturing technicians,
- employers' strategies and preferences in training delivery, and
- employers' preferences for using formal education providers and credential attainment.

Design

The mixed-methods study consisted of two phases, compiling the perspectives of three different stakeholder groups: manufacturing operations directors, human resource managers, and manufacturing technicians. The first phase was quantitative, consisting of a survey of directors of manufacturing operations to provide a broad picture of the employers' perceptions of their manufacturing technicians' skills and needs for training. The second phase was qualitative, consisting of semi-structured interviews that added the perspectives of the human resources manager and manufacturing technician.

Participants

A convenience sample (Pettus et al., 2011) of manufacturers in the aerospace and defense industry was used. Manufacturing employers that participated in SCC's Business and Industry Advisory Committees, hired graduates, and participated in other college initiatives were emailed an invitation to participate in the survey. Additionally, Dorado County's Small Business Development Center, hosted at SCC, the Arizona Technology Council, the Arizona Commerce Authority, and the City of Tucson Office of Economic Initiatives, were asked to distribute the invitation among their manufacturing contacts. Survey invitations were sent to 343 operations

managers. The four external partners sent the invitation to an unknown additional number of manufacturers.

The second phase of the study included selecting three companies. One company represented each of the categories of AMT adoption, low, moderate, and high. The goal was to conduct follow-up interviews with the human resources manager and one manufacturing technician.

Measures and Instrumentation

Three different instruments were used to explore the five study constructs listed above. Table 2.1 shows a full detail of these constructs, including definitions, indicators used in data collection and analysis, and citations supporting the operational definition. Manufacturing managers' perceptions were captured through a survey (Appendix A), as fully described in the following subsection. The person responsible for managing the firm's human resources and a manufacturing technician from selected companies provided their perspectives on manufacturing skills and training needs in semi-structured interviews (Appendices B and C, respectively).

Survey

The relationship between employers' adoptions of new AMT and their training needs has not been extensively studied to date (U.S. GAO, 2019). A thorough search of past research did not reveal existing survey tools that could adequately address the constructs of this study. Several qualitative studies focused on employers' perceived needs and satisfaction with employee skills (Gvaramadze, 2010; Osterman & Weaver, 2016; Peddle, 2000); however, requests to five different researchers for their interview questions or scripts were unsuccessful. Because a previously validated survey tool was not found, a new survey tool (Appendix A) was

developed using concepts and questions from those past qualitative studies (Desplaces et al., 2019; Gvaramadze, 2010; Lanzolla & Suarez, 2012; Peddle, 2000; Soares, 2013).

Three different subject matter experts relevant to each area of inquiry reviewed the measure to increase the reliability of the survey instrument (Presser et al., 2004). These included a representative from an AMT equipment vendor who provided expertise on the equipment and technology adoption processes within manufacturing firms, SCC's dean of applied technology who oversaw the advanced manufacturing academic program, and SCC's vice president of workforce development who provided input on the cohesion between the technical and workforce related questions. Each reviewer received a digital version of the survey for comment, followed by a telephone interview to review their comments and provide an opportunity to expand on those comments. Finally, a technician employed at an aerospace manufacturing firm was recruited for a cognitive interview (Grill, 2004) to ensure that the questions read as intended and would elicit accurate responses from the participants.

The survey consists of 22 items (Table 2.1). The first five items collected demographic information about the respondent and the employer, including the firms' industry sector, providing options of manufacturing, aerospace, defense, and other, and the firm's size based on the number of employees and the number of manufacturing technicians employed. The response categories were based on the Small Business Administration Table of Size Standards (2019) for manufacturing firms, Congden's (2005) findings that the average size among the 399 firms in his study was 52 employees, and the categorization in the Maricopa Association of Governments Interactive Mapping and Analysis (2019) site.

Table 2.1

Factors Impacting Technology Adoption and Training Needs of Manufacturing Firms

Construct	Operational definition	Indicator	Instrument
Technology adoption	Technology adoption - The extent to which a company has thought about, purchased, implemented, and is using AMT in its manufacturing operations (Desplaces et al., 2019; Lanzolla & Suarez, 2012).	Knows it exists Has leadership support for its purchase and implementation Considering or evaluating purchasing options Has purchased Has installed It is fully operational It is used on a regular basis Plans to invest in AMT in the next 2 years	Survey multiple choice Q6-12
Employers' perceptions of manufacturing worker's skill level	The degree to which employers perceive that their employees that engage in assembly or fabrication functions on the manufacturing floor, manufacturing technicians, have the skills needed to operate AMT equipment (Gvaramadze, 2010; Lanzolla & Suarez, 2012; Peddle, 2000).	Impact of current workforce skill level when making decisions to purchase new ATM equipment. Employees' technical skills to operate existing AMT equipment. Employees' technical skills to operate AMT equipment to be adopted in the next 2 years. Employees' attitude toward the implementation of new or additional AMT. Technical skills of new hires to operate current AMT. Technical skills of new hires to operate future AMT. Ease of finding new hires that have the technical skills needed to operate current AMT. Employees' ability to perform skills.	Survey Likert scale Q13, multiple choice Q14-15, survey Likert scale Q16
Employer perception of training needs for manufacturing technicians	Employers' perceived need for technical training for manufacturing technician employees due to the firm's adoption of new technology or the evolution of existing technology in their manufacturing processes (Lanzolla & Suarez, 2012; Peddle, 2000; Soares, 2013).	Employees have received training on how to use recently purchased equipment. Employees will require training after the implementation of new or updated AMT. Company incentivizes employee development with opportunities for advancement tied to education or training.	Survey Likert scale Q13, multiple choice Q17
Employer strategies and preferences in training delivery	The employer's preferences and policies in how manufacturing technicians engage in training to gain the skills needed to operate AMT equipment (Gvaramadze, 2010; Peddle, 2000; Soares, 2013).	Education and/or training scheduling Education and/or training cost Education and/or training provider Education and/or training location Education and/or training duration Hands practice on specific equipment Education and/or training selection of skills topics Education and/or training modality	Survey multiple choice Q18-21, Likert scale Q22

Construct	Operational definition	Indicator	Instrument
Employers' preference for using formal education providers and credential attainment	Whether the employer has a preference to use an accredited institution of higher education as the provider of skills training that leads to degrees for manufacturing technicians (Peddle, 2000; Soares, 2013).	Attainment of an industry-recognized credential Attainment of college credit Attainment of an associates or bachelor's degree Attainment of certificates and credentials	Survey Likert scale Q22

The first construct explored in the survey was technology adoption defined as the extent to which a company had thought about, purchased, implemented, and used AMT in its manufacturing operations (Desplaces et al., 2019; Lanzolla & Suarez, 2012). The model developed by Desplaces et al. (2019) identified five stages in the technology adoption process and illustrated the degree to which manufacturers had adopted AMT equipment, such as computer numerical control (CNC) machines and 3D printers. Three additional variables were added based on Lanzolla and Suarez (2012), who extended the process of adoption beyond installation into its actual use.

The goal was to assess the extent of AMT adoption. Thus, survey Items 6 through 12 asked whether the company had leased or purchased at least one of the six AMTs listed, then asked those that answered yes whether it was currently in use, and if not, why not. These questions were drawn from Lanzolla and Suarez's (2012) description of how company leaders would make decisions about adopting new technologies. A list of commonly used technologies was adapted from Kotha and Swamidass's (2000) examination of the correlation between the use of AMT and the firms' growth strategy. An AMT equipment vendor representative identified technologies from Kotha and Swamidass that were no longer relevant to modern manufacturing for exclusion, consolidating the AMT equipment list from 14 questions to six.

The second construct, employers' perceptions of manufacturing technicians' skill levels, was defined as the degree to which employers perceived employees who engaged in assembly or fabrication functions on the manufacturing floor had the skills needed for the job (Gvaramadze, 2010; Lanzolla & Suarez, 2012; Peddle, 2000). This construct was assessed in four items, Questions X through Y. Question 13 included seven items about the company's future AMT purchase plans and the impact those plans would have on employees' required skills and future training needs using a 5-point Likert scale. Two multiple choice questions asked whether new hires had the necessary technical skills to operate current and future AMT, as well as the employer's experience finding new hires.

Manufacturing technicians' skill levels were further examined in Item 16 using a 5-point Likert scale, rating their manufacturing technicians' abilities to perform each of 13 different skills (Table 2.1). Twelve of these skills were drawn from Peddle's (2000) studies on employers' needs for skilled workers between 1992 and 1999 that led him to conclude that employers' perceptions and needs changed little over the course of that decade. One additional skill, troubleshooting, was added based on feedback from SCC's dean of applied technology who cited that as a distinct skill that employers considered.

The third construct, employers' perceptions of training needs for manufacturing technicians, was addressed in Items 13 through 16. This construct was defined as employers' perceived needs for technical training for manufacturing technicians due to the firm's adoption of new technology or evolution of existing technology in their manufacturing processes (Lanzolla & Suarez, 2012; Peddle, 2000; Soares, 2013). Whether the company incentivized employee development was asked separately in a multiple-choice question with answers that included offering automatic raises and promotions, raises and promotions when they became

available, and only encouragement or not actively encouraging education or training in any way. This question was included because the employer's support and encouragement of education were significant factors in an employee taking part in training (Tran & Smith, 2017).

The fourth construct, employers' strategies and preferences in training delivery, was defined as employers' preferences and policies in how manufacturing technicians engaged in training to gain the skills needed to operate AMT equipment (Gvaramadze, 2010; Peddle, 2000; Soares, 2013). Eight items, listed in Table 2.1, were used to ask the respondent about the company's policies around paying for and facilitating training. Multiple-choice questions numbered 18 through 22 were drafted referencing research by Gvaramadze (2010), who found that cost, time, and access were all factors in the success of upskilling programs.

The fifth construct, employers' preferences for using formal education providers and credential attainment, was defined as employers' preferences for educational providers for manufacturing technicians' training and the outcome desired from that education (Peddle, 2000; Soares, 2013). The corresponding items in Question 22 were drawn from Soares (2013) to understand the type of credentials that employers considered to validate their employees' learning. The respondent was asked the importance of industry-recognized credentials and certificates, earning college credits, and attainment of associate and bachelor's degrees.

Semi-Structured Interview Script for Human Resources Manager

Interview items followed a general interview guide approach (Turner, 2010), which provided structure to ensure the same line of questioning was followed in each interview, with the flexibility to find nuances among the employers' processes and needs. The human resource manager's interview script (Appendix B) addressed Constructs 2 through 5: the firm's perception of manufacturing workers' skills, firm's perception of manufacturing workers' training needs,

the employer's strategies and preferences on training delivery, and their preferences for how education was provided.

The semi-structured interview protocol included five open-ended questions, each with additional follow-up questions. The interview protocol included technical and nontechnical skills important to employers (Soares, 2013; Peddle, 2000), preferences for training, and the relationship with SCC. Prior research has shown that an existing relationship with a community college increases the probability that it will be the preferred training provider (Osterman & Weaver, 2016).

Interview Script for Manufacturing Technician

Interview items for the manufacturing technician also followed a general interview guide approach (Turner, 2010), as described previously. The script for manufacturing technicians (Appendix C) consisted of five open-ended questions, with several follow-up questions. The questions distinguished between technical and nontechnical skills and asked if the employee would like additional training provided by the employer. It also asked whether the participant had taken classes at SCC and to define the outcome of that experience (Dill & Henley, 1998). The questions were based on Constructs 2 through 5 to identify gaps between employers' perceptions of employees' skills and the employees' beliefs (Peddle, 2000).

Procedure

Quantitative data were collected through a survey. Participants were invited via email to respond to the electronic survey, which was open for 3 weeks. The survey data were analyzed using a crosstabulation comparing results by level of AMT adoption. Three companies were selected using purposive sampling to take part in subsequent interviews. The qualitative

interview data collected from each company's human resources manager and one manufacturing technician who corroborated and added context to the survey findings.

Participant Selection Process

Recruitment for survey respondents took place through email invitations directly sent to manufacturing companies in SCC's employer database. Additionally, SCC's partner organizations were asked to disseminate the invitation to their members and contacts. The invitation was sent through the secure email platform, Mailchimp, which tracked whether emails were opened. The email invitation explained the purpose of the study and provided a link to the survey instrument on Qualtrics. Whenever possible, invitations were directed to the person in the firm with the highest rank in the manufacturing operations department; however, the exact title varied depending on the size and organizational structure of the company. The invitation included instructions to forward the email to the most appropriate person at the company. Contacts who had not yet responded received two reminder emails 5 days apart.

Three companies were selected from the survey respondents for the qualitative portion of the assessment using a purposive process (Pettus et al., 2011). After each company was assigned an AMT adoption score, as described in the analysis section, the company was categorized as low, moderate, and high AMT adopters. The company with the highest AMT score of each of the three adoption categories was selected to ensure that the low adoption company selected had sufficient experience with AMT to share in an interview. The human resources manager who oversaw the company's workforce strategy was the firm's subject matter expert on hiring and training (Osterman, 2016) and was the person asked to participate in the interviews. Each human resources manager was asked to identify a manufacturing technician willing to be interviewed.

Data Collection Methods

The study consisted of two phases: quantitative and qualitative. In the first phase, a survey was mailed electronically to participants who had submitted their responses on Qualtrics (Appendix A). Participants were provided Johns Hopkins University's informed-consent policies preceding the survey, with instructions for withdrawing consent at any time by not completing or submitting the survey. Once those data were collected and analyzed, three respondent companies were selected for the second phase of the study based on their reported levels of adoption of technology, as described below.

In the second phase of the study, one human resources manager and one manufacturing technician from each of the three companies were selected and contacted for interviews (Appendices C and D). Due to current health concerns, all interviews took place by phone. The interviews were recorded using QuickTime's audio recording function or iPhone's voice recorder. The interviews were transcribed using the online platform Otter.ai. All data were stored in the investigator's password-secured personal computer.

Data Analysis

Survey data were analyzed using SPSS statistical software, using cross tabulations to examine the responses by the companies' levels of AMT adoption. The level of AMT adoption was scored as follows:

- A score of 1.0 was assigned to each AMT in use, and a score of 0.5 was assigned when AMT was being evaluated for purchase. The final AMT adoption score was calculated by adding the scores for each of the six AMT included in the survey.
- Companies were then ranked by their AMT adoption scores and placed into one of three categories: low (scores of 0 to 2.5), moderate (3.0 to 5.5), and high adoption

(6.0 to 12). For example, a company with a 4.0 score fell into the moderate adoption category.

- The final selection of the company to interview was determined by the highest AMT score within each of the adoption categories.

The remaining survey questions were analyzed using crosstabulation to demonstrate the relationship and frequencies of variables by their AMT adoption category. The frequency with which each response option was selected was summed and compared by the company's level of AMT adoption to identify patterns. Findings from this analysis were noted and further explored in the interview data collection process.

Interviews were transcribed using the online platform, otter.ai, and analyzed through three rounds of coding. First, interview scripts were compared by company, examining keywords and themes shared by the human resources manager and technician from each company. Then, a similar comparison was done by roles, comparing keywords and themes between the three human resources managers and three technicians. Finally, the keywords and themes from all six interview scripts were compared with the findings from the survey. This final step corroborated the perceptions from the human resources managers and technicians with the responses given by manufacturing leadership.

Initial Findings and Discussion

As presented in Chapter 1, SCC believed that Dorado County's manufacturers had adopted technology at a similar pace as the rest of the country and anticipated this action would lead to a need for upskilling and reskilling of the local workforce. This needs assessment sought to answer whether local manufacturers had adopted more technology, whether that would intensify the need for training, and how employers would like that training delivered. The

following subsection describes the findings from the survey and interviews that have helped address the study's research questions.

Findings

Of the 343 operations managers contacted directly and an unknown number contacted by external partners, 41 firms opened the survey, and 28 initiated a survey submission. Of those, 25 fully completed the survey, and three were partially completed. All 28 submissions were included in the technology adoption analysis, and 27 submissions were included in the analysis of questions referencing employer perception of technicians' skills. Table 2.2 shows the participating companies' AMT adoption scores.

Table 2.2

Adoption Scores

Adoption	Score range	Number of companies
Low adoption	0.0 to 2.5	11
Moderate adoption	3.0 to 5.5	12
High adoption	6.0 and above	5

Twenty-three companies scored between 0.0 to 5.5, so the low and moderate adoption categories were defined by establishing a break at the midpoint of the range. Five companies scoring 6 or above were included in the high adoption category. In the low adopter category, three companies tied for the same score (2.5). The final selection of the company to interview was determined by their responses to Q12b: "My employees will require training after the implementation of new or updated advanced manufacturing technology into our manufacturing process." The answer was scored on a Likert scale, with the response, "strongly agree," given a score of 5, and "strongly disagree" was given a score of 1. One company responded with "neither agree nor disagree;" one responded, "somewhat agree;" and the third one responded, they strongly agreed that they would need training when implementing new AMT. The company that

expressed a need for training was chosen to ensure the interview respondents could share training plans and experiences around training needs. The following subsections summarize the interview findings from each company selected.

Company A – Low Advanced Manufacturing Technologies Adoption. Company A reported using two of the six types of AMTs listed in the survey. The human resources manager was also the company owner and CEO. They had 10 employees in their manufacturing areas. The human resources manager saw AMT to maintain productivity when they could not find more people to hire within the budget.

Company A's human resources manager spoke about their frustrations with employees lacking the abilities to learn new skills effectively. For example, they mentioned a soft skill as the ability to take notes. After further clarifying, they explained that employees could not synthesize information and recall it when learning and performing a new skill. By contrast, the technician from Company A, the shop lead, believed that they had the nontechnical skills needed to do the job, and the only training that might be useful was business or finance. The human resources had to show workers repeatedly how to do a job and added, "It gets costly, and we just don't have the time" (G. Gonzales, personal communication, January 17, 2021). Nevertheless, the technician believed that with 20 years of experience in manufacturing, they would not need additional training. They asserted that if new AMT was purchased, the training provided by the AMT vendor would be sufficient.

Company B – Moderate Advanced Manufacturing Technologies Adoption. Company B reported using four of the six types of AMTs listed in the survey. The human resources manager also oversaw training. They had multiple locations in the United States, and their

Dorado County facility employed approximately 350 people. The human resources manager saw AMT as increasing productivity.

Both the human resources manager and technician agreed that new employees lacked initiatives. The technician thought supervisory and leadership training would help. The human resources manager believed that there was, sometimes, a lack of understanding of what was required to do the job. They mentioned the harsh conditions, as well as the hard and monotonous nature of manufacturing work. The human resources manager attempted to motivate employees with pay increases, and the technician said that they most valued the type of work and job stability more so than the pay. The human resources manager mentioned a need to fulfill the expectations of their shareholders. The technician mentioned wanting to understand better where their work fit in with the company.

Company C – High Advanced Manufacturing Technologies Adoption. Company C reported using all six types of AMTs listed in the survey. The human resources manager interviewed specializes in training employees. The company operated globally, and the local operation was the world headquarters for one division. Company C's use of AMT was focused on quality and market competitiveness.

Both the technician and human resources manager agreed that the most useful and needed soft skill was business communications. The technician spoke of public speaking, written communication, and intrapersonal communication being skills they learned before being hired. Human resources spoke of training offered internally but in a decentralized manner and online modality that they did not believe would do the job. However, as one location of a large multinational company, they acknowledged they had little say in training strategies and decisions.

On the technical skill side, the human resources manager believed that it was difficult to find employees with technical skills. They noted that people were not exposed to manufacturing as a career as much as they were to science, technology, engineering, and math fields. The technician agreed that they lacked certain skills when hired and had not received nor found opportunities for internal training. They noted technical training had primarily been informal and provided by other employees.

Both the technician and the human resources manager referenced the complexities of trying to offer training in such a large and decentralized organization. The human resources manager talked about the ebb and flow of funds that had cut the company's worldwide training staff from 400 people 10 years ago to 30 today, serving 100,000 employees around the world. The technician spoke of the highly competitive nature of their industry, where customers always wanted the newest technology, which would change their manufacturing processes and the need for training. The human resources manager shared that as the company had reorganized, it had shifted to making each division responsible for their own training. As training became duplicative and efforts redundant, they expected the responsibility of training to be shifted back to a centralized model. The human resources manager noted that centralized training would bring its own challenges, including offering training in multiple languages. Moving to an online environment might deliver training customized to the locality and even the individual, but it could limit the subject matter. human resources manager believed that technical skills still needed a hands-on component.

In response to RQ1 (To what extent have Dorado County manufacturers adopted AMTs in their manufacturing processes?), most employers had not fully embraced AMTs; the most used AMTs were CNC machines (71%), additive manufacturing and 3D printing (50%), and

computer-aided inspection system (29%). Consider that the company most invested in AMT used all six types of equipment, three companies did not use any, and 18 companies used one or two. In that case, all but three of the companies agreed or strongly agreed that their companies would be investing in new AMTs in the next 2 years.

In response to RQ2 (How satisfied are Dorado County employers with their manufacturing technicians' skills?), employers reported being satisfied with the level of technical skills of their employees now and soon but lacking in nontechnical skills. Eighty-five percent of respondents expressed satisfaction with their manufacturing technicians' abilities to operate their existing AMT equipment, and 67% were satisfied with their abilities to operate AMTs adopted in the next 2 years. They also reported that their employees had the attitudes to embrace new AMT. However, regarding nontechnical skills in management, leadership, and business communications (Table 2.3), respondents reported being less satisfied with their employees' abilities, and 84% believed training should include developing appropriate workplace behaviors.

Table 2.3

Percentage of Good or Excellent Scores by Advanced Manufacturing Technologies Adoption Level

Skill	Low (n = 9)	Moderate (n = 11)	High (n = 5)
Technical skills			
Advanced computer skills	33	45	80
Basic math	56	73	60
Computer literacy	67	45	80
Equipment operation	78	82	100
Technology adaptability	56	73	80
Troubleshooting	67	64	80
Nontechnical skills			
Business communications	56	18	60
Leadership	11	55	60
Management	22	27	60
Problem-solving	89	91	100
Reading and writing	67	55	80
Supervision	67	55	40
Teamwork	67	91	100

The three human resource managers expressed high levels of frustration in reference to nontechnical skills, citing deficiencies in writing and communication skills, as well as an overall lack of initiative. Each provided examples of how their employees lacked these skills. Manager B said, “You can’t teach want to” (K. McCabe, personal communication, January 18, 2021). Manager A described employees who would not find something useful to do, such as sweeping or wiping down machines, unless specifically told to do so (G. Gonzales, personal communication, January 17, 2021).

All three of the technicians interviewed seemed satisfied with their abilities to perform the technical skills associated with their jobs and the training they had received. However, they emphasized their frustrations with coworkers and younger employees who did not have the nontechnical skills needed for their job. Two of the interviewees communicated that they had learned their nontechnical skills before starting in their current jobs. The technician from Company B spoke of learning problem solving and teambuilding skills while in the Navy, and the technician from Company C believed that participating in various extracurricular activities while at university had provided those skills. Both suggested similar learning opportunities were needed for their companies.

In response to RQ3 (How do the MTs nontechnical skills affect their understanding of expected workplace behavior?), employers reported that they had provided training internally or relied on a college or university. If training occurred during the workday, the company would cover the expense. Sixty-six percent of companies incentivized education, 33% only encouraged it, and one company reported it did neither. Seventy-six percent of companies allowed work time for training. Twenty-four percent expected employees to do it on their own time, and most were in the low adoption category. Ninety-two percent of participants indicated hands-on practice was

important in training delivery, 88% said training should be short and specific, and 68% preferred face-to-face modalities (Table 2.4).

Table 2.4

Percent Agreement With the Characteristics of Training by Advanced Manufacturing Technologies Adoption Level

Characteristic	Low (n = 9)	Moderate (n = 11)	High (n = 4)
Should be short and cover specific skills	78	91	100
Should include hands-on practice on specific equipment	89	91	100
Should include a menu of skills trainings for employees to choose from	22	64	80
The training provider should establish what skills employees need to be competent technicians	44	82	80
Should include development of appropriate workplace behaviors	67	91	100
Should be online as much as possible	33	55	20
Should be face-to-face as much as possible	67	64	80

Employers were somewhat divided on the educational outcomes that mattered most to them. When asked whether an employee's ability to perform a skill was more important than having earned a certificate or credential, 80% of the high adoption companies, 73% of the moderate adoption companies, and 67% of the low adoption companies agreed or strongly agreed. Nevertheless, 64% of respondents said that training should lead to an industry recognized credential. Only 28% believed that training should lead to college credit, even though one of the most preferred sources of training were community colleges or universities (Table 2.5). Almost half of the respondents would like employees to work toward an associate degree (48%), with more of the high adoption companies in favor (60%). Slightly fewer, 36% of respondents, would like them to work toward a bachelor's degree.

Table 2.5

Company Preferences for Training Provider (Percent)

	Adoption rate grouping			
	Low (n = 9)	Moderate (n = 11)	High (n = 5)	Total (n = 25)
Training is internal	44	27	40	36
CC or Univ	11	45	40	32
External provider	22	9	0	12
Equipment vendor	22	0	20	12
Other	0	18	0	8
Total	100	100	100	100

The human resources manager interviewed shared that new employees learned the skills specific to that company's operations on-the-job from the other employees. At Company A, it was informal. At Company B, it was a formal apprenticeship program. Conversely, Company C used a mix of formal training offered through the corporate office and the local office. In all three cases, once they had gained experience, technicians received training and were trusted to handle more advanced equipment. They usually participated in technical training provided by the equipment vendor when a new technology was adopted.

Similarly, the technicians who participated in the interviews described participating in a combination of trainings that included internal, external, formal, and informal experiences to help them gain skills. The technicians from Companies A and B seemed to trust that they would be provided with appropriate technical training as needed. The technician from Company C said that if they needed technical training, they would need to pursue it on their own. However, when it came nontechnical training, the Company C technician expressed that the company had options for employees at higher levels of the organization but did not feel that training was available to technicians.

The researcher identified an additional and unanticipated finding. The three human resources managers who participated in the interviews reported that the lack of available workers in the labor pool was a real problem. They all believed that training was a secondary concern because it was within their control, versus their inabilities to recruit enough job applicants to fill their vacancies. This issue was dire enough to impact their abilities to take on new work and expand their company. Companies eventually had to "poach" employees from other companies, making training a less attractive investment if there was a risk of losing the newly trained employee to another company or even a competitor. The three human resources managers also commented on the high rate of turnover they experience shortly after hiring someone new. They attributed the turnover to the difficult conditions and monotonous nature of the work. They also saw new employees get frustrated because of the low level of pay they received while in that training stage, making them more susceptible to leave or be poached. However, they said that those who stayed, stayed for a long time.

The needs analysis revealed that employers had found a way to resolve the need for technical training for new and existing employees. On-the-job training combined with training provided by equipment vendors and/or training offered by the community college satisfied employers, as employees had acquired the technical skills to operate AMT. However, their responses indicated a lack of nontechnical skills and desire for training in leadership, communication, and workplace behavior. The interviews that followed the survey confirmed these findings. All three human resource representatives indicated that they had a system in place to resolve gaps in technical skills but were continually frustrated by behaviors their employees did not demonstrate but were needed for successful job performance.

Discussion

As employers seek to adopt new AMTs, workers' skills become an essential consideration (Desplaces et al., 2019). Past research has found a gap between the skills employers need their workforce to possess and the skills workers have (Soares, 2013; WEF, 2016). However, the research presented in this chapter suggests that the technical skills gap is less problematic than a lack of nontechnical skills, manifesting differently for manufacturing employers, manufacturing technicians, and education providers.

As described in Chapter 1, U.S. growth in manufacturing has intensified the need for more workers, while the adoption of AMTs requires those workers to have higher-level technical skills (U.S. GAO, 2019). As the human resources managers expressed in their interviews, difficulties in hiring enough manufacturer technicians had required that employers would sometimes hire lower-skilled workers. Additionally, Baqadir et al. (2011) found that employers must retrain employees after hiring them. Thus, employers hiring untrained workers to meet the numbers required to maintain production levels will need a better understanding of the exact nature of the skills deficit they seek to address. Dorado County manufacturing employers expressed satisfaction with technical skill training available for their trained workers through the local community college, equipment vendors, or their own internal programs. However, even though they saw an NT skills gap, they had no strategy to address it, regardless of the company's level of AMT adoption.

Manufacturer technicians either pursue training on their own through a community college or other provider or are trained once employed by the employer or equipment vendor. These training providers focus on the technical skills needed for a manufacturing job. However, this study had shown that employers and the education providers they currently worked with did

not offer nontechnical skills training, and it is unknown whether there are systems in place for manufacturer technicians to seek out nontechnical skills training on their own. Nonetheless, employers expect manufacturer technicians to have these skills. This deficit poses a significant barrier to manufacturer technicians' career progression if they lack important skills expected by their employer.

This study focused on community colleges as the education provider of choice for manufacturing employees. Nevertheless, they too have fallen short in providing nontechnical skills training, as evidenced by the deficiencies identified in this study. Adding nontechnical skills training to an already dense course load would necessitate sacrificing other topics. Additionally, developing a new curriculum is expensive and time-consuming as it needs approval from the college's accrediting agency and faculty hired to teach it.

A better understanding of nontechnical skills is needed to create the systems by which education providers and employers can teach them. This study identified leadership, communication and, appropriate workplace behavior as nontechnical skills that need addressing. However, this study was not focused on nontechnical skills but explored an array of skills the literature indicated as relevant. It is worth noting the degree to which the manufacturing context has created an infrastructure for technical skills training that both employers and employees in this study felt were working. Creating an analogous system to address nontechnical skills will require a granular understanding of all the relevant nontechnical skills in manufacturing and how they are best taught to prepare 4IR workers more effectively for the highly competitive manufacturing industry than before (U.S. GAO, 2019).

Chapter 3

Intervention Literature Review

During an interview for the Chapter 2 needs assessment, one human resource (HR) manager commented that “you can’t teach ‘want-to’” (K. McCabe, personal communication, January 18, 2021), describing an overall frustration with manufacturing technicians' lack of motivations and initiatives. This manager's assessment of the employee's performance derives from the findings of the needs assessment study. The study revealed that employers believed that their manufacturing technicians (MT) lacked leadership skills, communication skills, and understandings of appropriate workplace behaviors. In addition, the HR managers in the study believed that a misalignment of expectations led many new employees to leave the company, and those with nontechnical (NT) skills stayed with the company for years. The NT skills gap identified in this needs assessment could have influenced employee turnover and production capacity (e.g., Deloitte, 2017), making the issue a priority for manufacturers to address. The following section provides literature about the background of NT skills.

Nontechnical Skills

Although employers can agree on the importance of soft skills, their definitions of the term and the specific skills it encompasses are ambiguous. The literature does little to show such issues. For example, Matteson et al. (2016) detailed multiple academic sources' lists of soft skills showing the breadth, lack of consensus, and considerable overlap. Matteson et al. (2016) concluded that "no formally agreed upon, universal set of soft skills exists" (p. 75). Therefore, one should specify the terminology and skills addressed in this intervention literature review.

The following studies use literature reviews as qualitative document analyses of the skills taxonomy in different research contexts. Aggregating the instances in which specific terms are

used in different studies provides evidence of the significance and acceptance of each term. In U.S. Agency for International Development-funded research, Gates et al. (2016) took a broad approach for identifying workforce success skills in highest demand in low- and middle-income countries across industries. The researchers aimed to inform U.S. Agency for International Development's youth development strategies and funding decisions. Gates et al. reviewed 380 empirical studies, employer surveys, and international reports. The researchers collected data from youth, employers, and workforce educators and experts. After coding, the researchers found five skills most closely linked to workplace success (Table 3.1; Gates et al., 2016).

Labor market data, such as job postings, are another source of NT skills, especially as used by employers. Deloitte (2017) collaborated with Workible (a large provider of job search platform technology in Australia) to study that country's soft skills needs and inform national policy. Workible analyzed over 168,000 job postings and 175,000 resumes in 60 industries. Deloitte compared Workible's list of NT skills to other data sources, such as LinkedIn and the Organisation for Economic Co-operation and Development, to identify overlap and gaps. The final list of the most in-demand NT skills in Australia included six skills (Table 3.1; Deloitte, 2017).

The U.S. labor market research firm, Burning Glass (2015), compared the skills that employers included in their job postings to the skills that employers believed were essential for job success. Burning Glass analyzed over 40,000 job postings on a platform to show the frequency with which skills were mentioned in job postings over a 12-month period. Burning Glass removed duplicates and synonyms, grouping similar skills. The organization found that 14,000 unique skills were distilled to 25. Burning Glass used the U.S. Department of Labor's O*NET to measure importance. Burning Glass calculated the difference between posting

frequency and relative importance, listing the top 10 highest priority skills for each industry studied. Table 3.1 shows the 10 highest priority skills for manufacturing (Burning Glass, 2015).

Benbow and Hora (2018) criticized how employability skills lists were formulated. Thus, they took a qualitative approach to assess the skills most important to manufacturing and biotechnology employers and educators. The researchers chose these specific industries as both were priority sectors in Wisconsin where the study occurred and focused on science, technology, engineering, and math occupations. The purposive sample included 43 manufacturing, nine biotechnology companies, eight associate level, and nine bachelor-level educational institutions in Wisconsin. Researchers interviewed the company representatives and educators in semi-structured interviews. Participants were asked to list the skills that they deemed most important for work success. The researchers coded and analyzed the responses, ending with a list of 14 skills ordered by each group's perception of its importance (Table 3.1).

Bender et al. (2014) addressed the need for clarity in NT skills taxonomy, developing a system of behavioral markers and nontechnical observable behaviors that would contribute to high work performance. The researchers did a systematic literature review to identify the NT skills of high-performing software developers and validated the list by surveying 20 employers and educators. Bender et al. cautioned that these behavior markers must be specific to the industry where applicable.

Table 3.1 shows the specific skills identified in each of the studies detailed above, organized by behavior marker categories applicable to manufacturing. Communication skills lead to greater team efficiency (Deloitte, 2017), so teamwork and interpersonal skills appear under the communication skills category. Critical thinking also encompasses higher-order thinking skills and problem-solving skills. Self-management includes motivation, self-control,

and work ethic. Initiative, which employers referenced repeatedly in their interviews, is also categorized under self-management (Gates et al., 2016).

Table 3.1

Comparison of Skills by Study

Category	Burning Glass (2015)	Gates et al. (2016)	Deloitte (2017)	Benbow and Hora (2018)
Communication	Communication	Communication	Communication	Communication
	Building effective relationships	Social skills	Teamwork	Teamwork
				Interpersonal
Critical thinking	Critical thinking	Higher-order thinking	Critical thinking	Problem-solving
	Analytical skills		Problem-solving	
	Creativity			
	Problem-solving			
Self-management		Self-control	Self-management	Time management
		Positive self-concept		Attitude
		Initiative-taking		Work ethic
				Self-motivated
Other	Project management		Digital literacy	Lifelong learning
	Supervisory skills			Technical ability
	Writing			Technical knowledge
	Basic math			
	Customer service			

Addressing the NT skills gap requires more than identifying the in-demand skills; an assessment tool is needed to measure change. Lacher et al. (2015) followed Bender et al. (2014), developing a Nontechnical Skills Assessment based on the behavior markers that Bender et al. created for the healthcare and aviation industries. Lacher et al. (2015) tested whether the assessment tool could consistently and objectively measure NT skills. Students in a graduate computer science university program were videotaped while working on two different projects developing software solutions. The researchers selected specific clips, provided instructions, instructed participants to watch the videos, and rated the students and their interactions. The

researchers then compared the participant ratings. The findings indicated that the raters agreed on eight of the nine NT skills but disagreed on the assessment of problem solving. Lacher et al. concluded that using behavior markers to assess skills and training outcomes provides a reliable approach for this nebulous set of skills.

NT skills are interconnected, nuanced, and contextual, making them difficult to assess individually using a checklist approach (Bender et al., 2014). The complexity in defining NT skills also makes them challenging to assess using traditional teaching and evaluation methods (Benbow & Hora, 2018). The needs assessment presented in Chapter 2 identified leadership, communication, and appropriate workplace behavior as NT skills that employers felt needed more attention. However, Benbow and Hora (2018) conducted a comprehensive focus by addressing several issues pertaining to the fourth industrial revolution skills gap.

The upcoming sections examine multiple studies specific to NT skills from diverse viewpoints and contexts and identifies those skills most relevant to the manufacturing workforce. The skills were then organized into three categories using Lacher et al.'s (2015) behavior marker approach: communication, critical thinking, and self-management. This chapter explores possible strategies to address the communication, critical thinking, and self-management skills gap between employers' expectations and employee behavior. Addressing the problem requires assessing interventions at various levels from government-driven economic development policy to responses from individual employers and education providers. The following section proposes a theoretical framework to explain the factors around the NT skills gap.

Theoretical Framework

Attribution theory (Weiner, 1972) provides a helpful lens from which to understand the NT skills gap that negatively impacts workers on the job success and hinders the competitiveness

of the country's manufacturing sector (U.S. GAO, 2019). The attribution theory framework aligned with a person's approach to the three NT skills addressed in this chapter: communication, critical thinking, and self-management. Individuals react to different circumstances depending on their perceptions of what caused the circumstance (Weiner, 1972). Understanding the attribution theory is valuable for developing strategies to address the NT skill gap.

Attribution theory proposes that people are motivated differently based on whether they attribute outcomes to their own actions perceived within their controls or factors in the environment they believe outside of their controls (Weiner, 1972). Attribution theory proposes three dimensions to explain a person's actions: locus, stability, and controllability (Weiner, 1972). Locus describes an individual's attribution of an outcome to either internal or external factors. Effort is an example of an internal factor, and luck is an external factor. This dimension describes whether an attribute is temporary or permanent. For example, effort and luck are temporary, but intelligence and the complexity of a task are permanent. The control dimension refers to whether the individual has control over the situation. The factors influencing the outcome of a situation can be either internal or external. For example, effort is both internal and controllable, and a task's complexity is external and uncontrollable.

These three components of the attribution theory illustrate the causes that a person assigns to an outcome that motivates their future behaviors (Weiner, 2018). The attribution theory differs from the traditional decision-making approach that explains behavior as a straightforward assessment between costs and benefits (Gurevich et al., 2012). An example of the rational decision-making approach is a person deciding to go back to school because the investment in tuition is smaller than a potential increase in salary. The attribution theory

indicated that a person might consider that they had performed poorly in past educational settings because the teachers never liked them, factoring into the person deciding not to pursue education. In this example, the person perceived an external locus of control, teachers did not like them, which seemed stable, considering teachers in general, and out of their control because the problem was caused by a teacher. The elements of attribution theory can also describe how an observer may interpret the behaviors of another person, such as a supervisor and coworker.

Harvey et al. (2014) highlighted how little attribution theory had been explored in organizational and industrial psychology literature. Nevertheless, the behaviors relevant to the field, such as employee behavior, motivation, leader/member relationships, conflict resolution, performance, and training, are driven by attributions (Harvey et al., 2014). Heckman and Kautz (2012) stated, "Traits are stable across situations, but their manifestation depends on incentives to apply effort in the situations where they are measured and also depends on other traits and skills" (p. 462). For example, when the manager quoted expressed frustration over employees' lack of initiatives, the manager interpreted the behavior as internally driven, stable, and controllable. In other words, the manager believed the employee's inaction was a choice, and they should simply change their behaviors. However, the employee might have felt intimidated by a belligerent coworker, an external factor, or afraid to make a mistake, which were internal factors beyond a managerial scope. Thus, the attribution theory might describe both the supervisor's perception and employee's state of mind.

Attribution theory's impact on how individuals make decisions needs to be considered in drafting economic policy. Gurevich et al. (2012) studied how the effects of an individual's perception of the origin of a gain impacted their decisions and motivations after receiving the payout. The researchers created a scenario with 215 university undergraduate students in Israel,

pairing students in a game and providing information regarding whether they won or lost, who contributed more to the outcome, and explanations for why their partner behaved certain ways. Gurevich et al. found that all three of the attribution theory dimensions, locus, stability, and controllability, influenced participants' decisions to share the winnings from the game. For example, participants sought to be fair but were partial when told the other person had not given much effort to their participation in the game.

This research contributes to the appropriateness of attribution theory in addressing the NT skills gap, demonstrating that people are motivated in their behaviors by various considerations not always evident to the observer yet needing to be addressed in interventions that seek to change behavior. Next, the review considers policy options, employer responses, and intervention options (e.g., training methods for NT skills). The final section proposes an intervention that supports manufacturing firms' abilities to cultivate the skilled workforce needed.

Addressing the Workforce Gap in Manufacturing

Having a workforce with the correct skillset is imperative for a firm's productivity and industrial competitiveness. As demonstrated in Chapter 2, the skills that manufacturers consider most scarce and in demand are NT skills. Also shown from the needs assessment data in Chapter 2, employers do not have a strategy to ensure their workers receive the necessary training; instead, employers hire employees who already possess such skills. However, with the shortage of workers in today's manufacturing workforce, company leaders can no longer limit hiring to candidates who already possess NT skills. Additionally, NT skills are difficult to define (as shown earlier in this chapter) and measure. Therefore, developing a strategy for building the infrastructure to teach them requires a multilevel approach, as detailed in the next subsections.

A Workforce Development Response

Workforce development has been the subject of many government-sponsored and government-funded interventions (Blume et al., 2019; Fox, 2015; U.S. GAO, 2019). However, the focus has been on technical skills, especially in manufacturing-oriented programs. Nevertheless, "interventions that promote beneficial changes in personality have an important place in a portfolio of public policies to foster human development" (Heckman & Kautz, 2012, p. 462). However, people do not always respond as anticipated when a new economic initiative is introduced (Gurevich et al., 2012). People's attributions impact their responses to incentives intended to elicit a particular behavior. However, if a program is not designed to account for the beneficiaries' attribution-based responses rather than rational responses, the intervention will not have the intended effect (Gurevich et al., 2012). Triple bottom line (TBL) and place-based leadership (PBL) strategies include the voices of those constituents they aim to help, increasing the likelihood of building the right incentives to motivate workers and employers to address the NT skills gap. These two economic development approaches are described next.

The TBL approach to economic development differs from traditional strategies in that it also considers social and environmental factors (Hammer & Pivo, 2017). As a result, TBL plays a role in communities' sustainable development and well-being. Hammer and Pivo (2017) explored the perceptions of TBL investments and strategies of 413 economic development practitioners throughout the United States, surveyed by the Economic Development Administration and other national economic development organizations in 2011. The researchers found that regional collaboration, quality of life, workforce development, and accessibility are seldom measured project outcomes. Hammer and Pivo cautioned that economic growth that did not consider social and environmental factors could cause harm to development and well-being.

The researchers then surveyed 381 economic development practitioners from across the United States to assess their knowledge and experience with TBL (Hammer & Pivo, 2017). From those responses, they identified 18 diverse communities that had enacted TBL and conducted semi-structured interviews with at least one project representative from each regarding the implementation, accomplishments, and outcomes of the TBL initiative. The researchers found that communities needed a cohesive and collaborative workforce development strategy to create, retain, and attract businesses and jobs. The respondents credited the success of their initiatives to the partnerships and cooperation among stakeholders, leading to better planning, buy-in, and resources (Hammer & Pivo, 2017).

PBL is another regional economic development strategy that depends on a coordinated approach. PBL extends the responsibility of economic development leadership beyond elected officials to include civil society, individuals, and key agencies such as chambers of commerce and business associations (Beer et al., 2019). Beer et al. (2019) compared PBL practices across six different economically developed countries using a vignette approach to focus group participants. The participants discussed the appropriate regional response, including addressing workforce implications. The countries included Australia, Finland, Germany, Italy, the United States, and the United Kingdom, all selected because they represented diverse types of governments and economies and cultural and social norms. The researchers presented two scenarios to 12 focus groups with 90 community leaders from various industries, industry associations, and public sector entities. Beer et al. posed the same questions to each focus group and scored participants' responses collectively based on the expected effectiveness of the proposed local response. Although each country's responses differed by type of government

structure and local culture, they all relied on one lead organization, either public or private, engaging interested stakeholders in the response (Beer et al., 2019).

Successful PBL entails a contextualized, proactive, coordinated community response to a clearly delineated problem. A PBL response to a community's workforce needs would enable employers and their associations, training providers and community colleges, and government economic development agencies to align their NT skills needs and work together. TAACCCT grants, described in Chapter 1, are an example of a successful PBL initiative that considers the needs of employers, training providers, and workers found in the United States (Blume et al., 2019).

Both TBL and PBL entail a structured and unified approach to economic development that facilitate educational institutions' engagement with those efforts to ensure their curricula aligns with the community's needs. Benneworth et al. (2016) examined how universities' internal structures and actors could influence the institutions' direct involvement in regional PBL activities. Their multiple case study analysis included three universities, one in the Netherlands, one in Norway, and one in Finland. The researchers found that universities that promoted institutional entrepreneurship internally engaged at a deeper level externally and had a more pronounced impact on the extent of participation in regional economic development strategy from other institutions, including employers, social organizations, and government entities (Benneworth et al., 2016).

Lowe and Feldman (2018) conducted similar research in the United States, considering how economic development practitioners in North Carolina supported the local biosciences sector. Following a case study approach, the researchers reviewed and coded various documents such as annual reports, strategy documents, press releases, and newspaper articles dating back to

the 1970s. The researchers also conducted semi-structured interviews with former and current staff and executives to assess the development of the North Carolina Biotechnology Center. A primary factor in the project's success was a formal structure by which stakeholders could evaluate new and innovative initiatives and determine whether the initiatives should move beyond a pilot stage. The researchers also found that moving the initiative beyond satisfying the needs of one small stakeholder group helped ensure long-term economic and societal benefits to residents of the entire region.

The studies described thus far have included economic development approaches that can address the specific workforce training needs of the communities they mean to impact. Both Benneworth et al. (2016) and Lowe and Feldman (2018) provided examples of economic development initiatives that incorporated higher education in their implementation. Fox (2015) added to this thread describing six large-scale initiatives that promote and support workforce development education implemented by community colleges. Private foundations funded five of the six initiatives described in the study, including Bridges to Opportunity Breaking Through, Shifting Gears, Accelerating Opportunity, and Completion by Design. This finding illustrated a trend toward non-governmental organization involvement in workforce development. State governments funded only one initiative, Integrated Basic Education and Skills Training. Fox showed that successful programs lead to follow-up actions and spread from region to region. These six programs show how "careful investment in innovative practice backed by evaluation and research creates a more effective system overall" (Fox, 2015, p. 739).

Similarly, D'Amico et al. (2014) further showed the impact community colleges can have on workforce education initiatives by acting as the lead organization. D'Amico et al. examined issues around community college funding, enrollment, and workforce education using data from

2011, 2012, and 2013 Survey of Access and Finance Issues that the Education Policy Center at The University of Alabama administers annually to the National Council of State Directors of Community Colleges. The researchers analyzed the Likert-scale responses to find correlations between the variables and assess the strength of relationships over time. Findings included the need for additional funding to support high-cost career programs and the importance of community colleges' relationships with business and industry (D'Amico et al., 2014). The initiatives presented by Fox (2015) and D'Amico et al. (2014) were led by community colleges, and as in the TBL and PBL approaches, required coordination with funders, employers, and other colleges to implement successfully.

The policies and programs described in this section focus on large-scale initiatives to create opportunities and improve well-being. Initiatives such as TBL and PBL require the alignment of stakeholders and the inclusion of beneficiaries to understand the motivations that will generate the desired actions. Workforce education is a crucial component of TBL, and PBL strategies and higher education institutions, including community colleges, are vital in ensuring the education is available and accessible. Whether community colleges or private organizations, training providers must align with local economic development strategies to ensure they offer the necessary skills training (Fox, 2015), which should include technical and NT skills. Policy initiatives risk being unsuccessful when they do not include inclusive policies, such as in TBL, which consider employers' and workers' needs, especially regarding education and training.

Employer Led Training Models

Employers will base their training decisions on their business strategy. For example, whether to provide NT skills training internally or externally and whether employees should be expected to have the skillset before being hired are all decisions employers must make in

addressing the NT skills gap. This subsection explores the benefits and costs of these training strategies to the employer.

Behaghel et al. (2012) provided an example of internal training looking at how employers deal with the new skill requirements common in companies undergoing information technology adoption. Using data from annual national surveys of French employers and employees, the researchers assessed 1,537 firms on their adoption of information technology, the number of employed and unemployed workers per square kilometers, in 348 local labor markets throughout France. The researchers found that the manufacturing firms in the study were more successful in upgrading the skills profile of their workforce by training incumbent employees more so than by hiring new workers who already possessed the skills (Behaghel et al., 2012). This study provides evidence of the benefits of training over hiring as a skills acquisition strategy.

Henriksen and Rolstadås (2010) examined the relationship between knowledge and strategy in the Scandinavian manufacturing industry case study. First, the researchers analyzed strategic documents and other industry sources and interviewed key personnel from the automotive manufacturing industry. Next, the researchers evaluated firms' ability to adapt to their environment, leveraging their knowledge resources, including advanced information technologies and a highly skilled workforce. Finally, the researchers found that knowledge resources need to align with business strategy: "What is crucial knowledge, how do we create it, and how to transfer it to meet our overall company goals?" (Henriksen & Rolstadås, 2010, p. 2413). This study focused on the need for knowledge transfer in a lean manufacturing environment. Although the differentiation between technical and NT skills was not explicit, the researchers pointed to NT skills such as problem-solving and communication being critical in an environment where every employee is responsible for product quality. The researchers posited

that the knowledge needed in this context is best learned hands-on in the workplace. The researchers also found that alignment between the type of training, the skill being taught, and the evaluation criteria impacted the effectiveness of the training.

Conversely, Mollona and Hales (2006) found that when the cost of training was higher than the cost of skilled labor, manufacturing firm leaders would often hire workers who already had the skills needed for the job. In their computer simulation of a skills-based job market, Mollona and Hales studied companies' hiring decisions based on the applicants' skills. The simulation did not name specific skills, instead denoting whether a skill was strategic or not and in high demand or not in their various scenarios. After 120 cycles of the simulation, the firms that had the best outcomes were those that hired and retained highly talented employees over the long term (Mollona & Hales, 2006). In scenarios of highly dynamic environments, employees with skills that were in low supply, but high demand received better job offers. The model suggests that workers can risk financing in their education with confidence that their investments will pay off with a higher starting salary (Mollona & Hales, 2006).

This model assumes that workers will make a rational decision to incur the cost and risk of training before being hired to secure a higher wage. However, the attribution theory suggests their decisions are not that straightforward, and workers would consider other factors (Gurevich et al., 2012). The results of Burning Glass's (2015) analysis of job postings illustrated how employers hire for one set of skills even if they value a different set, putting into question whether workers' investing in NT skills on their own will have the desired financial results. This subsection detailed the best way for employers to structure training to improve the firms' outcomes. The following subsection considers training options from workers' perspectives,

identifying challenges faced when engaging in training and proposing interventions to mitigate learners' challenges.

Employee Driven Training Models

Post-traditional students are more likely to pursue education when seeking to achieve employment goals (Soares, 2013). However, the information students need to make career decisions confidently is not always available (Almeida et al., 2012). Additionally, post-traditional students who have been out of school for some time may not be confident in their abilities to succeed in an academic setting (Cummins et al., 2018). This subsection considers education from post-traditional learners' perspectives, focusing on offerings that enhance workers' outcomes, whether the learner or the employer initiates the training.

The attribution theory explains post-traditional learners' engagement within the educational context. Learners' perceptions of locus, stability, and control may influence decisions to start, persist, and complete educational programs (Gurevich et al., 2012). For example, an employee encountering challenges at work because of poor NT skills may believe the problem is external, permanent, and out of their control and blame a supervisor that seems to single them out over a specific problem. In this case, the employee may decide training will not do anything to resolve the situation, instead choosing to leave that job. Alternately, the employee may believe they have inherited a difficult temperament from a parent, which is internal and permanent. Again, the employee may not be motivated to participate in training because they may not believe they can change workers' behaviors. On the other hand, an employee who sees a communication problem with their supervisor and believes learning new skills may improve the situation, potentially improving their financial outcomes, may succeed in NT training.

The American Enterprise Institute evaluated three workforce programs by organizations in New York, Oklahoma, and Ohio that had implemented a new soft skills training into their curriculums between 2011 and 2013 (Schaberg, 2019). Schaberg (2019) used a randomized-controlled trial design, with 2,564 individuals assigned to a treatment or control group. The researcher tracked them over 3 years to assess the impact of the soft skills training. Each training program was developed by the organization. The study consisted of five and 12 sessions for 60 and 84 hours across various industries. The skills taught by all the providers included time management, problem solving, and communication. Additional skills included were sector-focused and differed by provider. All three programs made improvements continuously based on trainer and participant feedback. The training included group and interactive activities and simulated the work environment. Staff at all the sites believed that the group interactions were an essential element in participants' learning (Schaberg, 2019).

Schaberg (2019) demonstrated how soft skills training helped change participant behavior and improve their understanding of workplace expectations. The three programs in this study developed an NT skills curriculum appropriate for the local context. The following sections detail various strategies to help adult learners persist and succeed in reaching their educational and professional goals that can apply to other contexts.

Teaching Post-Traditional Learners Nontechnical Skills

Stuart et al. (2014) found that students who understand the potential outcomes of their educations were more willing to make sacrifices to balance family, work, and school. Stuart et al. explored labor market factors to explain why some students would persist and others would abandon their academic goals. Analyzing data from a Midwestern U.S. community college serving over 52,000 students, the researchers used Standard Occupation Codes associated with

the programs of study they offered and data from the Bureau of Labor Statistics to explore the relationship between the number of jobs available, earnings, and educational requirements. Stuart et al. found that students based their persistence decisions on labor market dynamics and the earning potential of the chosen program of study.

However, Harlow and Bowman (2016) found a lack of available information for post-traditional students to make informed career decisions. They studied community college students' career decision self-efficacy (CDSE) and career maturity, defined as individuals' perception of their ability to make good career decisions and career maturity as a person's ability to make career choices, including having enough information about options and the steps needed to enter a career. The researchers surveyed 268 students, 168 freshmen and sophomores between 18 and 25 from a midsized Midwestern university and 100 from a nearby community college. The researchers conducted an analysis of variance calculations between different variables. The researchers found that first-generation community college students reported similar levels of CDSE as first-generation baccalaureate students and higher levels than non-first-generation baccalaureate students. However, both groups of first-generation students reported having lower career maturity levels than non-first-generation students. Almeida et al. (2012) found that 54% of community college students worked over 20 hours a week while attending school. Harlow and Bowman (2016) suggested that work experience might explain working college students' CDSE because they had more information and context than nonworking students. This finding aligned with D'Aloisio (2006) and other research presented in Chapter 1, indicating that nontraditional students were motivated by career goals (e.g., Ghilani, 2008; Reyes et al., 2019). Harlow and Bowman (2016) suggested that students could benefit from information about careers, self-exploration, and goal setting.

Almeida et al. (2012) recognized the need for support services such as counseling and job-search assistance. The researchers reported on various interventions to address workforce training needs, such as on-the-job training and vocational training programs offered by governments and non-governmental organizations. However, the interventions described did not address the prospective worker's decision-making and motivations, as Harvey et al. (2014) portrayed in their attribution theory research. Almeida et al. (2012) listed factors that could deter participation: a lack of information about training options, the need for certainty regarding the availability of jobs to warrant the investment, and false expectations of the potential return on investment.

Du Bois-Reymond et al. (2001) also explored the barriers adults face as students. Their longitudinal study in the Netherlands showed that not a single participant from a lower economic status had completed a degree from a college or university. The researchers initiated their research in 1988 with 120 volunteer participants from several high schools in the city of Leiden. Researchers tried to include students from diverse socioeconomic backgrounds, gender, and school type; however, their final sample included 45% males and 55% females, with low socioeconomic status boys slightly underrepresented. However, the researchers believed that their sample reflected the general trends in high school enrollment at that time. Researchers conducted interviews in 1988, 1989, 1990, and 1997. After attrition, the group consisted of 85 participants between the ages of 24 and 27. Multiple researchers analyzed the interview transcripts to ensure reliability. Among their conclusions was that the high demands of working, learning, and caring for children were challenging, leading to individuals making difficult choices (Du Bois-Reymond et al., 2001). These life circumstances could be influenced by the flexibility of online education; however, the Dutch researchers found that the school must

communicate this value to prospective students, recognizing the role of the attribution theory in decision-making processes.

Technology-Driven Instruction

Garza Mitchell (2017) reviewed eight studies of online education conducted between 2003 and 2012. The researchers studied changes in students' demographics, the types of schools, the course offerings, and the terminology and definitions of online education (Garza Mitchell, 2017). The researchers found benefits to students' ability to take courses outside their locality. However, moving technical hands-on classes to an entirely online format is not always possible, so those classes still require an in-person component that limits the courses beyond their region. Other specialized courses, such as NT skills training, are suitable to be offered online, allowing students to receive training regardless of their location (Henriksen & Rolstadås, 2010).

Githens et al. (2014) examined community colleges' roles in workforce education, considering online courses. First, the researchers randomly selected 321 community colleges through the American Association of Community Colleges' member roster of 1,081 schools. The researchers defined "online" programs as those consisting of at least 50% instruction relying on online technologies, so this study included hybrid courses as well. Next, Githens et al. gathered institutional, economic, and social data from various publicly available archives and databases and supplemented missing data by contacting the school. Finally, using MANOVA analysis, the researchers compared institutional characteristics with its program offerings. The researchers found that students would benefit from the program's flexibility, especially when statewide systems coordinated their online offerings to provide a more robust menu of courses.

Technology enables training to support different modalities, and online modalities can abate students' geographic constraints (Henriksen & Rolstadås, 2010). However, Public Agenda

(2013) found that both students and employers were skeptical of the value of online education. Public Agenda conducted a phone survey of 656 randomly selected human resources professionals from four major United States metropolitan areas from companies listed in the Dun & Bradstreet database. Public Agenda found that 42% of employers believed that students did not learn as much in online-only programs as in face-to-face ones, and 39% believed that online-only programs were easier to pass. Public Agenda also interviewed a nationally representative sample of 215 community college students over the telephone and online. Although 18% of student participants believed, like employers, that online classes were easier than in-person classes, 38% thought they were more difficult. However, as online education technology improves, perceptions would change as well.

Online programs can mitigate program weaknesses such as perceived difficulty, promoting engagement, and structured support. Martin and Bolliger (2018) identified students' online support and engagement preferences. Faculty members at eight universities in the United States distributed surveys to 155 online students at the participating institutions. The researchers explored three constructs: student-to-student interactions, student-to-instructor interactions, and student-to-content engagement. Students reported that engagement with their instructor is the most important and valuable to their experiences: 94% of students believed that instructor communications were critical, and 90% believed that posting grading rubrics was important. Additionally, students valued the instructor knowing students' names, having a forum where students could ask questions, and the importance of posting an assignment checklist (Martin & Bolliger, 2018). The findings in this study aligned with the study reviewed in Chapter 1 (e.g., Clark, 2012), which demonstrated that post-traditional students would value their relationship with instructors in better positions to help students succeed.

Engaging post-traditional learners in education requires understanding their lived experiences and providing the right motivation to demonstrate the benefits of learning. Additionally, instructional delivery needs to address the unique needs of working adults juggling multiple responsibilities beyond their professional life (Du Bois-Reymond et al., 2001). Leveraging online technology is one way to accomplish this. An alternative training intervention that can be useful in teaching NT skills is experiential learning models. The following subsection describes some examples of this hands-on approach and explores their suitability for NT skills training.

Experiential Learning

As explained by Henriksen and Rolstadas (2010), manufacturers need knowledge created in their organization to be transferred using hands-on contextualized modalities. A well-known example of this type of experiential learning is offered by the U.S. military that transfers the military culture in a short amount of time through basic training. New military recruits undergo intensive physical and emotional training as they learn military codes, norms, language, and overall culture (Redmond et al., 2015). Experiential learning is deliberately planned to provide the learner with a specific experience, including focus, action, support, feedback, and debriefing. Experiential education is premised on the connections between topics and the student's relationship with the topic while investigating those connections (Joplin, 1981). This action-reflection cycle involves the learner having an experience and subsequently reflecting on the impact of the experience and the learning that comes from it. This mental model echoes Benbow and Hora's (2018) approach to NT skills as interconnected and nuanced, making experiential learning a potential approach to NT skills training.

Olivares et al. (2019) used a challenge-based learning approach to teaching NT skills. The Tecnologico de Monterrey offered 1,295 real life learning opportunities in 36 cities across ten countries using the university system's multi-campus footprint. During the initiative, students worked in multidisciplinary teams for one week to solve real-world problems under the guidance of a faculty member. Teams worked on diverse challenges such as virtual reality for architectural design, fundraising campaigns, community help during an earthquake, and first aid and rescue simulations. Of the students who participated, 929 answered pre- and post-questionnaires to assess their perceptions of learning skills based on 14 individual competencies. The researchers found that students achieved higher scores in five competencies: self-directed learning, intellectual curiosity, critical thinking, problem-solving, teamwork, and innovation. The researchers concluded that immersive learning experiences were effective ways to teach employable skills, although they recognized that they only measured short-term outcomes in their study.

Heimbeck et al. (2003) explored using error management in training. Undergraduates between the ages of 19 and 37 from various disciplines in a German university were taught a new software package in a 45-minute session. The 87 participants were randomly divided into three groups. One received instructions to embrace errors and learn from them. One did not receive instructions or encouragement to make errors. The last group received detailed instructions on how to accomplish the training tasks but no error management message. The participants were given a questionnaire a few days before the experiment, a test immediately after training, another test a week after the training, and participated in a debriefing. The researchers found that the group given error management instructions to accept errors and learn from them did better on the outcome tests at all stages than either of the other two groups. A

week later, the groups were tested to evaluate retention, and the positive effects of error management with instructions persisted. The groups that received no error avoidance instructions and no task instructions had the poorest results (Heimbeck et al., 2003). Error avoidance training leads to better learning in all cases, making this a viable teaching methodology. This study presented problem-solving scenarios; however, the researchers suggested using error management in social skills training as an area of future research.

Musa et al. (2012) explored how project-based learning helped university students in Malaysia acquire soft skills to meet 21st-century workplace needs. Twenty-nine students taking a workplace communications course worked in groups of two or three to identify and develop a solution for a real-world workplace problem. Students were surveyed after they delivered the final project presentation to the class and instructor at Week 14 of the course. The quantitative survey used a 5-point Likert scale from *strongly disagree* to *strongly agree*, asking students to assess their learning on the constructs of teamwork, project management, communication skills, interpersonal skills, and problem solving. Using descriptive statistics to analyze participant self-reported improvements, Musa et al. concluded that their project-based approach did succeed in aiding the transfer of soft skills to the participants in this course.

Various factors play a role in identifying a viable and sustainable solution for the delivery of NT skills. First, workforce and economic development strategies should incentivize NT skills training like they have technical skills. Second, addressing the skills gap could be undertaken by the employer or an external entity, but it must fit in with workers' lives. As demonstrated by the research presented in this section (Garza Mitchell, 2017; Githens et al., 2014; Henriksen & Rolstadås, 2010), leveraging technology and online training offers the flexibility post-traditional learners need. Finally, the teaching methods used for technical skills are not the same as those

needed for NT skills, but examples exist of programs that have found ways to do so successfully (Schaberg, 2019). Education providers need to identify the teaching methods best suited for NT skills training such as challenge based learning (Olivares et al., 2019), error management training (Heimbeck et al., 2003), and project-based learning (Musa et al., 2012). The section that follows explore intervention criteria and strategies appropriate for the context of post-traditional learners in manufacturing.

Summary of the Proposed Intervention

The proposed intervention addressed the NT skills gap by leveraging students' motivations to set career- or job-related goals (Du Bois-Reymond et al., 2001) and engagement with employers to reach workers (Fox, 2015). The intervention planned to use an online asynchronous teaching and experiential project-based learning focusing on self-directed activities. Participants were technicians from local manufacturers that had been employed for 2 years or less. Their short time with their current employers addressed the needs assessment findings from interview participants who indicated that employees lacking NT skills tended to leave the organization within a few months of being hired. The program would consist of four 90-minute synchronous sessions every 2 weeks, daily 10-minute online activities, and four hands-on assignments that participants completed between in-person sessions. Spacing the treatment would increase the likelihood of changed behavior (Rischke et al., 2011). The modules would cover the NT skills needed to succeed in the workplace: communication, critical thinking, and self-management (Table 3.1). The course duration balanced the amount of instruction necessary to teach the skills, as intended by the training guide and employers' abilities to release their MTs for participation in the training.

The skills identified in the needs analysis and detailed in past research were embedded in a project that would blend the action-reflection cycle of experiential learning (Joplin, 1981) with scaffolded concepts (Hmelo-Silver et al., 2007) throughout the training. The topics included an introduction to workforce readiness, where participants learned about the customer/manufacturer relationship, the importance of teamwork, communication, and problem solving. In addition, participants developed communication, critical thinking, and self-management skills while increasing their understandings of appropriate workplace behaviors. The goal of this intervention was for participants to understand and demonstrate the nontechnical skills identified in the needs assessment and relevant literature (e.g., Benbow & Hora, 2018; Burning Glass, 2015; Deloitte, 2017; Gates et al., 2016).

Conclusion

This chapter addressed one manufacturer's belief that initiative could not be taught (K. McCabe, personal communication, January 18, 2021). This review of literature sought to explain better what NT skills were to understand whether they could be taught. The literature showed three skills most relevant to the manufacturing context: communication, critical thinking, and self-management (Deloitte, 2017; Benbow & Hora, 2018; Burning Glass, 2015; Gates et al., 2016). The attribution theory (Weiner, 1972) offered a structured approach to explain how people were motivated to react in different circumstances. Locus was a person's attribution to an outcome being caused by internal or external factors. Stability was whether the situation was temporary or permanent. Control was whether the person had control over the outcome. Locus, stability, and control were used to explain the need to educate workers on how attributions could be reconsidered so that they had agency over their own results.

Burning Glass (2015) found that employers valued soft skills but were hired for technical skills. Their research indicated that technical skills training helped participants find jobs, and soft skills helped them succeed in those jobs. The intervention was used to address employers' goals of improving firms' performances and supporting workers' efforts to improve their personal performances and earning potentials. The intervention was used to recognize post-traditional learners' needs for flexibility. The following chapter describes this intervention in detail.

Chapter 4

Intervention Procedure and Program Evaluation Methodology

The competitiveness of manufacturing firms relies on a business strategy that increasingly includes adopting advanced manufacturing technologies (AMT; Kotha & Swamidass, 2000), requiring workers to have higher-level skills (Desplaces et al., 2019; Peddle, 2000). Past research highlights the gap between skills employers need and manufacturing employees' skills (Soares, 2013; WEF, 2016). Aerospace and defense manufacturing is a priority industry sector for Dorado County (Dorado County's Economic Development Plan, 2019); consequently, the community must ensure it has met those employers' workforce needs. Ensuring aerospace and defense supply chain employers have the workforce they require starts with a better understanding of the skills gap to develop a strategy.

The mixed-methods needs assessment presented in Chapter 2 clarified the skills gap by demonstrating that employers felt workers had the technical skills to operate AMT equipment and believed they had the resources to address future technical training needs. However, employers were concerned about their MTs' lack of NT skills. Researchers have referred to NT skills using several terms: soft skills, employability skills, personality traits (Benbow & Hora, 2018; Burning Glass, 2015; Deloitte, 2017; Gates et al., 2016). The 28 aerospace and defense supply chain manufacturing employers that participated expressed that their MTs were deficient in NT skills, such as initiative, business communications, management, and leadership. Further, they currently have no existing solution to remedy this gap regardless of the company's current level of AMT adoption. This chapter describes an intervention study that addresses the NT skills gap through an experiential training program conducted for MTs.

The goal of this intervention was for participants to understand better the NT skills identified in the needs assessment and relevant literature (Börner et al., 2018) and how NT skills could impact job performance. This researcher addressed three research questions. The first relates to the intervention process, and the last two relate to the intervention outcome:

RQ1. To what extent was the intervention implemented as designed?

RQ2. How has the MTs' participation in the intervention developed their NT skills: communication, critical thinking, and self-management?

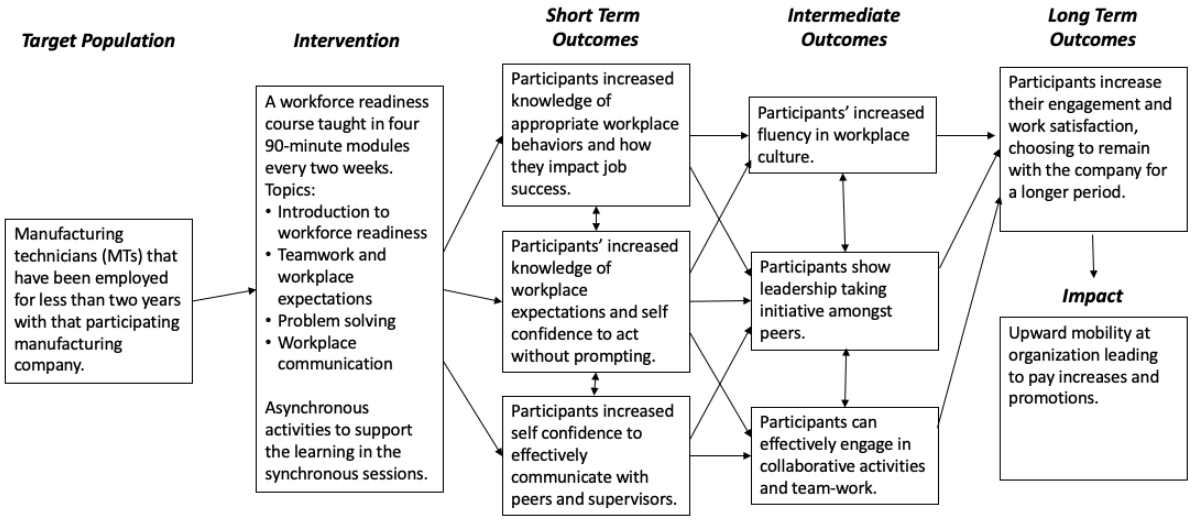
RQ3. How do the MTs NT skills affect their understanding of expected workplace behavior?

The skills identified in the needs assessment and confirmed in the research presented in Chapter 3 informed an intervention that blended the action-reflection cycle of experiential learning (Joplin, 1981) with scaffolded concepts (Hmelo-Silver et al., 2007) and error management training (Heimbeck et al., 2003). The topics covered by the intervention included an introduction to workforce readiness; the importance of teamwork, communication, and problem-solving skills (Figure 4.1); and expansion of employees' understandings of appropriate workplace behaviors and how they impact their job success.

Anticipated immediate outcomes included participants' improved communication, critical thinking, self-management skills, and knowledge of appropriate workplace behaviors (Figure 4.1). Medium- and long-term outcomes were also expected; however, they were beyond the timeframe of this intervention. These included participants' abilities to take the initiative and lead coworkers at appropriate times and an improved ability to listen, understand, and respond to peers and supervisors.

Figure 4.1

Theory of Treatment



Research Design

NT skills are interconnected, nuanced, and contextual (Benbow & Hora, 2018). A person may know the appropriate behavior yet lack the self-confidence to demonstrate it or may exhibit behavior in one context but not another. The mixed-methods design best draws from qualitative and quantitative approaches while minimizing their weaknesses (R. B. Johnson & Onwuegbuzie, 2004). Quantitative data were used to establish whether learning took place, and qualitative data would tell the story of the participant's changes in mindset, making a mixed-methods paradigm the most appropriate.

This intervention used a convergent parallel mixed-methods design (Creswell & Plano Clark, 2018). Qualitative and quantitative data were collected concurrently from the same samples before, during, and after the intervention. The 10-week intervention consisted of an information session, four modules over 8 weeks, and a debrief session. Each of the four modules

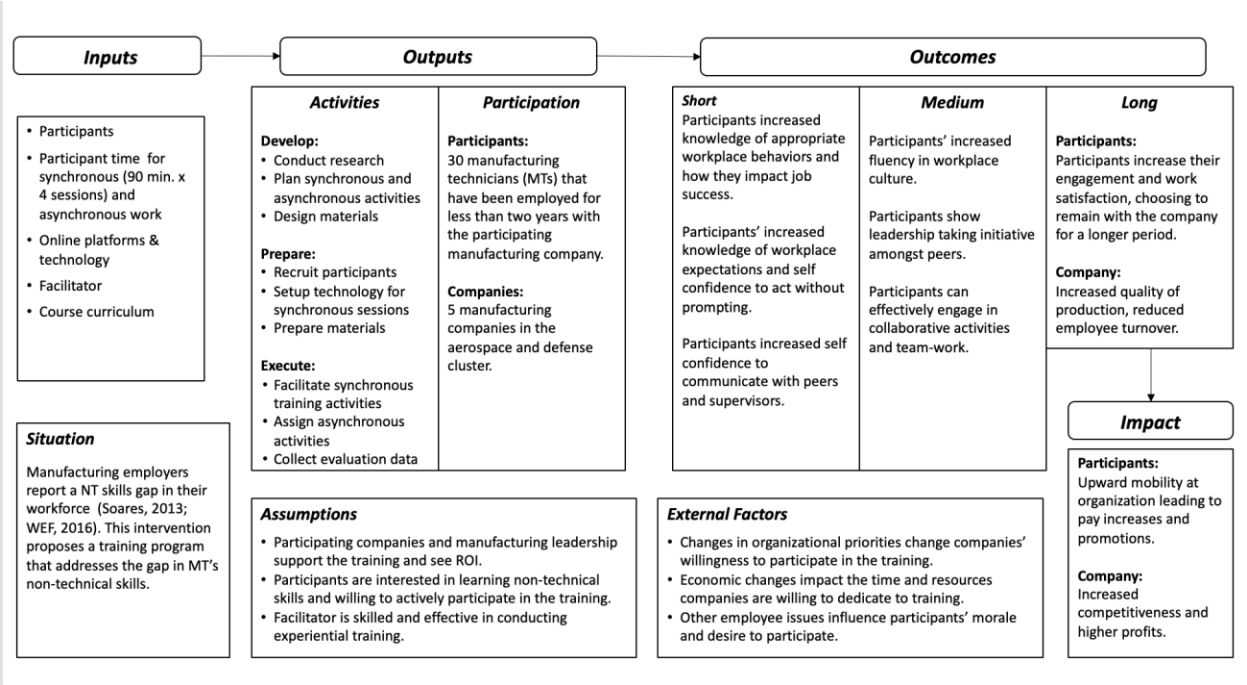
included an instructor-led synchronous session, an asynchronous experiential activity, and an asynchronous online Skillsline Journey.

As shown in the logic model (Figure 4.2), participants were expected to improve their communication, critical thinking, and self-management skills in the short term and demonstrate improved understandings of expected workplace behaviors. Participants would improve their fluency in workplace culture, leadership and initiative, and teamwork in the medium-term. Participants would be more engaged and satisfied with their job in the long term, reducing the likelihood of leaving the company. In contrast, the company would see increased production quality and reduced employee turnover. It was anticipated that participants would have upward mobility in the organization, pay increases, and promotions. The organization would be more competitive and earn higher profits.

The successful implementation of this intervention depended on employers supporting the program and recognizing the return on investment for their MTs' time and effort. The participants must be interested in learning NT skills and willing to participate in the training actively. Finally, the facilitator should be skilled and effective in conducting experiential training. Other aspects that could impact the intervention are detailed in the logic model's assumptions and external factors portions.

Figure 4.2

Logic Model



Process Evaluation

One way of attributing an intervention's outcomes to the intervention itself is by measuring the fidelity implementation to its design (Holliday, 2014). The implementation fidelity was addressed in RQ1. Quantitative data were collected using the online platform's analytic data from the participant's user profiles and qualitative data from the researcher's reflective journal and the participant focus group and interviews. The fidelity of implementation is further detailed in the following paragraphs.

Participant responsiveness describes how participants engage with the program content and take part in the program activities (Dusenbury et al., 2003). The Skillsline online platform, consisting of daily lessons on essential workplace skills described in more detail in a subsequent section, relies on participant interaction. Additionally, spacing activities increases the likelihood that participants adopt the desired behaviors (Rischke et al., 2011). The intervention's

synchronous sessions and corresponding asynchronous activities were experiential (Joplin, 1981). Participation in both was required for participants to receive the correct dosage of the program and achieve implementation fidelity (Dusenbury et al., 2003). Finally, the design required that the facilitator deliver the program effectively and adhere to its design to ensure effectiveness (Dusenbury et al., 2003). The facilitator, in this case, was the researcher, who set up the activities, and provided appropriate instructions while promoting creativity, problem solving, and communication skills practice.

Outcome Evaluation

The outcome evaluation included both quantitative and qualitative data. Quantitative data were gathered weekly from students' activity reports (Appendix I) and the Skillsline platform's quizzes as participants completed their lessons. Qualitative outcome data were collected through focus groups and interviews with a subset of participants and in the researcher's reflective journal. Data were analyzed separately then merged for a complete picture of the outcome of the intervention. The researcher combined both types of data by comparing and identifying patterns, differences, and similarities (R. B. Johnson & Onwuegbuzie, 2004).

Method

The following intervention addressed MTs NT skills gap through a 10-week experiential training program (Table 4.1). The training consisted of four modules: (a) introduction to workforce readiness, (b) communication skills, (c) teamwork and workplace expectations, and (d) problem solving. Each module began with a 90-minute instructor-led synchronous session over Zoom. Participants performed daily 10- to 15-minute lessons on the Skillsline online platform. Finally, participants completed an asynchronous experiential activity aligned with the content of each module.

Table 4.1

Session Topics

Sessions	Synchronous session topic	Skillsline Journey (focus)	Assignment
Info session	Introduction and overview		
1	Introduction to workforce readiness	Look Within (Self-agency)	Interview a coworker with a tenure of 5 years or more.
2	Communication skills	Connect (Collaboration)	Self-reflection on teamworking style and preferences
3	Teamwork and workplace expectations	Think (Higher-order thinking)	Breaking down a complex work problem
4	Problem-solving	Advance (Intentionality)	Written exercise - draft an email to company CEO about a problem from Session 3
Debrief	Program debrief	Get Results (Results orientation)	

Participants

Participant recruitment focused on MTs from local aerospace and defense supply chain manufacturers. Results from the needs assessment indicated that employees lacking NT skills tended to leave the organization within a few months of being hired. Therefore, the researcher targeted MTs employed for less than 2 years.

Participant inclusion criteria were manufacturing technicians over 18 years old working on the production floor in any production occupation such as welding, machining, assembly, equipment maintenance, or quality assurance. Participants needed daily access to a smartphone or internet-enabled computer. Participants should not have been in a supervisory role nor with the company for more than two years. Employees were asked to verify eligibility when they signed up for the program during the information session. Participants were not responsible for any costs or received payment (i.e., money, gift certificates, coupons, etc.) or offered incentives (i.e., sweepstakes or class credit).

Measures or Instrumentation

This mixed-methods intervention used several instruments to document the process and outcomes. The quantitative instruments included a demographic questionnaire, the Skillsline use data, and completion information for the intervention activities. The qualitative measures included a focus group at the beginning of the intervention, the researcher's reflective journal in which she documented the evolution of the intervention, and individual interviews after the intervention concluded. This section describes each of these measures and instruments in the order they occurred.

Demographic Questionnaire

Participants were asked to complete an online demographic questionnaire (Appendix E). The questionnaire included company information, their date of hire, and an alternate name to maintain their anonymity on the Skillsline platform. The questionnaire also included questions about past NT skills learning opportunities with their current employer, past employers, school, or other community-based providers.

Focus Group

The purpose of the initial focus group was to establish participants' perception of their soft skills, specifically their understanding of three constructs: workplace behavior, initiative, and communication skills (Appendix F) before the training commenced. The researcher followed a focus group interview protocol (Lochmiller & Lester, 2017) adapted from the behavioral event interview approach (Dillon & Taylor, 2015) to elicit the most robust responses by basing them on actual scenarios the participant may have experienced. The researcher asked questions, such as the following: "Have any of you had an experience where your supervisor asked you to do something, and you didn't know how to do it? How did you respond?" (Appendix F). The

researcher posed similar questions for each of the examined three constructs: communication, critical thinking, and self-management. The focus group was held virtually on the Zoom platform and took approximately 30 min. It was recorded and transcribed for analysis.

Platform-Use Data

The Skillsline platform uses error management (Heimbeck et al., 2003) as part of its methodology. Error management is most effective when explanations are delivered after the questions are presented. For this reason, the intervention was designed so that participants first completed a Skillsline Journey and received the researcher-led instruction afterward. Thus, participants received instructions to access the Skillsline platform during the information session and were told to begin the first Skillsline Journey discussed in the first synchronous session.

Skillsline was developed for educators to teach "the essential human skills [students] will need for lifelong learning and career success" (Skillsline, n.d.). The Skillsline curriculum consists of five modules called Journeys: Look Within, Connect, Think, Advance, and Get Results. Each Journey consisted of four or five lessons on the corresponding topic. In each Journey, participants were asked a question to reflect on a topic followed immediately by a short explanation in text or video form (Appendix H). Each Skillsline module consisted of between 102 and 221 questions (Appendix I) organized in four to five missions per module. At the end of each module, the platform presented a reflection quiz consisting of 10 to 12 questions before moving on to the next module. The platform recorded the responses reported to the researcher for analysis.

Researcher/Instructor Reflective Journal

The researcher, who facilitated the synchronous sessions, kept a journal detailing the execution of each synchronous session, including participants' attendance and interactions

during discussions. The purpose of the researcher's journal was to document the fidelity of implementation of the synchronous sessions and participants' responsiveness and learning.

The researcher's reflective journal also documented participants' completion of the asynchronous experiential activity over the two weeks of each module (Appendix J). These activities were meant to help students practice or reflect on their learning. For example, the first activity was to interview a person who had worked for a longer period at that company and ask what advice they would give their younger self to be more successful at work. This activity required participants to practice their communication skills while learning something about workplace behavior. During each session, the researcher asked participants whether they had completed the work and documented their responses to assess the fidelity of this component of the intervention.

Interviews

Interviews were conducted once the intervention period had concluded. The format was semi-structured, using the behavioral event interview approach (Dillon & Taylor, 2015). The researcher asked the participant to think of how they would react to scenarios they could face or have faced at work about each of the three constructs: appropriate workplace behavior, initiative, and communication. (Appendix G). For example, one question was the following:

> If you face a situation at work where you are not certain how to act, how would you approach the situation? Can you recall a specific example? What tools or skills, if any, did you learn in this program that would be useful in this situation?

Interviews were held virtually over the Zoom platform and took approximately 15 to 20 minutes each. They were recorded and transcribed for analysis.

Procedure

The intervention elements were structured to support the participants' learning while recognizing the demands of MT's job. The treatment components were delivered over a 10-week period, which increased the likelihood of changed behavior (Rischke et al., 2011). The intervention duration balanced the amount of instruction needed to teach the skills effectively and employers' ability to release their MTs from work for participation in the training.

Participant Recruitment

Participants were recruited from local aerospace and defense supply chain employers. An email invitation (Appendix K) was sent to the list of 220 employers used for the needs assessment to reach the MTs. Employers wishing to participate were asked to respond to the email invitation to receive instructions and recruitment materials for the employer to disseminate their MTs. Four employers requested additional information. The researcher sent a digital flyer (Appendix L) detailing the intervention to the employers that requested it. Two employers were not interested in offering the intervention to their employees. Another was interested but for upper management, not MTs. The fourth employer agreed to distribute the information flyer to MTs in various departments. Although the intervention design called for recruitment through multiple employers, only one employer participated. Additionally, none of the MTs who volunteered met the criteria of having worked 2 years or less with that employer. To proceed with the intervention, the researcher chose to include the volunteers because of the interest in the program demonstrated during the information session, filing an IRB amendment accordingly.

A meta-analysis of training methods studies considered the effect size as a major part of its comparison study (Arthur et al., 2003) and found that the average effect size for change in behavior interventions, the construct most relevant to this intervention, was 0.62. The

intervention study required a sample size of 23 participants to achieve this same effect size. However, eight MTs signed up to attend a 45-minute information session where the researcher reviewed the entire intervention schedule and activities. All eight participants chose to continue with the program and were provided informed consent forms (Appendix M) via email to sign and email or text back. One participant withdrew after the first session leaving seven participants who completed the full intervention.

Intervention

The intervention lasted ten weeks. After the information meeting, participants had ten days to complete the first Skillsline Journey. The rest of the intervention consisted of four content sessions, each lasting two weeks. Content sessions included a 90-minute online synchronous session, an asynchronous experiential activity, and a Skillsline Journey that participants were assigned to work on 10 minutes per day. The following sections describe the implementation and data collection for each intervention element.

Data Collection

Data collection began with participant demographic information and establishing whether they had received NT skills training in the past. The remaining data collection methods were directly linked to answering one of the three research questions (Table 4.2). These methods included the analytics from the Skillsline platform generated automatically, the researcher's reflective journal detailing attendance and participation, a focus group before the intervention, and individual interviews post-intervention. The following subsection describes the data collection in detail.

Table 4.2

Summary Matrix

Research question	Construct	Data source	Data collection	Frequency
To what extent was the intervention implemented as designed?	Fidelity of implementation	Skillsline platform analytics	Lessons completed and frequency of engagement	Platform analytics, in real time
		Session attendance	Attendance log	Session attendance and researcher journal entries every two weeks
		Researcher's reflective journal	Researcher's reflective journal	
How has the MTs participation in the intervention developed their NT skills: communication, critical thinking, and self-management?	Communication Critical thinking Self-management	Participants' focus group and interview responses	Focus group and interviews	At the start of and end of the program
		Skillsline analytics	Skillsline lessons	Daily
How do the MTs NT skills affect their understanding of expected workplace behavior?	Appropriate workplace behavior	Participants' focus group and interview responses	Focus group and interviews	At the start of and end of the program
		Skillsline analytics	Skillsline lessons	Daily

Demographic Questionnaire

During the information session, participants completed an online form with demographic information. Four participants reported working in the machine shop, two in quality assurance and one in maintenance (Table 4.3).

Table 4.3

Participant Demographic Information

Position	Gender	Age	Years with company
Quality Assurance Inspector	Female	22	3.5
Quality Assurance Inspector	Male	31	4.0
CNC Machinist	Male	21	3.5
CNC Machinist	Male	26	3.5
CNC Machinist	Male	25	7.5
CNC Machinist	Male	28	2.5
Welder	Male	19	0.5
Manufacturing Engineering Tech.	Male	30	3.5

Focus Group

During the information session, the researcher asked participants to volunteer for a focus group immediately following the information session; seven participants volunteered, and one did not. Participants who volunteered remained in the Zoom room meeting once the information session concluded. The researcher informed participants that the session's audio would be recorded for later analysis. The researcher asked the questions as planned (Appendix F), and participants responded with examples and past experiences as requested.

Daily Skillsline Journey Online Lessons

The Skillsline platform recorded the responses reported to the researcher for analysis. Completion data were provided to the researcher on-demand throughout the intervention period in the instructor section of the Skillsline website. The response data for all participants was provided on the last day of the intervention period.

Researcher's Reflective Journal

There were four 90-minute synchronous sessions conducted virtually and a 45-minute debrief session. The researcher recorded attendance for each session in the reflective journal. Each session started with a brief recap of the previous session, a discussion of the asynchronous

experiential activity, and Skillsline Journey. The researcher presented video educational materials then led a discussion of how participants would relate the examples to their workplace behavior. The synchronous sessions included several discussion prompts related to the weeks' asynchronous work. The first discussion was around the Skillsline module, including any technical difficulties they experienced and their reaction to the topics and questions.

The second discussion was on the experiential activity. Participants completed an asynchronous experiential activity over the two weeks of each module. The researcher provided instructions for a work product (Appendix J) during the first session and discussed it during the following session. Each work product activity was different and aligned with that week's Skillsline Journey topic (Table 4.1). The researcher led a discussion during each corresponding synchronous session, beginning with session two and continuing through the last session, which she documented in the reflective journal and noted whether each participant had completed the activity. Participants shared their experiences completing the assignment and what they learned from the activity during the discussion.

The final discussion was about the module's overall theme, ensuring participants connected the Skillsline concepts to the experiential activity and the facilitator's presentation. The researcher noted each participants' feedback regarding each session, participant engagement during the session activities, and whether the timing of activities worked as planned. The researcher's journal was used to measure fidelity of implementation and evidence of participants' learning during the intervention.

Interviews

Participants were solicited for voluntary post-intervention interviews (Appendix G). Interviews were scheduled during the week following the final session and conducted via Zoom.

Interview audio was recorded for later analysis using the record function in Zoom. The researcher followed the interview script (Appendix G) and asked follow-up questions. The interviews lasted between 15 and 20 minutes.

Data Analysis

Quantitative data were analyzed first. Advantages to quantitative research design are that it is relatively easy to collect the data, statistical software aids in the analysis, and large amounts of data can be analyzed relatively efficiently (R. B. Johnson & Onwuegbuzie, 2004). Quantitative data from session attendance, experiential learning assignment completion, Skillsline completion, and schedule adherence were analyzed separately for each participant to assess their level of participation and dosage.

The researcher began by compiling information on participants' experiences with NT skills training from the demographic survey participants completed during the information session. The researcher then sorted the Skillsline user data provided by the platform to assess how many Journeys each participant completed, how many questions they responded to in each Journey, and how many questions they answered correctly before receiving the corresponding lesson. The researcher also documented how many questions were answered each day of the intervention to assess implementation fidelity.

Qualitative methods present a valuable approach in analyzing a complex topic such as NT skills and allow a deeper look at how the participants are changing and growing. A qualitative design can capture more detail, factoring in the intervention's context and responding to changes and unexpected circumstances as the intervention unfolds (R. B. Johnson & Onwuegbuzie, 2004). Focus group and interview recordings were transcribed for coding.

The researcher did a thematic analysis of the qualitative data in the order collected. Starting with the focus group questions and examples the participants provided, then the notes from the synchronous session discussions, and finally the interviews. The researcher used a spreadsheet to track comments related to three a priori themes, the NT skills being taught: communication, critical thinking, and self-management. After organizing the data by the participant and identifying relevant comments, the researcher reviewed again to identify subthemes (Table 4.4).

Table 4.4

Qualitative Data Themes and Subthemes

Communication	Critical thinking	Self-management
Asking questions	Learn from mistakes	Dedication
Different points of view	Asking questions	Portraying an image
Humility	Making corrections	Humility
Owning up to mistakes	Motivation	Perception of leadership
Speaking up	Finding a better way	Moderating reactions

In analyzing the individual comments and examples, new patterns emerged indicating that although participants understood the basic tenets of NT skills, as illustrated by their high scores on the Skillsline lessons (Table 4.1), they were judicious when they used these skills. This section describes in detail each of the data sources and individual analyses.

Focus Group

The initial focus group recording was transcribed using the platform Otter.ai, and then the researcher reviewed the transcription for accuracy. The transcription was coded for keywords and the a priori themes (Table 4.4) that would indicate participants' understandings of soft skills and suggest their approach to workplace behaviors before participating in the intervention. The coding was organized and analyzed by a participant and analyzed in the aggregate for the group.

Skillsline

Participants had different experiences accomplishing the daily online lessons. For example, the participants who worked in the machine shop were allotted 10 minutes to complete their lessons immediately after their lunch break. As a result, those participants had a higher rate of adherence to the schedule than participants who worked on their own (Table 4.5).

Both Cole and Jamie had private workstations with their computers, yet according to the data provided from the Skillsline platform, they both had trouble keeping up with the daily lessons (Skillsline, 2022). Cole's interview took 52 minutes to detail the limitations faced when participating in the program despite his desire to be more fully engaged than before (personal communication, February 9, 2022). He stated that he initially intended to work after lunch like the other participants, but because he was the only one in the company holding his job, he found that he could not keep to that time due to work-related interruptions. He instead found that first thing in the morning was the best time for him. Jamie also had trouble making time daily (Jamie, debrief session, February 8, 2022). Instead, she worked fewer days but for longer periods. However, she completed more lessons than the other participants (Table 4.5); she only worked on lessons for 14 days of the 10-week intervention (Skillsline, 2022). However, she recognized that she could scarcely remember the lessons, especially those from the beginning of the program (Jamie, debrief session, February 8, 2022). During the debrief session (February 8, 2022) and interviews, Christian (February 9, 2022), Luke (February 10, 2022), Spike (February 10, 2022), and Sol (February 10, 2022) demonstrated that they recalled the lessons from the beginning and could refer to specific lessons that were most impactful for them. Table 4.5 shows the number of lessons completed by each participant.

Table 4.5

Percent of Lessons Completed by Participant

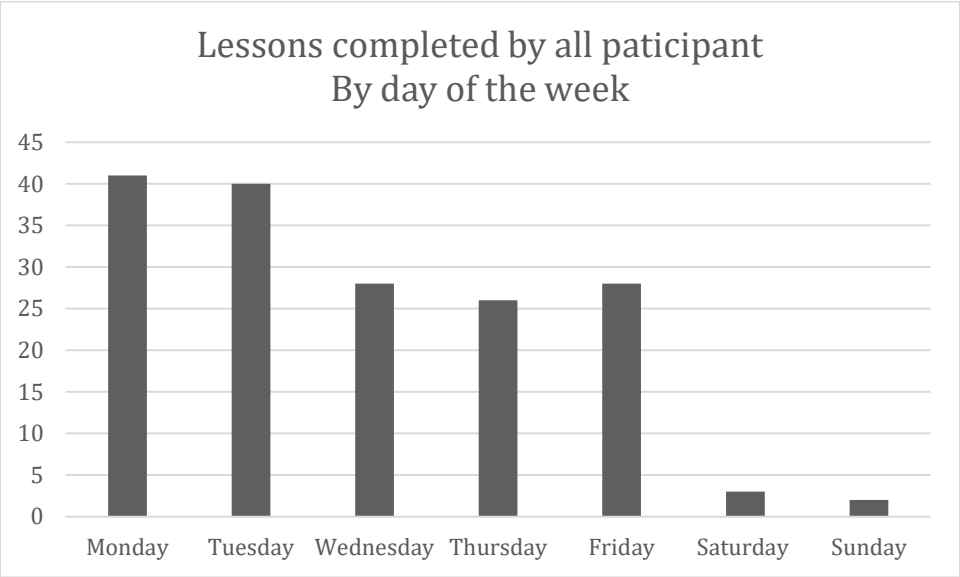
Journey	Cole	Jamie	Spike	Dan	Christian	Luke	Sol
Look within	0%	99%	48%	61%	27%	91%	79%
Connect	40%	93%	93%	93%	93%	86%	59%
Think	0%	85%	85%	39%	85%	30%	79%
Advance	31%	81%	31%	49%	19%	0%	86%
Get results	0%	89%	89%	56%	89%	0%	90%
Total	15%	91%	70%	63%	62%	52%	77%
Days of Skillsline engagement	8%	29%	56%	85%	56%	46%	60%
Synchronous session attendance	67%	100%	83%	100%	100%	67%	100%
Experiential activity completion	75%	75%	0%	100%	100%	75%	100%

Lessons Completed and Frequency of Engagement

The Skillsline platform provided real-time data of participants' progress in responding to the questions in each Journey. Engagement and adherence were measured as the percentage of days the participant completed at least one lesson (Table 4.5). Examining the participants engagement with the online platform reveals a weekly pattern. Considering that the synchronous sessions were held on Tuesday, the heavier Skillsline participation on Monday and Tuesday could motivate the upcoming instructor interaction (Figure 4.3).

Figure 4.3

Lessons Completed by All Participants



The Skillsline platform reports provided participants' responses to each question, whether the answer was correct, and the date and time when it was answered. Participants' accuracies in responding averaged between 74% and 80%. Cole was an outlier, with an accuracy of 91%; however, he only responded to 15% of the questions in two Journeys.

Each Skillsline Journey included two checkpoints, at the midpoint and the end. The checkpoints were designed to revisit the topics of the lessons so that participants could assess their learning. The intervention design calculated the difference between participants' lesson scores and checkpoint scores to measure their learning. However, only one participant completed all the checkpoints, and the rest completed a few, which made running a quantitative analysis impossible.

The researcher compared the number of questions that each participant responded to in each Journey and the participants' accuracies to the qualitative data from the research journal for each session. This process allowed for triangulation to verify the findings from each session and

provide more robust evidence toward the results (R. B. Johnson & Onwuegbuzie, 2004). In addition, the richness of both data sets increased the breadth of understanding of the study outcomes (R. B. Johnson & Onwuegbuzie, 2004).

Researcher's Reflective Journal

The researcher reviewed the journal by session, first coding for keywords and themes related to that session's topic, then overall perceptions about soft skills. The researcher considered statements that indicated a change in thought or behavior. Participants' contributions were noted, and then the group's discussions were analyzed. This process was repeated for the information session, the four content sessions, and the debrief session.

The researcher took attendance during the synchronous sessions as a measure of fidelity of implementation (Table 4.5). Although Cole could not attend the first session due to a work conflict, all seven participants attended the second session. Cole again missed Session 3, which was the least attended, with only four participants present. With this intervention taking place during the COVID-19 pandemic, two participants were absent due to contracting the illness. One of those two had not yet returned to work for the final session, which had six participants. Participants paid attention and were responsive during discussions. They offered candid examples of situations, making for in-depth discussions around each topic. Two weeks after the fourth session, the researcher led a final 45-minute debrief session to discuss the last assignment and Skillsline module. The researcher gathered feedback on the entire program. The researcher also noted who engaged in the discussions around the experiential activities in the research journal. As part of the discussion, the researcher noted which participant had completed the activity (Table 4.5).

Interviews

Five participants gave a concluding interview. The researcher transcribed each of the five interview audio recordings using the platform, Otter.ai, and reviewed the transcriptions for accuracy. After participating in the intervention, the transcriptions were coded for keywords and themes that would indicate a change in participants' understanding of soft skills and their behaviors in the workplace. References to learning that occurred during the program and particularly helpful topics or tools were noted. The last interview question asked about the participants' perceptions of the intervention's components. The responses to this question were coded separately and used in the formative analysis of the intervention.

Limitations of the Research Design

The convergent parallel mixed-methods design has many advantages over either a solely qualitative or solely quantitative method. Especially in this case, when the NT skills constructs being studied were unclear and difficult to measure, the corroboration and convergence of the mixed-methods design were used to assess multiple types of data and strengthen the evidence of the study findings (Leviton & Lipsey, 2007). However, with a topic so difficult to measure and already been identified as interconnected and nuanced (Benbow & Hora, 2018), identifying the alternative explanations beforehand was challenging (Shadish et al., 2002).

Many factors are at play in assessing the learning of NT skills, making causal inference more difficult (Leviton & Lipsey, 2007). The disadvantage to this design is being unable to make causal inferences. In addition, the convergent mixed-methods design has unique threats to validity (Creswell & Plano Clark, 2018) that were addressed by the program design to increase the reliability of the findings. First, the qualitative and quantitative tools had parallel questions assessing the same concept. Second, data were analyzed using a convergent data analysis

integration strategy. Finally, the researcher engaged in the further analysis if the data showed disconfirming results (see Creswell & Plano Clark, 2018).

Chapter 5

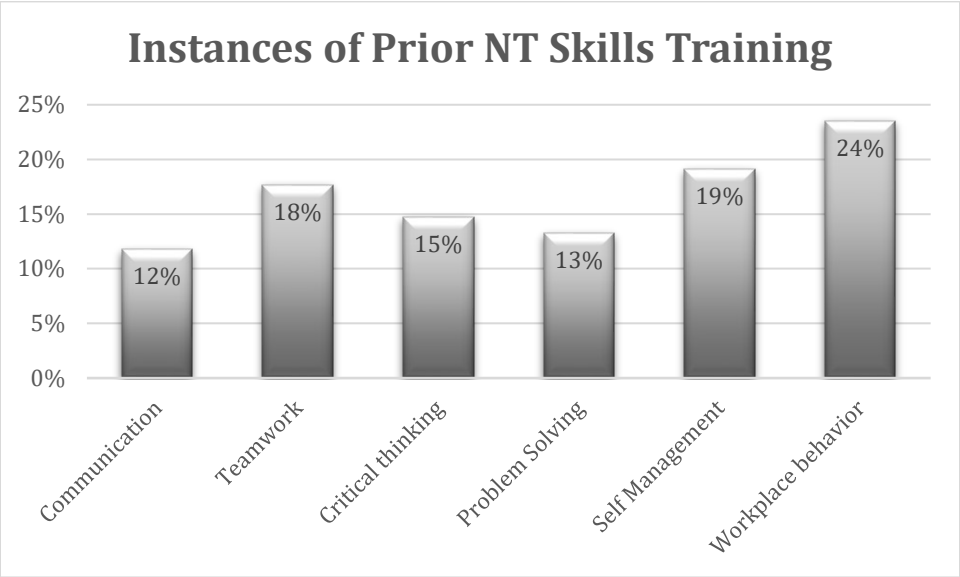
Findings and Discussion

The intervention described in Chapter 4 used an online platform, synchronous sessions, and experiential activities to teach communication, critical thinking, and self-management (Table 5.1). The daily online lessons provided spaced learning; the synchronous sessions provided instructor support and interaction. The experiential activities contextualized the learning. The findings described in this chapter may show that this combination of teaching methodologies can effectively teach NT skills. The chapter also highlights newly discovered factors that impact MTs' workplace behaviors.

The participants came to the intervention with similar backgrounds, ages, and experience levels. During the information session, the demographic survey participants filled out to establish how much prior NT skills training they had received. They were asked which skills they had been exposed to in the past (Information Session, December 9, 2021). The most common topic reported was appropriate workplace behavior, self-management, and teamwork (Figure 5.1).

Figure 5.1

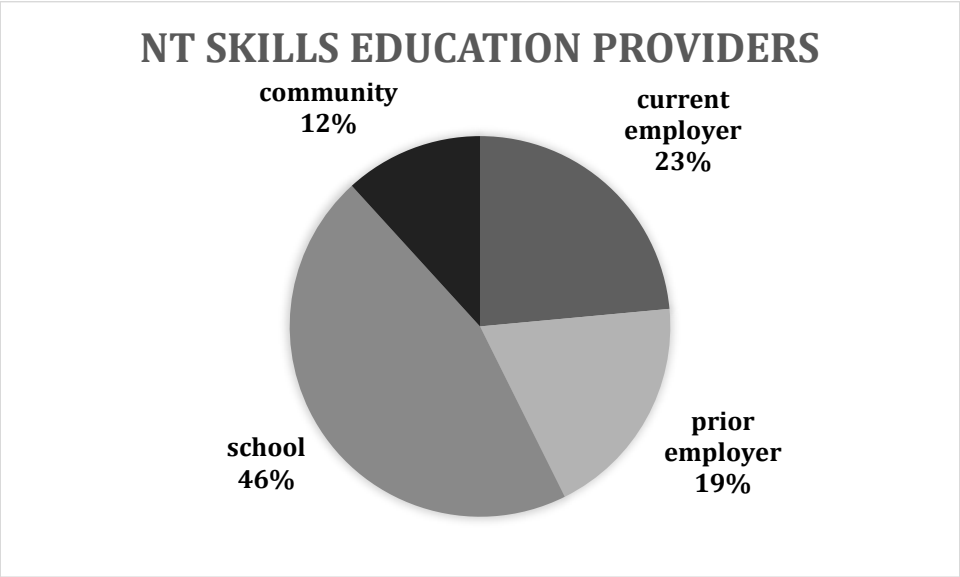
Prior Nontechnical Skills Training



Participants were also asked where they had received prior training. One participant stated that he had only received NT skills training in workplace behavior, which he credited to the current employer. The rest of the participants had received training on multiple skills at schools, their current or past employers, or in community-related activities (Demographic Survey, December 3, 2021; Figure 5.2).

Figure 5.2

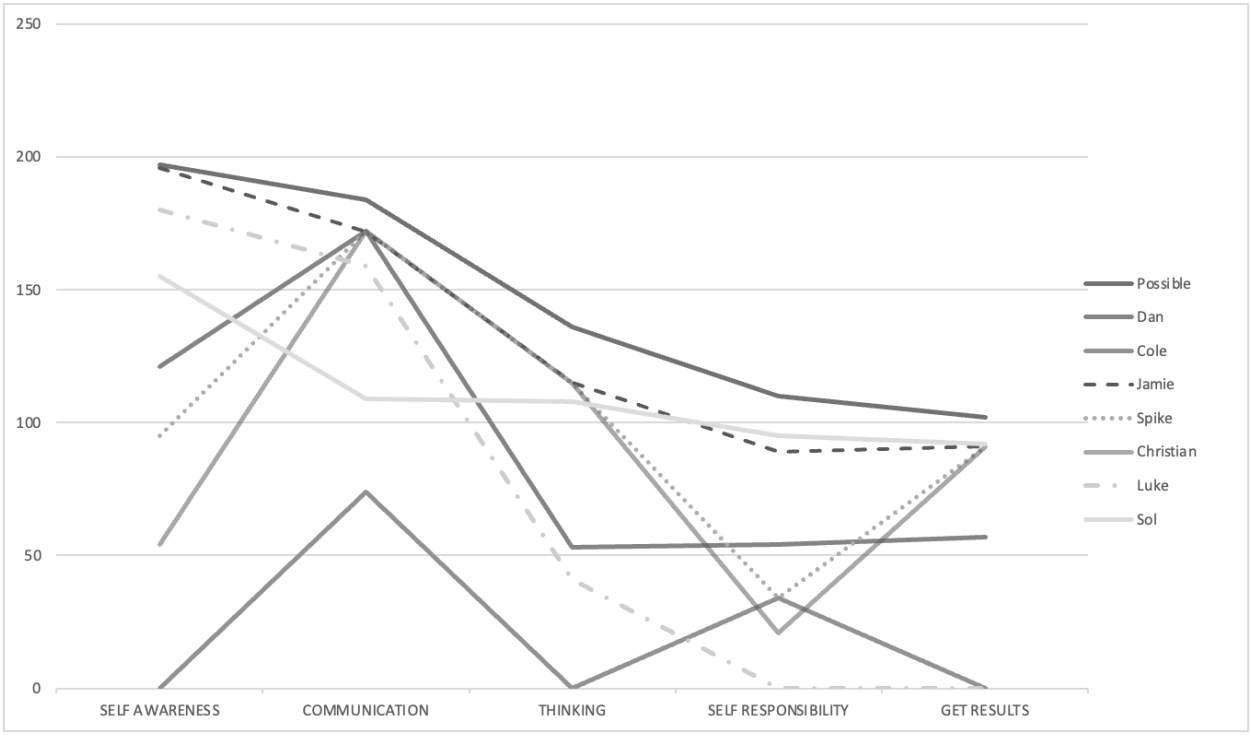
Nontechnical Skills Education Providers



The most significant content for the intervention was delivered through the Skillsline platform, which consisted of five Journeys, each with a different topic (Table 5.1). The first Journey was assigned at the information session, and a new one every 2 weeks. Each Journey consisted of a different number of questions, so the researcher graphed the number of questions possible and the total questions each participant answered (Figure 5.3). The three participants who had been ill during the intervention, Luke, Christian, and Spike, had drops in activity in that same timeframe. Jamie and Sol were consistent in their participation.

Figure 5.3

Number of Questions Possible and Total Questions Answered



The researcher also considered the number of questions that participants answered correctly before being exposed to the corresponding content (Figure 5.3). Participants answered more than half of the questions they attempted correctly, even though they came before the lesson. Despite this finding, participants believed they had learned new concepts, ways of approaching the NT skills covered, and better vocabularies for discussing NT skills in their daily lives (Debrief session, February 8, 2022; Interviews, February 9–10, 2022).

In merging the data from Skillsline with the qualitative data from the research journal, the researcher assessed whether participants had learned the different topics and how they had retained and applied the skills. The following sections provide a detailed discussion of each 2-week session. Each session summary includes the topics covered, a table describing each

participant's engagement in various activities, and reflections and quotes from the synchronous session recorded in the researcher's journal.

Session 1, December 14, 2021 – Introduction to Workforce Readiness

The workforce readiness session focused on identifying what makes someone successful and applying that to the participants' work context. The topics covered in the Look Within Journey included having a growth mindset, accountability, emotional intelligence, and various topics around understanding oneself, including managing stress, resilience, and motivation. All the participants attempted the Skillsline lessons; however, Sol, Dan, and Cole completed some lessons from the first Journey and some from following the session's Journey.

During Session 2, they indicated that it was unclear that they should only do the assigned Journey. All participants reported feeling confident using the platform during the discussion and found it easy to navigate. Luke reported that he found some questions overly simplistic. For example, he described a question about how to ask for more feedback, and he felt the answer should be to ask for it, but that was incorrect. Jamie agreed with Luke, stating that some questions were misleading, although she did not remember specific examples. However, Spike, Sol, Christian, and Dan believed that the questions were straightforward and easy to answer. Dan stated that the questions were "pretty precise." Because not all the participants had done the correct Journey, the researcher postponed further discussion until after her presentation.

Table 5.1

Session 1 Participant Completion

	Skillsline			
	Questions answered	Completion	Accuracy	Attended session
Dan	121	61%	69%	Yes
Sol	155	79%	74%	Yes
Luke	180	91%	75%	Yes
Christian	54	27%	83%	Yes
Spike	95	48%	82%	Yes
Jamie	196	99%	72%	Yes
Cole	0	0%	0%	No

The main content of the session revolved around a video interview of the basketball player Kobe Bryant describing his attitudes and actions that led to his success (Motiversity, 2019). The researcher paused the video at various points to prompt discussion on strategies for improving performance and increasing motivation. Participants discussed actions they can take to become great in their practice. Dan spoke of the skill and practice required to become an expert welder, but "when you get there, it doesn't matter whether you are on a $10,000 machine or a $1,000 machine from Harbor Freight, it's all about technique" (Session 1, December 14, 2021). Spike (Session 1, December 14, 2021) discussed struggling with people in the machine shop who had been there a long time and did not acknowledge their mistakes, blaming an external factor, such as a fault with the equipment or materials. According to Spike, supervisors rarely held such people accountable. Sol (Session 1, December 14, 2021) noted that recognizing a mistake was the first step to learning how to correct it, and at the end of the day, it did not matter who was at fault; the goal was to get the job done.

At the end of the session, the researcher reminded participants of the date of the next session, the next Skillsline Journey, and the activity they should complete in the following 2

weeks. Once the discussion concluded, the researcher introduced them to the next Skillsline Journey. The researcher also reminded participants of the date of the next session and provided instructions on the activity they should complete in the following 2 weeks.

Session 2, December 28, 2021 – Communication Skills

The communication skills session focused on improving communications skills in the varied circumstances of the work context. The topics included in the Skillsline Journey Connect consisted of listening skills, different approaches to communication, effective messaging, teamwork, welcoming diversity. During the Skillsline discussion, Luke, Christian, and Dan expressed that the concept of different people having different communication preferences was new to them. Luke mentioned that he appreciated learning to get his point across without hurting other people's feelings. He realized he could alter his approach between being direct and to the point and using compassion and empathy depending on his message and audience. Although Skillsline offered eight different communication approaches, the participants only mentioned logic and compassion in the discussion.

Table 5.2

Session 2 Participant Completion

	Skillsline				
	Questions answered	Completion	Accuracy	Attended session	Completed activity
Dan	172	93%	74%	Yes	Yes
Sol	109	59%	75%	Yes	Yes
Luke	159	86%	81%	Yes	Yes
Christian	172	93%	75%	Yes	Yes
Spike	172	93%	81%	Yes	No
Jamie	172	93%	77%	Yes	Yes
Cole	74	40%	91%	No	Yes

Participants were assigned an activity to identify someone in the company who had worked there for at least 5 years and ask them, “If you were to meet yourself on your first day of work at this company, what advice would you give your earlier self?” They had to think of at least four follow-up questions that the participant would like to know about the company or supervisor's expectations. Christian, Jamie, Dan, Luke, and Cole reported back on their experiences conducting the interview. They all believed it had been a worthwhile learning exercise. In his interview, Dan asked about the most difficult soft skill learned while working for that company and gained the answer of communication. Luke asked the person he interviewed whether he saw himself as a logical or compassionate communicator. His interviewee responded that the approach depended on the situation and that it was necessary to know how to be both. Jamie (Research Journal, December 28, 2021) asked her interviewee, “What communication skills do your supervisors or managers lack or have that you feel make a difference in your work environment?” The response was emotion in communicating. The interviewee offered an example of a manager who made others feel comfortable by showing interest in the conversation. In contrast, another manager dissuaded others from engaging because of his stiff demeanor (Research Journal, December 28, 2021).

The researcher presented a clip from a presentation by author Malcolm Gladwell telling the story of two flights: one where the pilot demonstrated excellent communication skills and succeeded in resolving a difficult situation, and one where the pilot and copilot did not communicate effectively and crashed the plane (The Film Archives, 2013). Participants discussed the two scenarios and the roles of timing and urgency in communication. Dan shared that bad communication could happen when someone is afraid of getting into trouble. Christian said the urgency of the situation called for a more direct approach. He added that sometimes,

"the boss isn't being a boss, so you have to step up and show initiative" (Christian, Research Journal, December 28, 2021). Cole (Research Journal, December 28, 2021) warned that if the person was perceived as overconfident, the situation could escalate, creating new conflict. Christian added that speaking up could be perceived differently depending on the boss. He believed that if a person said something, they should convey consistency and not change their minds. Jamie (Research Journal, December 28, 2021) noted that her boss allowed her to challenge him and remained open to different perspectives. Once the discussion concluded, the researcher introduced the participants to the next Skillsline Journey, reminded them of the date of the next session, and provided instructions on the activity they should complete in the following 2 weeks.

Session 3, January 11, 2022 – Teamwork and Workplace Expectations

The teamwork and workplace expectations session focused on helping participants understand how critical thinking and teamwork skills together help problem solve in the workplace. The topics covered in the Skillsline Think Journey included critical thinking, creative thinking, systems thinking, and thinking strategies. The participants believed that a valuable take-away from the Journey was understanding that different thinking styles could exist (Research Journal, January 11, 2022). Christian (Research Journal, January 11, 2022) demonstrated that he was already putting together the Connect Journey and the Think Journey and thinking of how to apply both in the workplace. He said he could use the different thinking styles to understand the best way to communicate with coworkers. Sol (Research Journal, January 11, 2022) found it interesting how different ways of thinking were categorized and added that he did not know different thinking styles could exist.

Table 5.3

Session 3 Participant Completion

	Skillsline				
	Questions answered	Completion	Accuracy	Attended session	Completed activity
Dan	53	39%	72%	Yes	Yes
Sol	108	79%	76%	Yes	Yes
Luke	41	30%	83%	No	No
Christian	115	85%	71%	Yes	Yes
Spike	115	85%	73%	No	No
Jamie	115	85%	63%	Yes	Yes
Cole	0	0%	0%	No	No

Participants were assigned the activity to find an opportunity to collaborate with at least one other person on a task or project and identify the role they were most comfortable taking in the group setting. The four participants present at the session completed the activity. Christian (Research Journal, January 11, 2022) provided an example where he was assigned to a new area of the company and took a contributor role. Once he felt comfortable with his new responsibilities, he found a process improvement that would save time and improve quality; thus, he took on a leadership role while implementing the solution. Jamie had a similar example, where she found a process improvement and implemented it. She started the labor-intensive work required to implement the solution herself, but she said other coworkers "jumped in" to help. However, Jamie (Research Journal, January 11, 2022) labeled her role as leader/contributor rather than seeing herself as the leader, minimizing the significance of initiating the change.

The researcher moved on to further elaborate on systems thinking and critical thinking. She presented a video of MIT professor Peter Senge (Wile, 2014) describing systems thinking regarding family relationships and led the participants to discuss the importance of taking responsibility for the role employees play in the larger company system. Christian (Research

Journal, January 11, 2022) gave an example of one person making an error on a part and the negative repercussions on other departments that use that part in assembly. Sol (Research Journal, January 11, 2022) chose to share an example from a previous job. He explained that a loose screw or poorly connected hose could have catastrophic results when he worked in aviation. The group then discussed strategies to help avoid mistakes, such as keeping checklists and creating redundancies. Once the discussion concluded, the researcher introduced them to the next Skillsline Journey, reminded participants of the date of the next session, and provided instructions on the activity that they should complete in the following 2 weeks.

Session 4, January 25, 2022 – Creative Problem Solving

The creative problem-solving session brought the learning from all the previous sessions together to apply them in solving problems in the workplace. The topics covered in the Advance Journey included being proactive, managing information, problem solving, and solution implementation. Only two participants, Sol and Jamie, completed a substantial number of lessons (Table 5.4), so the Skillsline discussion was short. However, Christian and Dan (Research Journal, January 25, 2022) reflected on a lesson about getting off autopilot (i.e., being intentional about their actions) that they believed was noteworthy.

Table 5.4

Session 4 Participant Completion

	Skillsline				
	Questions answered	Completion	Accuracy	Attended session	Completed activity
Dan	54	49%	83%	Yes	Yes
Sol	95	86%	83%	Yes	Yes
Luke	0	0%	0%	No	Yes
Christian	21	19%	90%	Yes	Yes
Spike	34	31%	79%	Yes	No
Jamie	89	81%	78%	Yes	No
Cole	34	31%	91%	Yes	Yes

Participants were assigned the activity to identify a complex problem at work and describe it in as much detail as possible by thinking of its components, people involved, and possible solutions. The initial discussion focused on the problem of a manager, whom all the participants agreed did not have the necessary knowledge to do his job or management skills to lead his team. Christian (Research Journal, January 25, 2022) expressed frustration in trying to communicate with someone who "doesn't know why things happen." Cole (Research Journal, January 25, 2022) added that he had witnessed the manager interacting with customers and providing incorrect information. They both brainstormed the best way to approach the problem and decided that bringing documented examples of lost time or money because of this manager's actions to the company president (Cole & Christian, Research Journal, January 25, 2022).

The researcher led a discussion on strategies to identify the root cause to solve it effectively. She shared a video of Clay Christiansen (Capaldi, 2016), sharing how he and a group of students could help a company increase its sales by going beyond the assumptions of what the problem was and finding the actual cause. The participants discussed examples they faced where they have had to investigate and possibly change their original assessment of the cause. Spike

(Research Journal, January 25, 2022) shared that if he sees someone using an incorrect tool for the job, he assumes that person does not know what they are doing. However, in one case, after looking further, he found that there was only one tool available, and another employee was using it. This person was improvising to keep from wasting time. Spike concluded that the solution was to order a second tool.

The researcher also explained divergent and convergent thinking, introduced in Skillsline Think Journey, and presented various strategies to help broaden the possible solutions. Participants shared some of their strategies. Christian (Research Journal, January 25, 2022) said he liked to think of options while he planned so that he would have an alternative ready if needed. Dan (Research Journal, January 25, 2022) said he liked to write down all his ideas because his mind was so fast that he would forget. Cole (Research Journal, January 25, 2022) liked to organize ideas into topics and subtopics. Once the discussion concluded, the researcher introduced them to the next Skillsline Journey, reminded participants of the date of the next session, and provided instructions on the activity they should complete in the following two weeks.

Debrief Session, February 8, 2022

The debrief session included a discussion of the final Skillsline Journey, Get Results, and the asynchronous activity that participants were asked to complete before the session. The topics covered in the Get Results Journey included effort and responsibility, self-management, conscientiousness at work, and initiative.

Table 5.5

Debrief Session Participant Completion

	Skillsline				
	Questions answered	Completion	Accuracy	Attended session	Completed activity
Dan	57	56%	74%	Yes	Yes
Sol	92	90%	88%	Yes	Yes
Luke	0	0%	0%	Yes	Yes
Christian	91	89%	88%	Yes	Yes
Spike	91	89%	86%	Yes	No
Jamie	91	89%	80%	Yes	Yes
Cole	0	0%	0%	Yes	Yes

Participants were assigned to draft an email to the company's CEO explaining the problem they identified during the prior session and offering recommendations on how to solve it. Participants were not expected to send the email to the CEO. However, when they asked what to do with the email, they decided sending it to the researcher would be a good way to conclude the exercise. Cole, Jamie, Sol, and Dan completed the assignment and emailed it to the researcher, describing various issues they felt needed to be addressed.

Both Jamie and Sol's emails were plainly written and not formatted as formal communication. The problem Jamie (Personal communication, February 7, 2022) detailed was the communication and leadership challenges the entire group had discussed during the synchronous sessions, and most of the email was dedicated to explaining why leadership needs to do more to address this problem. Jamie suggested a solution of implementing NT skills training for supervisors. Sol's (Personal communication, February 7, 2022) email identified the problem of the machine shop's compressed labor force due to illness-related absences and very succinctly suggested a revised temporary schedule to help alleviate the pressure.

Dan's (Personal communication, February 7, 2022) email was thorough and well written, especially considering he was the youngest and least experienced participant. He explained a problem with blueprints not being printed according to industry standards which caused those reading the blueprints to take extra time to interpret them. He suggested a meeting with the involved parties to review the correct practices and discuss a way to collaboratively develop a solution that will help save time and improve communication. His email demonstrated a strategic approach that identified the problem without personalizing it and laid out a clear and feasible solution.

Cole (Research Journal, February 8, 2022) decided that he would go beyond the exercise and implement his idea. Cole described how the company often received equipment that needed to be installed, but the maintenance team was not advised ahead of time. When the equipment arrived, time was lost tracking down the purpose, planning its installation, and acquiring any parts needed to get the equipment functioning. Thus, Cole created a simple sign-off process to ensure that the maintenance team knew when the equipment was ordered rather than when it arrived to start planning the installation concurrently. Cole noted that this simple change could save the company time and money, demonstrating that the investment in the intervention had already worked. Cole explained that he had not previously felt ownership of problems that he was indirectly asked to solve. However, during the intervention, he realized how the company and his leadership listened when he spoke up; thus, he encouraged all employees to show initiative.

Themes

Participants provided many examples during the session discussions of instances where they needed to use these skills in the workplace with both positive and negative results.

However, they also referenced situational factors that either enabled them or inhibited them from demonstrating the appropriate behavior at a given time. The following sections detail each of the NT skills examined in this intervention: communication, critical thinking, and self-management.

Communication

As described in Chapter 3, communication includes building effective relationships, teamwork, interpersonal, and social (Benbow & Hora, 2018; Burning Glass, 2015; Deloitte, 2017; Gates et al., 2016). During the focus group (December 3, 2021), participants reported that when facing a work situation in which they did not know what to do, they simply asked other coworkers or supervisors for help. They also shared that if the problems were beyond their ability to resolve, they would seek a more experienced person to take over. For example, Cole (Focus Group, December 3, 2021) talked about being asked to do electrical work that could seriously damage the machine if not done correctly, so he asked his supervisor to hire an electrician.

However, participants often had trouble communicating to their supervisors' importance or level of need. For example, Luke (Focus Group, December 3, 2021) said that "sometimes, you'll have a problem. And you don't even have the right vocabulary to use to try and explain what the problem is." He further explained that what he learned in school did not provide the correct vocabulary to communicate with supervisors or external providers in problem-solving situations. However, he said he now understood how to explain the troubleshooting he had already done and provide the reasons why he was at a point where outside help was needed.

Throughout the sessions, participants expressed that communication was the lesson they learned from the most and the skill they would benefit from the most. They were intrigued by the concept of not everyone thinking in the same way and not having the same communication style.

During his interview, Christian gave an example of a coworker with whom he had difficulty communicating with in the past "because he doesn't understand a lot of things." He said he learned from this intervention to try different approaches:

> When [the coworker] says he doesn't understand, I tell him, let me show you. I'll show him so he can see what I'm doing…he was like, okay, yeah. So, it did work. So now I usually approach him that way first. (Personal communication, February 9, 2022)

The participants also commented on past experiences, that with their new understandings of communication styles, they would interpret differently. During his interview, Sol said that "communication is what helps deescalate hostility." He explained that a comment that in the past he might have interpreted as blame, he now would see is just investigating what happened. He added, "you tend to find out how they react…and everybody acts differently. So, I guess the training helps understand what type of person you're talking to" (Personal communication, February 10, 2022).

Participants mentioned the concept of logical versus compassionate styles as important when speaking to other technicians or management. Skillsline defines the logical approach as one of accountability and clear positive or negative actions, while the compassionate approach considers that mistakes happen and act as lessons. Jamie commented during the debrief session that she had learned she can be more effective if she uses a compassionate approach with some coworkers (February 8, 2022). The participants noted the impact that communication style from their manager or supervisor has on the participants' work, comparing a direct approach from one supervisor whose approach they perceive as too logical and uncaring to a very open and welcoming supervisor, and they perceive as compassionate. The compassionate manager's team believes her to be an excellent leader (Jamie, Session 2, December 28, 2021). Christian (Session

2, December 28, 2021) described how he is more compassionate outside of work and more logical at work, thinking about how his decisions impact the company but not considering the people's feelings. He stated that he had learned that it was not the best approach, and he needed to be compassionate with his coworkers. The participants also discussed the difference between having the confidence to raise an issue and appearing cocky. Participants' considerations of how their actions are perceived lead to the critical thinking topic are discussed next.

Critical Thinking

Critical thinking includes problem-solving, creativity, analysis, and higher-order thinking (Benbow & Hora, 2018; Burning Glass, 2015; Deloitte, 2017; Gates et al., 2016). Based on the researcher's notes regarding critical thinking, the participants seemed less engaged and enthusiastic than they were about communication. During the focus group, participants shared situations when they ran into difficulties and immediately requested help from coworkers and supervisors. For example, Dan (Focus Group, December 3, 2021) described being asked to make a picklist and not knowing how to proceed. He asked a manager who walked him through the new process that has now become routine. The participants also recounted instances when asking for help but not receiving it or waiting for it because the people they ask do not have time. Sol (Focus Group, December 3, 2021) shared that while working with a past employer, he would spend much time getting his supervisor and inspectors to provide the guidance he needed to complete a job.

However, Sol was sent from person to person, trying to get someone to take the time to help, and then was reprimanded because it took too long to complete the task. All seven participants agreed, either through positive or negative experiences, that supervisors' attitude toward learning and supporting their teams is essential in ensuring the MTs can do their job.

During the interviews and debrief session, the participants demonstrated they had the vocabulary and skills to identify the cause of a problem and then find the best way to communicate the issue to the appropriate person. Luke (Personal communication, February 10, 2022) said he could construct more professional-sounding arguments, and Dan (Debrief session, February 8, 2022) said the defining problems aspect of the training was useful. He now believed that he could find a problem and develop a solution. At the end of the intervention in the debrief and interviews, participants had learned the vocabulary and skills to find the root cause of a problem and solution.

One area of critical thinking the participants were most interested in was how to respond when they had made mistakes. They understood the dynamic of balancing accepting fault with the possible repercussions. For example, Jamie (Debrief Session, February 8, 2022) discussed her role in the documentation process needed to ship their products. She compared any mistakes to a butterfly effect. If the customer catches the error, it will impact the company's performance rating; if they lose a customer, it can impact its bottom line and all the employees' bonuses for the year. So catching mistakes and fixing them is of high priority in her job.

Similarly, Sol (Personal communication, February 10, 2022) described checking the parts made to ensure they all meet the specifications. However, if there was a variance, he could not get hung up on whether it was his mistake or the equipment. He must stop right away and work to correct the issue. Some participants believed the company was open to MTs taking ownership of their mistakes without penalty. For example, Sol (Personal communication, February 10, 2022) reported feeling comfortable addressing such issues (Debrief session, February 8, 2022). Cole (Personal communication, February 9, 2022) had “never seen anybody here get in trouble.”

Self-Management

Self-management includes self-control, attitude, work ethic, and motivation (Benbow & Hora, 2018; Burning Glass, 2015; Deloitte, 2017; Gates et al., 2016). These skills were woven into the entirety of the intervention program as participants learned self-management in their interactions with others and problem solving. Participants reported one key learning as understanding the perspective of the other person. For example, early in the program, Christian (Session 2, December 28, 2021) said he did not like to change his mind for fear of being perceived as inconsistent. By the end of the program, Christian (Personal communication, February 9, 2022) reported that he had learned how to explain himself better and felt more confident in his communication ability.

The participants also felt that learning that people have different thinking and communication styles was crucial in understanding how to approach an interaction. Spike (Personal communication, December 10, 2022) explained that he had learned "to look at other people's perspectives" and not take things personally. He also said that he kept issues that came up to himself in the past but had learned that he needed to be more transparent with this supervisor. Participants will now pause before initiating a conversation to ensure they used the right approach to that interaction. For example, Sol (Personal communication, February 10, 2022) learned that everyone acted differently; thus, he had to assess what type of person you are talking to find the best approach.

Cole (Personal communication, February 9, 2022) demonstrated through his comments throughout the intervention that he felt little control over his daily work. He explained that right after lunch, when the operations team was working on their Skillsline lessons, he would inevitably be pulled to resolve some unexpected issue. He expressed frustration that he was

forced to miss synchronous sessions because of unscheduled and unexpected deliveries. However, toward the end of the intervention, he realized that he could implement a process that would limit these unexpected occurrences and gain some control over his schedule. Between being assigned the activity for session three, identifying a problem, and the one for session four, drafting an email of the problem and solution for the CEO, Cole moved forward to implement his solution showing his initiative skills. Although Cole's communication and critical thinking skills were well honed before the intervention, improving his self-management skills significantly impacted his workplace performance.

Conclusions

NT skills training conducted using the appropriate methods can be effective and lead to appropriate workplace behavior. However, NT skills are contextual, so the opportunity to apply as students learn is critical. The methodology described in Chapter 4, including a combination of approaches that offered both structure and flexibility, successfully taught the NT skills of communication, critical thinking, and self-management. This intervention sought to answer three research questions. First, to what extent was the intervention implemented as designed? Except for not having recruited the desired number of participants to meet the effect size of 23 as detailed in the previous chapter, and the tenure of participants with their employer, all the other intervention elements were implemented as planned. Second, how has the MTs' participation in the intervention developed their NT skills of communication, critical thinking, and self-management? The previous section provided evidence that the participants did improve their understanding of each NT skill addressed with this intervention. Although participants started the intervention with different prior experiences and past training, they each expressed how they had developed their skills. The final research question was, how did the MTs' NT skills affect their

understandings of expected workplace behaviors? This section answers this question by looking at an approach for teaching soft skills, a model to foster appropriate workplace behavior, and will conclude by exploring implications for practice.

An Approach for Teaching Nontechnical Skills

The implementation of the intervention varied for participants depending on their work settings. The settings could best be described as administrative independent, operations independent, and operations team. There were two independent participants, and both had different approaches to this training. The operations team consisted of five participants, and all worked to complete the training in similar ways.

Administrative Independent. The only participant in this category was Jamie, who was 22 years old and had worked at this company for three and a half years. As a quality assurance inspector, her role involved working with both internal and external stakeholders. She was passionate about her job and demonstrated that she understood expected workplace behaviors coming into the intervention. Although she mostly worked independently, she was not the only person in the company with that job.

Jamie came to the intervention with already well-developed communication skills. She indicated that she routinely spoke with customers that were often much older and more experienced than her. She felt confident speaking with them and often received advice on work-related issues. Jamie also gave many examples from past work challenges that demonstrated she had good problem-solving skills even before this intervention. Jamie's area of opportunity was in self-management. She revealed this aspect in how she engaged with the training, such as not following the daily online lessons as indicated by the intervention protocol.

During the debrief session (February 8, 2022), she admitted that she did not recall much of the Skillsline lessons because she did them all at once. Although she contributed to the discussions, the researcher often had to call on her to elicit responses. It is also worth noting that in the teamwork activity, she shared an experience identifying a problem and then recruiting help to enact a solution. She acted as a leader without recognizing her actions as such. She undervalued her contribution to the situation.

Operations Team. The operations team consisted of the machine shop operators that included Sol, 28 years old and with the company for 2 years; Spike, 25 years old and with the company for 7.5 years; Luke, 21 years old and with the company for 3.5 years; and Christian, 26 years old and with the company for 3.5 years. Although Dan was a welder, his work structure mirrored that of the machine shop operators, so he was also included in this category. This team reported to the same supervisor who supported their participation. The supervisor allocated the time they needed for daily lessons and the synchronous sessions.

The operations team came to the intervention with good communication skills but a shallow understanding of the level of control over the outcome of an interaction. This team appreciated learning that different communication styles vary depending on the situation and person. They learned that they have the power to observe the other person and change their approach to elicit the response they are considering. They gave examples of how this new skill will help coworkers and leadership. Similarly, this new understanding of how they can be intentional about their communications exemplifies their critical thinking skills. Although they all provided examples of problems they have solved in the past, their examples showed they relied on asking for help soon after identifying the problem. Throughout the intervention, they learned how to deconstruct the problem and ideate solutions that they could suggest to their

leadership. The participants in this category recognized the importance of using critical thinking skills to look at problems from various perspectives.

Where the team excelled was in self-management skills. They performed all the activities as instructed, with only illness getting in the way. They provided examples of actions they knew they could take to improve a situation or solve a problem but held back because of the possible repercussions from a defensive supervisor. This finding demonstrated an understanding of their position as lower-level employees in the organizational hierarchy and the lack of power in the company. However, they learned approaches they could take to overcome this organizational threat. In the session debrief and final interviews, they stated they now knew to pause and analyze the situation before speaking and acting.

Operations Independent. As a manufacturing engineer, Cole oversaw equipment maintenance for the entire company. At 30 years old, he was the oldest participant but has only worked for the company for 3.5 years. He was the only one with this position, so he had significant conflicts with the synchronous sessions out of his control and time constraints that limited his ability to complete the Skillsline lessons. More importantly, he was so busy juggling all his responsibilities that although he made his best effort to be engaged with the intervention, he could not give it the attention he would have liked.

Assessing the intervention elements concerning how the different types of participants engaged with it offer some insight into the role each element played in the intervention outcomes. The intervention design was premised on experiential learning, which entails a curated experience, including focus, action, support, feedback, and debriefing (Joplin, 1981). The topics from the Skillsline platform, the synchronous sessions, and the experiential activities were meant

to create the best possible environment for participants to learn and reflect on their workplace behavior.

The Skillsline platform met several criteria. First, it addressed the unique needs of post-traditional learners (Du Bois-Reymond et al., 2001) by leveraging the flexibility of asynchronous online instruction (Garza Mitchell, 2017; Githens et al., 2014; Henriksen & Rolstadås, 2010). Additionally, the daily 10-minute lessons format leveraged spaced learning (Rischke et al., 2011) while using error management in posing the question before providing the explanation participants (Heimbeck et al., 2003) together helped increase participants' retention. The effectiveness of this approach was illustrated by contrasting the outcomes of participants who adhered to the daily schedule to those that did not. Cole provided an excellent example of how the after-lunch schedule did not work for him, so he did his lessons in the morning while Jamie did her lessons in longer chunks. However, in both cases, they did not get as large of a benefit as the machine shop team that worked together and had dedicated time and supervisor support to complete their daily lessons. The instructor-led synchronous sessions offered participants opportunities to share and reflect on the skills line learning. The regular engagement with the instructor kept participants motivated (Clark, 2012; Martin & Bolliger, 2018) and allowed for further deepening their understanding of the asynchronous work.

As was explained in defining NT skills in Chapter 3, it is difficult to assess the learning of one individual NT skill at a time. This intervention demonstrated that as participants learned critical thinking skills, they also needed communication skills to explain a problem to others and self-management skills to ensure they framed their communication appropriately. The experiential work activities were the best place to assess this complex interaction. Each activity was designed to build on the skills learned from the program's start. The CEO email's

culminating activity demonstrated the interaction of communication, critical thinking, and self-management in how they identified a problem, ideated a solution, and clearly articulated both in one communication.

Leveraging Nontechnical Skills to Foster Appropriate Workplace Behavior

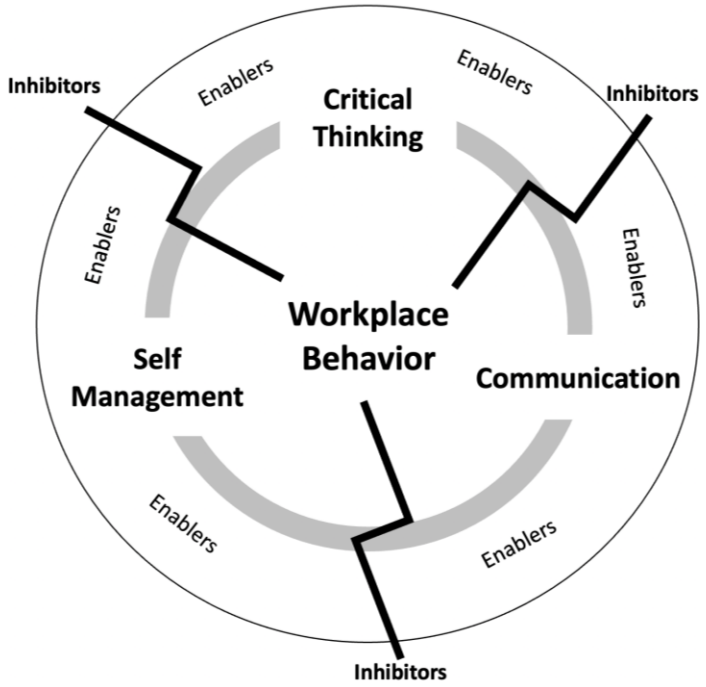
The Skillsline lessons and the discussions during the synchronous sessions corroborate that although young, these participants were not unfamiliar with NT skills or appropriate workplace behavior in general. However, participants indicated that whether they enact the soft skills depends on the situation. In particular, their supervisor's leadership style seemed to have the greatest impact on the participants' workplace behavior. Suppose an employer is seeking a workforce that exhibits good communication, critical thinking, and self-management skills. In that case, they should also ensure that they have leadership in place to support those behaviors.

The intervention participants repeatedly referenced enablers and inhibitors to appropriate workplace behavior regularly encountered at work. Most participants had been in the workforce long enough to have learned the NT skills in this intervention (Table 4.3). The exception was Sol, who only had 6 months on the job and was 19 years old. Nevertheless, he scored similarly to his coworkers on the Skillsline questions and demonstrated his understanding of NT skills when participating in the discussions.

The participants' comments during the discussions consistently reverted to the same underlying factors that led them to a certain course of action in their work interactions. They went as far as to identify individuals within the organization that either fostered or deterred them from fully engaging in their work. The researcher drafted Figure 5.4 to illustrate the relationship between the exhibited workplace behavior, the NT skills previously identified as most relevant in manufacturing, and the enablers and inhibitors of MTs' behaviors.

Figure 5.4

Relationship Between Nontechnical Skills and Workplace Behavior



This depiction of the factors behind workplace behavior aligns with attribution theory as introduced in Chapter 3. An employee's actions are driven by their interpretation of causality, controllability, and stability, driving their motivation, relationships, and performance (Harvey et al., 2014). Similarly, the findings from this intervention indicate that an employees' perception of their context guides how they choose to communicate, approach problems, and behave. This is reflected in attribution theory as intentionality reflecting the individual's ability to act according to their interpretation of factors in the environment (Harvey et al., 2014).

The first factor in workplace behavior identified by participants is NT skills knowledge. Although the participants in this intervention claimed to have learned NT skills beforehand, they also learned new ones they felt would benefit them. The MTs did not recognize their NT skills knowledge gaps until they arrived at this training. This intervention exposed them to concepts such as multiple approaches to thinking and communicating. If an MT does not know they need

training, they will not seek it out. That leaves the employer, more precisely the MTs leadership, to identify the need and decide if and how to address it.

Although this intervention demonstrated that NT skills can be taught, it also revealed that employers play a role in encouraging enablers and limiting inhibitors so that their employees can utilize their NT skills. The second factor is leadership, which according to participants was both an enabler and inhibitor of workplace. MTs need to feel comfortable and psychologically safe to speak their minds and show initiative (Ringleb et al., 2012), but as the participants shared, not all their supervisors did this. Participants gave various examples of facing a problem they needed to communicate to a supervisor and describing their different approaches depending on the reaction they anticipated from the supervisor. The participants who fell within the operations team expressed frustration at not being able to contribute to solving the problem because an unsupportive supervisor inhibited them. On several occasions, the participants said they wished certain supervisors would participate in training such as this one to improve their NT skills and become better leaders.

Closely tied to leadership is the third factor in workplace behavior, the MTs time. Time can be both an enabler and an inhibitor of appropriate workplace behavior. Participants provided many examples of wanting to do the right thing but being rushed and holding back from asking the right questions or taking their time to resolve a problem appropriately. For example, Christian (Personal communication, February 9, 2022) explained that he tried to problem solve himself, but if it took too much time, he needed to "go higher up."

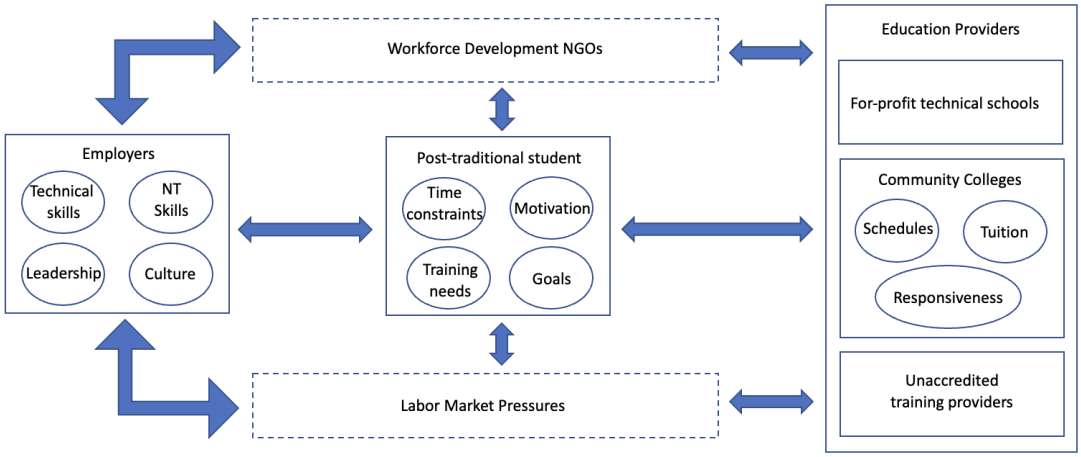
Implications for Practice

The literature review in Chapter 1 identified three main stakeholders involved in the training of the manufacturing workforce. The first was manufacturing employers adopting

advanced technologies at an accelerated rate. Having learned during the needs assessment that employers needed skilled workers independent of their levels of technological adoption, the factors related to technology adoption can be removed from the conceptual framework instead of focusing on the different types of skills: technical and nontechnical (Figure 5.5). However, the pressures on the labor force were brought on by increased labor costs (Aaronson & Phelan, 2019), population changes (Jimeno 2019; Vespa et al., 2020), and a highly competitive labor market (U.S. GAO, 2019).

Figure 5.5

Updated Conceptual Framework



The second stakeholder group is the post-traditional students who are motivated to engage in skills training to increase their earnings potential (M. L. Johnson et al., 2016) but still juggles family obligations (Gagnon & Packard, 2012), work responsibilities, financial limitations, and time constraints (Kim & Baker, 2015). However, post-traditional students have support from workforce development non-governmental organizations (NGOs) that provide assistance to remove barriers and help students succeed in their career goals (Results for America, 2016). Workforce development NGOs prepare youth and adults for the workforce by providing services, resources, and training to resolve barriers keeping participants from

accessing family-sustaining wage jobs (Results for America, 2016). They often partner with educational institutions to provide technical training. In contrast, the organization provides wrap-around support, such as transportation, childcare, coaching and counseling, and funds to cover educational expenses.

The third stakeholder group is the education providers striving to address the new and growing new student demographic of post-traditional students. Changing the focus of the skills gap addressed in this dissertation from technical to nontechnical skills changes the pressures most relevant to community colleges, such as the cost of training equipment and regulations around degree programs. However, the issues that directly impact students are still relevant, such as tuition costs and course scheduling. Additionally, community colleges must be engaged with, and responsive to employer needs to ensure the skills the colleges teach are the skills employers value. Other education providers vying for the same students include for-profit schools (Soliz, 2018) and unaccredited training providers (White et al., 2018). Any of these training providers can engage in teaching nontechnical skills, whether embedding them in existing classes or creating new delivery mechanisms.

This section has described the intervention, detailing how each intervention component contributed to participants' learning. This section also proposed a model depicting the role NT skills play in the workplace context and how that context can impact whether an MT exhibits the desired workplace behaviors. The following section describes the different options for NT skills training by the stakeholders described here: employers, education providers, and workforce development NGOs.

Discussion

The problem of practice this dissertation sought to address is the skills gap in manufacturing to better prepare workers and maintain the nation's manufacturing industry competitiveness for the fourth industrial revolution. The research conducted indicated the following: Employers know how to resolve their MTs' technical skills training needs. The needs assessment in Chapter 2 revealed that from Dorado County employers' perspective, the skills gap is in NT skills and is not related to the company's level of technology adoption. The intervention in Chapter 4 demonstrated that the skills gap can be resolved by teaching NT skills and illustrated an effective teaching methodology. However, the intervention revealed that the employer needs to create an environment where workers feel they can utilize their NT skills in benefit of the employer without fear of repercussion. The onus of employee behavior at work cannot be on the MT alone. The employer, the company's leadership, and the culture of the organization impact MTs' workplace behaviors as well (Blomme et al., 2015). Leadership and workplace culture can be enablers or inhibitors and play an essential role in an MT's behaviors in the workplace (Ringleb et al., 2012).

Although employers in the needs assessment in Chapter 2 expressed dissatisfaction with their MTs' NT skills, their commitment to improving them became a suspect during recruitment for this intervention. The email invitation went out to the same employers that participated in the needs assessment, and several responded by asking follow-up questions but later declined to participate. One employer showed great enthusiasm and even wanted to participate himself but lost interest when the researcher informed him that the target for this intervention was manufacturing technicians, not leadership. Another employer declined when the researcher explained that the target for this intervention was employees who have been with the company

less than two years. A third employer said that they did an extensive job of screening applicants during the hiring process to ensure they had an NT skillset and therefore did not see a need for this training for his workforce.

These employers seemed unwilling to invest in MTs, especially those with the organization a short time. Nevertheless, participating in training such as this intervention could reduce their employees' likelihood of leaving (Leigh & Gifford, 1999). Additionally, employers may turn away excellent applicants by screening prospective employees for soft skills, which are hard to identify and measure (Lacher et al., 2015) because they do not demonstrate some predetermined behavior during the hiring process (Benbow & Hora, 2018).

On the other hand, a company may have a positive work culture where employees bring soft skills or are encouraged to develop and use them. That is the case with the final employer that responded to the intervention invitation. He had questions just like the rest and did not immediately understand the relevance of NT skills training or the benefits to his company. However, he felt that training that only cost him 10 minutes a day of his employees' work time was worth the investment (H. Stewart, personal communication, November 30, 2021). This employer is very well known for his supportive education practices. He offers a very robust tuition reimbursement program and encourages his employees to take as many classes as possible. Thus, it was unsurprising that he wanted his company to participate in the intervention. He agreed to distribute the intervention marketing materials to his employees, make the scheduling adjustments necessary, and provide the technology needed to anyone who volunteered to participate.

As described earlier, the operations team demonstrated that they adhered to the program and learned from it with supervisor support and the needed time and technology. The two

independent employees had various work-related barriers that kept them from fully leveraging the training. Employers are a good option to supply NT skills training to their employees because they provide context to the learning. Because employees are there daily, they can space out the learning to improve retention. However, they must also be able to provide the space, time, and leadership support, or the effort will be less effective.

Additionally, offering the training requires the employer either have the in-house expertise or outsource to a training provider. An online platform such as Skillsline provides flexibility and takes some of the teaching burdens off the employer. However, this intervention demonstrated that the platform on its own was not enough; the interaction with the instructor and the accountability of getting the lessons done before the next synchronous session motivated participants to remain engaged.

Training received via the employer is one option available to employed MTs. However, community colleges could be a resource for those not yet employed or if the employer is not providing the training. Employers prefer hiring students trained at a community college (Osterman & Weaver, 2016), and if the college embeds NT skills training, the graduates would be even more desirable to employers who value those skills. The prospect of a better job may make an investment in NT skills training more attractive to prospective students. However, making changes to curriculum can be expensive and adding new classes risky for an institution such as Sahuaro Community College if not financially incentivized to make these changes (Cox & Salle, 2018). Employers could also outsource NT skills training to the community college if they are willing to pay and set aside the time required for training (Grover & Miller, 2018). This scenario would be ideal because employees would have the context to apply their learning, and community colleges excel at teaching. However, as described previously, employers recruited for

this intervention did not demonstrate that NT skills training is important enough at the MT level to justify the time and money investment this arrangement would require.

A third option is training supplied by an external training provider. For-profit providers pose a similar scenario to MTs at the community college. However, workforce development NGOs are positioned to offer training and services that assist post-traditional students, displaced workers, and underemployed workers in their job search. Their typical training is focused on job search skills such as resume writing and interviewing. They often also offer computer classes and customer service classes. Adding NT skills training would increase their menu of services and potentially make their clients more competitive in the job market. These NGOs can reduce the cost of the training significantly or entirely based on their funding model, such that the only investment the MT must make is their time.

The benefit of the employer-driven model is that employers can identify the need and lead their MTs to participate in this training. The MT does not need to recognize a gap in their skills or even understand what NT skills are before the training. Training options offered by education providers such as community colleges or NGOs require that the MT recognize their training need and the positive impact on their careers that could result from addressing that need.

Attribution theory, described in Chapter 3, highlights how people act based on perceiving factors in their environment (Weiner, 1972). These factors are broken down as locus, whether an individual sees outcomes as driven by internal or external factors; stability, whether a situation is temporary or permanent; and control, whether the individual controls a situation and can influence the outcome. During the intervention, some participants believed that they were hindered by external factors and did not have control over their outcomes. This way of thinking limits a person's ability to pursue changes to improve themselves, how they approach a situation,

and seeing that they can bring about the desired outcome (Gurevich et al., 2012). For example, Luke commented that the Skillsline questions were misleading and badly formulated during the first session. However, several other participants felt the questions were clear and easy to answer. One explanation for Luke's reaction is that he looked for an external cause not to perform as well as he thought.

Similarly, during the second session, when participants reported on the experiential activity of interviewing a more senior coworker, Jamie asked her interviewee, "What communication skills do your supervisors or managers lack or have that you feel make a difference in your work environment?" (Session 2, December 28, 2021). The question is acceptable, except for the subtext that instead of using the interview to identify ways to make improvements to herself, she was looking at the leadership's behaviors. This finding could indicate a lack of perceived control over her actions. On the other hand, Cole could easily have blamed the interruptions in his job for not being able to complete the intervention assignments. Instead, he found a way to work around that by doing the asynchronous assignments at a different time than his coworkers. Even if he attributed his difficulties to an external factor, he felt enough control to make the necessary changes (Cole, Interview, February 9, 2022). Luke (Personal communication, February 10, 2022) shared that he had felt resentful in the past because his workload was often increased suddenly due to bad planning by other teams; thus, he felt powerless to stop it from happening. He felt little control over his circumstances. He stated that he now felt the confidence to develop a convincing plan and communicate it to the other team to let them know how those situations impacted and work to prevent it in the future. Luke changed his approach throughout the intervention from feeling that things that happened to him were permanent. This transformation exemplifies the desired outcome of this intervention.

Researcher Positionality

As the CEO of a nonprofit organization that supports adults pursuing post-secondary education, the research conducted in this intervention is highly relevant. Education is supposed to be a gateway out of poverty. Nevertheless, post-traditional learners every day face many barriers to achieving their dream. They must find time to attend classes, possibly working fewer hours, impacting their already tight budget. Students still must pay their bills which requires a job, making scheduling school an issue. Minimum wage jobs often do not have reliable schedules, making scheduling classes for an entire semester a real challenge. Students are left having to choose between working and going to school.

There is a misperception that going back to school to learn a new skill is a matter of choice. Marketing campaigns for training programs, government initiatives, and policy discourse focus on helping individuals decide to go back to school. However, pursuing an education may be hindered by finances, cultural expectations, or family pressure, further increasing the inequality of circumstances (Walby et al., 2012).

The researcher's organization seeks to remove some barriers to education for post-traditional students offering financial assistance, coaching, and training to prepare students for the workforce. This training makes the research presented here highly important to the researcher and her organization. The intervention participants represent the characteristics of the students served by the researcher's organization. Research conducted by practitioners leads to situated, evidence-based programs (Ravitch, 2014), and the learning from this intervention has already informed organizational decisions. As a result of the findings from this intervention, the researcher has implemented the NT skills training into her organizations' services. Although not all students will have the benefit from an employment context in which to apply the concepts, all

stand to gain a foundation that will improve their NT skills of communication, critical thinking, and self-management and potentially improve their employment prospects.

Limitations

There were several limitations to the study that could impact its validity. First, due to institutional research board approval, invitations to participate went out shortly before Thanksgiving 2021. That is when companies are busy trying to compensate for the holiday season loss of productivity that continues through December. As a result, although many invitations to participate were sent out, few employers responded. Moreover, continual follow-ups were also limited by the Thanksgiving holiday. Additionally, MT participation was impacted by having to deal with constant emergencies that needed immediate attention and didn't allow participants to attend their online or synchronous training. In contrast, the participants who had a supervisor who designated a time and place to complete their training work completed more of the work and demonstrated better retention.

Another limitation is that this intervention occurred during the COVID-19 pandemic. The pandemic impacted recruitment in that employers were strained to accommodate health measures and were short-staffed due to illness, creating reluctance to give up MTs' time to the training. Further, it impacted attendance with one participant missing one session and another missing two due to contracting COVID-19. Additionally, the pandemic impacted the research design, which under normal circumstances would have called for in-person synchronous sessions where the participants could engage with each other and with the facilitator. Due to health precautions, the synchronous interactions had to happen virtually, limiting engagement between participants and the researcher. Additionally, participants did not have cameras available, and although the participants could see the researcher, the researcher could not see what the participants were

doing or how they were reacting. For example, Sol (Personal communication, February 10, 2022) mentioned that there were times when he wanted to speak up during the intervention. However, he did not get a chance with so many other people participating. The researcher could not read body language, so while she tried to elicit contributions equally from all participants, she had no visual cues with which to assess their reactions.

Future Research

Central to the findings of this intervention is understanding the leader-member relationship in the organizational context as explained by attribution theory (Harvey et al., 2014). When supervisors and employees differ in their attribution of an outcome, interpersonal conflict can occur, especially when one incorrectly places blame on the other for a negative outcome or takes undue credit for a positive outcome (Harvey et al., 2014). This leader-member relationship is evident in several interactions in this study. The first is in the MT's perception of their supervisors, which the participants spoke about as being stable and either positive or negative depending on the specific supervisor. The second type of interaction is the supervisor's perception of the MT and the attributions the supervisor places on the MT's actions. Whether the supervisor perceives an MT's actions as internally caused, controllable, and stable drives how that supervisor controls reward and punishment (Harvey et al., 2014). Continued research is needed to understand how the role played by leader-member relationship: To what extent does a supervisor's leadership skills impact the workplace behavior of the MTs they supervise? A survey of MTs across multiple organizations asking how their leadership, company culture, and existing NT skills impact their behavior at work may reveal relationships between leadership and NT skills.

The third way leader-member interactions showed in the intervention is employers' perception of their staff and decisions about participating in the intervention. As described earlier in this chapter, only four employers invited to make this intervention available to their MTs responded, and three of those declined once they received information about the subject of the training and intended participants. Harvey et al. (2014) posit that perceptions of whether an action is internally or externally determined may be influenced by a person's position within the organization. Further study should address the question: How are employers' decisions about MTs' NT skills training impacted by the employers' belief that the MTs' behaviors are internally driven and stable, and thus not likely to change? An interview approach with employers of different sizes could generate the needed information to answer this question.

This intervention identified a link between MTs' workplace behavior, NT skills, and workplace context. Additionally, participants identified contextual factors that can inhibit or enable their use of these skills. This finding aligns with the model proposed by Kelley and Michela (1980), in which they consider that information, beliefs, and motivation antecede the attribution and consequence. Thus, an MT's past experiences with their leader and perceptions of the leader's ability would inform their attribution of the supervisor's actions and subsequent behavior. This antecedent-attribution link has been explored in the social sciences, but not in the organizational research literature. Kelley and Michela (1980) propose that once the attribution is made, a person will disregard new information, which could impact an employer's ability to improve company culture or the effect of providing leadership training to supervisors. Future research should explore the question: How can patterns of behavior resulting from the antecedent-attribution relationship be altered to make interventions at the supervisory and

management levels more effective? An intervention study in which both leaders and MTs are exposed to attributions and their role in workplace behavior could help explain this question.

Attribution theory has received less attention in the organizational sciences than in the social sciences, leaving gaps in the understanding of workplace behavior (Harvey et al., 2014). This dissertation adds to the understanding of attribution theory in an organizational context by exploring the role communication, critical thinking, and self-management skills play in MTs' workplace behavior. The emergent themes of NT skills knowledge, leadership, and time pointed to the important role of attributions; however, additional research is needed to better understand NT skills in manufacturing, as detailed in this section. Addressing the skills gap in manufacturing will enable MTs to do their best work and increase the competitiveness of the nation's manufacturing sector.

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Appendix A

Online Survey Instrument

Informed Consent Form

Q1.

Homewood Institutional Review Board (HIRB)

Informed Consent Form

PURPOSE OF RESEARCH STUDY:

The purpose of this research study is to examine an educational problem within an educational context to determine the salient factors contributing to this problem. The ultimate use of the data gathered will or may become part of the student researchers' dissertation research study.

PROCEDURES:

The student researcher will ask adult participants to complete educational surveys (10-15 minutes), participate in observations (45 minutes to 1 hour), interviews (45 minutes to 1 hour), and/or focus groups (45 minutes to 1 hour) to examine an educational problem within an educational context.

The student researcher will also collect pre-existing de-identified student educational data.

RISKS/DISCOMFORTS:

The risks associated with participation in this study are no greater than those encountered in daily life.

BENEFITS:

The research projects will help the student researcher to better understand the salient factors that are contributing to a problem within their educational organizations. This knowledge will help to develop informed interventions that will address these contributing factors.

VOLUNTARY PARTICIPATION AND RIGHT TO WITHDRAW:

Your participation in this study is entirely voluntary: You choose whether to participate. If you decide not to participate, there are no penalties, and you will not lose any benefits to which you would otherwise be entitled. If you choose to participate in the study, you can stop your participation at any time, without any penalty or loss of benefits. If you want to withdraw from the study, please email Ana Greif at agreif3@jhu.edu, Dr. Camille Bryant, at cbryan16@jhu.edu or Dr. Stephen Pape at stephen.pape@jhu.edu explicitly stating your intention.

If we learn any new information during the study that could affect whether you want to continue participating, we will discuss this information with you.

CIRCUMSTANCES THAT COULD LEAD US TO END YOUR PARTICIPATION:

There are circumstances for which the researcher may decide to end your participation before completing the study. If a you are no longer an employee within the organization, your participation within the study will be terminated.

CONFIDENTIALITY:

Any study records that identify you will be kept confidential to the extent possible by law. The records from your participation may be reviewed by people responsible for making sure that research is done properly, including members of the Johns Hopkins University Homewood Institutional Review Board and officials from government agencies such as the National Institutes of Health and the Office for Human Research Protections. All of these people are required to keep your identity confidential. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

Surveys collected in electronic format will be stored on a password protected computer. All paper documents will be kept in a locked file that is only accessible to the student researcher. Finally, all files will be erased and paper documents shredded seven years after collection.

COMPENSATION:

You will not receive any payment or other compensation for participating in this study.

IF YOU HAVE QUESTIONS OR CONCERNS:

You can ask questions about this research study now or at any time during the study, by talking to the JHU faculty member working with you or by contacting Ana Greif at agreif3@jhu.edu, Dr. Camille Bryant via e-mail at cbryan16@jhu.edu or Dr. Stephen Pape at stephen.pape@jhu.edu.

If you have questions about your rights as a research participant or feel that you have not been treated fairly, please call the Homewood Institutional Review Board at Johns Hopkins University at (410) 516-6580.

WHAT CLICKING NEXT MEANS:

Clicking next and continuing on to the survey means that you understand the information in this consent form. It also means that you agree to participate in the study.

By continuing on to the survey, you have not waived any legal rights you otherwise would have as a participant in a research study.

Company Information

Q2. Please tell us about you.

Company name

First name

Last name

Job title

E-mail address

Q3. What is your company's core business? (Select all that apply)

- ☐ Manufacturing
- ☐ Aerospace
- ☐ Defense
- ☐ Other

Q4. How many employees does your company have?

- ○ 1-50
- ○ 51-250
- ○ 251-500
- ○ 501-2000
- ○ More than 2000

Q5. How many manufacturing technicians does your company employ?

- ○ 1-20
- ○ 21-100
- ○ 101-500
- ○ 501-2000
- ○ More than 2000

AMT Adoption

Q6. Please indicate whether your company has purchased or leased at least one of the following advanced manufacturing technology (AMT) equipment:

- ☐ Pick and place robot
- ☐ Robot other than pick and place
- ☐
- ☐ CNC machine
- ☐ Additive manufacturing and 3D printing
- ☐

Flexible manufacturing cell (FMC)

Computer-aided inspection system

Q7a. Is the Pick and place robot currently being used?

- Yes, just as intended
- No, because it has not been installed
- No, because it is not currently needed
- It is too expensive to operate
- It does not produce the desired results
- It is too difficult to operate
- We lack a skilled person to operate it
- Other

Q7b. Why does your company not own a Pick and place robot?

- It is not relevant to our processes
- We have heard about them but have not acted
- We have the support of our leadership to purchase or lease
- We are currently considering/evaluating purchasing options

Q8a. Is the Robot other than pick and place currently being used?

- ○ Yes, just as intended
- ○ No, because it has not been installed
- ○ No, because it is not currently needed
- ○ It is too expensive to operate
- ○ It does not produce the desired results
- ○ It is too difficult to operate
- ○ We lack a skilled person to operate it
- ○ Other
- ○ [ ]

Q8b. Why does your company not own Robot other than pick and place equipment?

- ○ It is not relevant to our processes
- ○ We have heard about them but have not acted
- ○ We have the support of our leadership to purchase or lease
- ○ We are currently considering/evaluating purchasing options

Q9a. Is the Flexible manufacturing cell (FMC) currently being used?

- ○ Yes, just as intended
- ○ No, because it has not been installed
- ○ No, because it is not currently needed
- ○ It is too expensive to operate
- ○ It does not produce the desired results
- ○ It is too difficult to operate
- ○ We lack a skilled person to operate it
- ○ Other

Q9b. Why does your company not own Flexible manufacturing cell (FMC) equipment?

- It is not relevant to our processes
- We have heard about them but have not acted
- We have the support of our leadership to purchase or lease
- We are currently considering/evaluating purchasing options

Q10a. Is the CNC machine currently being used?

- Yes, just as intended
- No, because it has not been installed
- No, because it is not currently needed
- It is too expensive to operate
- It does not produce the desired results
- It is too difficult to operate
- We lack a skilled person to operate it
- Other

Q10b. Why does your company not own CNC machine equipment?

- ○ It is not relevant to our processes
- ○ We have heard about them but have not acted
- ○ We have the support of our leadership to purchase or lease
- ○ We are currently considering/evaluating purchasing options

Q11a. Is the Additive manufacturing and 3D printing currently being used?

- ○ Yes, just as intended
- ○ No, because it has not been installed
- ○ No, because it is not currently needed
- ○ It is too expensive to operate
- ○ It does not produce the desired results
- ○ It is too difficult to operate
- ○ We lack a skilled person to operate it
- ○ Other

Q11b. Why does your company not own Additive manufacturing and 3D printing equipment?

- ○ It is not relevant to our processes
- ○ We have heard about them but have not acted
- ○ We have the support of our leadership to purchase or lease
- ○ We are currently considering/evaluating purchasing options

Q12a. Is the Computer-aided inspection system currently being used?

- ○ Yes, just as intended
- ○ No, because it has not been installed
- ○ No, because it is not currently needed
- ○ It is too expensive to operate
- ○ It does not produce the desired results
- ○ It is too difficult to operate
- ○ We lack a skilled person to operate it
- ○ Other

Q12b. Why does your company not own Computer-aided inspection system equipment?

- ○ It is not relevant to our processes
- ○ We have heard about them but have not acted
- ○ We have the support of our leadership to purchase or lease
- ○ We are currently considering/evaluating purchasing options

Training Needs

Q13. Indicate the extent to which you agree or disagree with the following statements regarding your current manufacturing workforce.

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
My company plans to invest in new advanced manufacturing equipment in the next 2 years.	○	○	○	○	○
My employees will require training after the implementation of new or updated advanced manufacturing technology into our manufacturing process.	○	○	○	○	○
In the past, when new equipment is purchased, employees have received training on how to use it.	○	○	○	○	○
The skills level of my current workforce is a consideration when making decisions to purchase new advanced manufacturing equipment.	○	○	○	○	○
My employees have the technical skills to operate our existing manufacturing technology.	○	○	○	○	○

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
My employees have the technical skills to operate manufacturing technology we will adopt in the next 2 years.	○	○	○	○	○
My employees have the attitude necessary to embrace the implementation of new or additional technology to our manufacturing process.	○	○	○	○	○

Q14. When we hire new manufacturing technicians:

- ○ We look for candidates that already have the technical skills they need to do the job they are being hired for today
- ○ We look for candidates that have the technical skills for the jobs we anticipate will be needed in the future
- ○ We don't hire for skills, we have other criteria like cultural fit or attitude
- ○ Hiring is done in another area of the company so I don't know

Q15. When recruiting new manufacturing technicians:

- ○ We have no trouble finding qualified candidates
- ○ We attract candidates but they don't have the skills required for the job
- ○ We cannot find enough candidates regardless of qualifications
- ○ Recruitment is done in another area of the company so I don't know

Q16. How do you rate your manufacturing technicians on their ability to perform these skills:

	Terrible	Poor	Average	Good	Excellent
Problem-solving	○	○	○	○	○
Teamwork	○	○	○	○	○
Supervision	○	○	○	○	○
Management	○	○	○	○	○
Leadership	○	○	○	○	○
Computer literacy	○	○	○	○	○
Advanced computer skills (i.e. operating systems, networks, etc.)	○	○	○	○	○
Equipment operation	○	○	○	○	○
Troubleshooting	○	○	○	○	○
Reading and writing	○	○	○	○	○
Basic math	○	○	○	○	○
Business communications	○	○	○	○	○

	Terrible	Poor	Average	Good	Excellent
Technology adaptability	○	○	○	○	○

Q17. Does the company incentivize employee development by providing manufacturing technicians with opportunities for advancement tied to education and/or training?

- ○ Yes, raises and/or promotions are directly tied to credentials, certificates, degrees, or other specific education attainment.
- ○ Yes, their educational attainment can lead to a raise and/or promotion, but it is not automatic and other criteria must be met.
- ○ No, we encourage manufacturing technicians to participate in education and/or training but attainment is not tied to raises and/or promotions.
- ○ No, we do not actively encourage participation in education and/or training.

Q18. When do your manufacturing technicians participate in education and/or training?

- ○ On their own time outside of work hours
- ○ During the work day, on company time
- ○ A mix of both
- ○ We do not offer training

Q19. Does your company cover the cost of the training?

- ○ Yes, all of the cost
- ○ Yes, but only part of the cost, the employee pays the rest
- ○ Yes, the employee pays and we reimburse them if they are successful
- ○ No, the employee pays all of the cost

Q20. Do you have a policy or preference on which education provider is used for the training?

- ○ We provide training internally led by company staff or subcontracted trainers
- ○ An academic institution such as the local community college or university
- ○ An external training provider
- ○ The equipment vendor
- ○ [ ] Other

Q21. Do you have a policy or preference on where the training takes place and the modality used? (select all that apply)

- ○ Our company site
- ○ The education provider's site
- ○ A hotel or other 3rd party venue

- ○ Online
- ○ Blend of online and face-to-face
- ○ No preference
- ○ [ ] Other

Q22. Tell us more about your training needs.

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Training should be short and cover specific skills	○	○	○	○	○
Training should include hands-on practice on specific equipment	○	○	○	○	○
My employees should have a menu of skills trainings to choose from, to develop their own unique training pathway	○	○	○	○	○
The training provider needs to establish what skills employees need to be competent manufacturing technicians	○	○	○	○	○

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
The training should include development of appropriate workplace behaviors	○	○	○	○	○
Training should be online as much as possible	○	○	○	○	○
Training should be face-to-face as much as possible	○	○	○	○	○
Training should lead to an industry recognized credential	○	○	○	○	○
My employees need to earn college credit for skills they learn	○	○	○	○	○
Certificates and credentials don't matter as long as my employee can perform the skill	○	○	○	○	○
My employees should work towards earning an Associates Degree.	○	○	○	○	○
My employees should work towards earning a Bachelor's Degree	○	○	○	○	○

Appendix B

Interview Script for Human Resources Manager

1. What non-technical skills do you believe are important for your manufacturing technicians to have that would impact their ability to do their job?
    a. Do you believe your employees currently have those non-technical skills?
    b. If not, what is the current plan to address this gap?
    c. What is the best way to deliver nontechnical training for your manufacturing technicians? Think of scheduling, provider, and modality.
2. What are your main concerns or frustrations when it comes to delivering technical training to your manufacturing technicians?
    a. Do you believe your employees currently have those technical skills?
    b. Are there plans in place to address those gaps?
    c. What is the best way to deliver technical training for your manufacturing technicians? Think of scheduling, provider, and modality.
3. What do you believe is the best training approach if there were no constraints?
4. What changes do you see your company undergoing in the next two years that would impact your company's training needs?
    a. How would the way your company currently delivers training be impacted?
5. Do you currently have a partnership with [redacted] to train your employees?
    a. Do you hire [redacted] graduates?
    b. Do you anticipate using [redacted] to train your existing workers in the next two years?
    c. What training is the most appropriate for [redacted] to deliver?

Appendix C

Interview Script for Manufacturing Technicians

1. Do you feel you have the non-technical skills you need to do your job?
    a. Are there skills you would like your employer to provide training on? If so, which?
    b. Are there skills you plan to get training for on your own? If so, which?
    c. What is your preference for how non-technical training is delivered? Think of scheduling, provider, and modality.
2. Do you feel you have the technical skills you need to do your job? Think of what is required to operate advanced manufacturing technology equipment such as robots, CNC machines, 3D printers, and computer aided inspection systems.
    a. Are there skills you would like your employer to provide training on? If so, which?
    b. Are there skills you plan to get training for on your own? If so, which?
    c. What is your preference for how technical training is delivered? Think of scheduling, provider, and modality.
3. What changes do you see your company or industry undergoing in the next two years that would impact the training you will need in the next 2 years?
4. Have you ever or are you currently taking classes at [redacted]?
    a. If so, do you feel the education you received prepared you for your job?
    b. Do you anticipate getting education or training at [redacted] in the next two years?
    c. What training is the most appropriate for [redacted] to offer?
5. Do you feel you have been impacted by your company's implementation of new advanced manufacturing technology equipment in the last 2 years? If so, explain how.

Appendix D

Letter of Informed Consent

Approved February 27, 2018 Protocol Number: HIRB00006571

JOHNS HOPKINS
SCHOOL of EDUCATION

Johns Hopkins University
Homewood Institutional Review Board (HIRB)

Informed Consent Form	
Title:	Doctor of Education Needs Assessment for Research Methods and Systematic Inquiry I Course and Dissertation Research
Principal Investigator:	Dr. Camille Bryant, Associate Professor, JHU, SOE
Date:	February 27, 2018

PURPOSE OF RESEARCH STUDY:

The purpose of this research study is to examine an educational problem within an educational context to determine the salient factors contributing to this problem. The ultimate use of the data gathered will or may become part of the student researchers' dissertation research study.

PROCEDURES:

The student researcher will ask adult participants to complete educational surveys (10-15 minutes), participate in observations (45 minutes to 1 hour), interviews (45 minutes to 1 hour), and/or focus groups (45 minutes to 1 hour) to examine an educational problem within an educational context.

The student researcher will also collect pre-existing de-identified student educational data.

RISKS/DISCOMFORTS:

The risks associated with participation in this study are no greater than those encountered in daily life.

BENEFITS:

The research projects will help the student researcher to better understand the salient factors that are contributing to a problem within their educational organizations. This knowledge will help to develop informed interventions that will address these contributing factors.

VOLUNTARY PARTICIPATION AND RIGHT TO WITHDRAW:

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the study, please email (student investigator name and JHU e-mail), Dr. Camille Bryant, at cbryan16@jhu.edu or Dr. Stephen Pape at stephen.pape@jhu.edu explicitly stating your intention.

If we learn any new information during the study that could affect whether you want to continue participating, we will discuss this information with you.

CIRCUMSTANCES THAT COULD LEAD US TO END YOUR PARTICIPATION:

There are circumstances for which the researcher may decide to end your participation before completing the study. If a you are no longer an employee within the organization, your participation within the study will be terminated.

CONFIDENTIALITY:

Any study records that identify you will be kept confidential to the extent possible by law. The records from your participation may be reviewed by people responsible for making sure that research is done properly, including members of the Johns Hopkins University Homewood Institutional Review Board and officials from government agencies such as the National Institutes of Health and the Office for Human Research Protections. All of these people are required to keep your identity confidential. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

Surveys collected in electronic format will be stored on a password protected computer. All paper documents will be kept in a locked file that is only accessible to the student researcher. Finally, all files will be erased and paper documents shredded seven years after collection.

COMPENSATION:

You will not receive any payment or other compensation for participating in this study.

IF YOU HAVE QUESTIONS OR CONCERNS:

You can ask questions about this research study now or at any time during the study, by talking to the JHU faculty member working with you or by contacting (name and JHU email of student), Dr. Camille Bryant via e-mail at cbryan16@jhu.edu or Dr. Stephen Pape at stephen.pape@jhu.edu.

If you have questions about your rights as a research participant or feel that you have not been treated fairly, please call the Homewood Institutional Review Board at Johns Hopkins University at (410) 516-6580.

JOHNS HOPKINS
SCHOOL of EDUCATION

SIGNATURES

WHAT YOUR SIGNATURE MEANS:

Your signature below means that you understand the information in this consent form. Your signature also means that you agree to participate in the study.

By signing this consent form, you have not waived any legal rights you otherwise would have as a participant in a research study.

Participant's Signature **Date**

Signature of Person Obtaining Consent **Date**

(Investigator or HIRB Approved Designee)

Appendix E

Participant Information Form

Contact information

* Required

1. Email *

2. First name

3. Last name

4. Age *

5. Employer

6. Date of hire at current employer

Example: January 7, 2019

7. Title *

8. As part of this study you can participate in a focus group to help us understand your past work experiences. The focus group will take place over Zoom and will take no more than one hour. If you choose to participate we will contact you via email to schedule the focus group. *

   Mark only one oval.

   - ◯ I agree to participate in a focus group
   - ◯ I do not agree to participate in a focus group

9. At the conclusion of the training you can participate in an interview to help us understand your experience in this training. Interviews will take place over Zoom and will take no more than 30 minutes. If you choose to participate we will contact you via email to schedule the interview. *

   Mark only one oval.

   - ◯ I agree to participate in an interview
   - ◯ I do not agree to participate in an interview

Alternate name

In order for your identity to remain anonymous throughout this survey, you will be using a different name of your choice. Please indicate the name you would like to use.

10. Alternate first name *

    _____

11. Alternate last name *

    _____

12. Have you received training on the following topics? Please indicate where the training was provided.

Check all that apply.

	Current employer	Past employer	School	Community
Communication	☐	☐	☐	☐
Teamwork	☐	☐	☐	☐
Critial thinking	☐	☐	☐	☐
Problem solving	☐	☐	☐	☐
Self management (motivation, work ethic, attitude)	☐	☐	☐	☐
Appropriate workplace behavior	☐	☐	☐	☐

Appendix F

Script for Initial Focus Groups

1. Have any of you had an experience where your supervisor asked you to do something, and you didn't know how to do it? How did you respond?
2. Can you think of a problem at work that needed to be addressed but you felt you were not the right person to do it? How did you respond?
3. Tell me about a time when you weren't sure how to communicate with someone at work. It could be with a coworker, a supervisor, or someone else. How did you resolve it?

Appendix G

Script for Final Interview

1. If you face a situation at work where you are not certain how to act, how would you approach the situation? Can you recall a specific example? What tools or skills, if any, did you learn in this program that would be useful in this situation?
2. If you encounter a problem at work that you don't believe is your role to address, how would you address the situation? Can you recall a specific example? What tools or skills, if any, did you learn in this program that would be useful in this situation?
3. If you had something important to communicate to a superior at work, how would you accomplish this? Can you recall an example? What tools or skills, if any, did you learn in this program, that would be useful in this scenario?
    a. Was there a situation during the training in which you felt more confident communicating because of the skills you learned in this program?
4. What were your overall impressions of this training program?
    a. What was your experience with the synchronous sessions?
    b. What was your experience with the exercises between sessions? Did you encounter any problems doing them? How so?
    c. What was your experience with the Skillsline platform? Did you encounter any problems using it? How so?

Appendix H

Sample Skillsline Quiz Questions

Why might people hide their imperfections?
A. They fear others won't like or love them if they are flawed
B. They fear being judged negatively by others
C. They fear they won't fit in fit in or belong to a group
D. All of the above

What is true of following established rules?
A. This stimulates creativity
B. This tends to preserve status quo
C. This provides new options and ideas
D. This helps you break out of unhelpful habits

Consider the logic of:
I messed up on my job interview >> I will always mess up job interviews >> I'll never get a job.
What type of reasoning is this?
A. Inductive
B. Deductive

How can you proactively improve your relationships?
A. Wait for people to let you know what you're doing wrong
B. Assume everything is good
C. Check in and ask for feedback
D. No need, as your relationships are fine now
E. All of the above

Appendix I

Sample Skillsline Lesson Index

Journey 1: Look Within

- Embrace learning
- Show accountability
- Enhance emotional intelligence
- Care for yourself
- Know yourself

Journey 2: Connect

- Listen carefully
- Adjust to different approaches
- Get your message across
- Engage in teamwork

Journey3: Think

- Learn critical thinking
- Apply critical thinking
- Practice creative thinking
- Engage in systems thinking
- Manage your thinking

Journey 4: Advance

- Move forward
- Be informed
- Solve problems
- Implement solutions

Journey 5: Get Results

- Strive to achieve
- Use resources effectively
- Stay on track
- Optimize your skills

Appendix J

Work Product Prompts

Module 1

Identify someone in your organization that has worked for the company for at least 5 years. Ask them if they are willing to be interviewed for your training course. Begin the interview by asking them:

> "If you were to meet yourself on your first day of work at this company, what advice would you give your earlier self?"

Think of at least four follow up questions that you would like to know about the company or supervisor expectations. Use what you learned in your Skillsline lessons to complete the exercise.

Module 2

Over the next two weeks, find an opportunity to collaborate with at least one other person on a task or project. Try to do this at work, however any setting is acceptable. Answer the following questions:

- What role are you most comfortable with in a group setting: a leader or a contributor? Explain why.
- Explain how the tasks in this example were identified and how you knew what you needed to do in your role. Did everyone jump in without discussion or was there a plan decided on first? Did you know what task you should do, or did you wait for someone to tell you? Did you feel everyone contributed equally? Why or why not.

Use what you learned in your Skillsline lessons to complete the exercise.

Module 3

In the next two weeks, identify a complex problem at work. It may be something that you have noticed for some time or something that has just come up. It does not need to be something you are directly involved in or within your control. Describe the problem in as much detail as you can. What are its components? Who is involved? How might you solve it? Use what you learned in your Skillsline lessons to complete the exercise.

Module 4

Thinking about the problem you wrote about for the previous module's work product; draft an email to the company's CEO explaining the problem and offer recommendations on how to solve it. This is only an exercise, and you are NOT expected to send the email. Use what you learn in your Skillsline lessons to complete the exercise.

Appendix K

Employer Email Invitation Script

Dear ,

My name is Ana Greif, a doctoral student at Johns Hopkins University and CEO of JobPath. I am continuing my dissertation research in which you participated last year. You provided valuable information that contributed to my findings. The results of my initial research showed that Dorado County manufacturers were satisfied with their manufacturing technicians' technical skills, and when training was needed, they knew how to get it. On the other hand, employers said employees' lack non-technical skills (soft skills) such as initiative, business communications, management, and leadership, and they currently have no existing solution to remedy this gap. I am writing today, to invite you to support the continuation of my research in which I will study an approach for manufacturing technicians to develop non-technical skills.

This research consists of a training program focused on non-technical skills including critical thinking, communication, and self-management. Your support would entail:

- Distributing information about this opportunity to participate to the manufacturing technicians (welding, machining, assembly, equipment maintenance, quality assurance, etc.) in your company.
- Allowing those who choose to participate the time required for synchronous Zoom sessions during their workday. There will be six sessions, one every two weeks, running from 30-90 minutes.
- Supplying participants with an internet enabled computer or tablet for the synchronous sessions if they need one.

Training is free to the company and the participant. If you would like your company to support this training, please reply to this email so I can send you recruitment materials to distribute to your employees.

Please let me know if you have any questions about the training, by email or call me at (520) 869-1775.

Thank you,

Ana Greif

Appendix L

Participant Recruitment Flyer

WORKFORCE READINESS:
IT'S NOT JUST ABOUT TECHNICAL SKILLS

A TRAINING PROGRAM FOR MANUFACTURING TECHNICIANS

This interactive, hands-on training program is focused on non-technical skills including critical thinking, communication, teamwork, creative problem-solving, and initiative. It consists of four 90-minute online sessions every two weeks, with an activity between sessions and daily lessons on an the Skillsline platform.

- Learn and practice non-technical skills that impact your success at work.
- Become familiar with skills and behaviors employers expect you to have through daily 10-minute lessons on your smartphone.
- Gain confidence communicating with co-workers, supervisors, and management

SIGN UP AT
WWW.JOBPATH.NET/STUDY.HTML

This is a research study

This program is a part of a research study titled *Addressing the skills gap in manufacturing: The skills that education forgot*. This study seeks to address need for manufacturing technicians to have non-technical skills. Participation in this study is completely voluntary. Training is free to the company and the participant. Your participation is confidential and only your attendance to synchronous sessions will be reported to your employer.

The Primary Investigator for this study is Dr. Elizabeth Brown. For more information contact Ana Greif at agreif3@jhu.edu.

Workshop schedule

November 30th, 2:00-2:30 p.m.
- Information session

December 14th, 2:00-3:30 p.m.
- Session 1 - Introduction to workforce readiness

December 28th, 2:00-3:30 p.m.
- Session 2 - Creative problem solving

January 11th, 2:00-3:30 p.m.
- Session 3 - Teamwork and workplace expectations

January 25th, 2:00-3:30 p.m.
- Session 4 - Communication skills

February 8th, 2:00-2:45 p.m.
- Closing session

Who should participate:

- ✓ Manufacturing technicians (welding, machining, assembly, equipment maintenance, quality assurance, etc.)
- ✓ Have worked for your company for less than two years.
- ✓ Have daily access to internet.
- ✓ Up to six technicians from each company.

Appendix M

Informed Consent Form

JOHNS HOPKINS UNIVERSITY
HOMEWOOD INSTITUTIONAL REVIEW BOARD (HIRB)

RESEARCH PARTICIPANT INFORMED CONSENT FORM

Study Title: Addressing the Manufacturing Skills-Gap: The Skills that Education Forgot

Application No.: HIRB00014133

Sponsor/Supporter/Funded By:

Principal Investigator: Elizabeth Brown, Professor, Johns Hopkins University [redacted]

You are being asked to join a research study. This is a student research project that is part of the Ed.D. dissertation at Johns Hopkins University, School of Education. Participation in this study is voluntary. Even if you decide to join now, you can change your mind later.

1. Research Summary (Key Information):

The information in this section is intended to be an introduction to the study only. Complete details of the study are listed in the sections below. If you are considering participation in the study, the entire document should be discussed with you before you make your final decision. You can ask questions about the study now and at any time in the future.

This study consists of four 90-minute interactive training sessions, a 45-minute information session, and a 45-minute wrap up session. The sessions will be virtual on the Zoom platform, scheduled every two weeks starting late 2021 and early 2022. During each training session the researcher will discuss the previous assignments, provide information on the new topic, and give instructions for the work you will do in the next two weeks.

At each session you will be provided with instructions for an out of class activity to do before the next session that will take approximately 30 minutes to complete. These activities may involve speaking with and/or meeting with other participants and speaking with co-workers who are not participants.

You will also do daily 10-15 minute lessons and quizzes on the Skillsline platform on a computer or your mobile phone.

You may also participate in an optional one-hour focus group the week after the information session and an optional 30-minute interview the week after the wrap-up session.

There are no significant risks to participants and no costs will be incurred by the participant or their employer. The topics are as follows:

- Information session
- Introduction to workforce readiness
- Teamwork and workplace expectations
- Problem solving
- Communication skills
- Wrap up session

2. Why is this research being done?

This research is being done to understand how manufacturing technicians can learn the non-technical skills such as communication, initiative, teamwork, and problem solving by going through a hands-on training program. A short study of Pima County manufacturing employers last year showed that they were satisfied with the technical skills of their technicians, but felt they needed non-technical skills to succeed on the job (Greif, 2020). This training is designed to help bridge that gap so that employees have all the knowledge and skills they need to succeed in their jobs and potentially access pay raises and promotions.

3. What will happen if you join this study?

If you agree to be in this study, we will ask you to do the following:

- Attend all four 90-minute training sessions, the 45-minute information session, and the 45-munute wrap-up session.
- Participate in out of class activities which may involve speaking and/or meeting with other participants and speaking with co-workers who are not participants. These activities should take approximately 30 minutes to complete.
- Spend 10-15 minutes daily completing the Skillsline lessons either on a computer or your mobile phone and take all the quizzes.
- Attend an optional one-hour focus group in the week after the information session and an optional 30-minute interview in the two weeks after the wrap-up session.

Photographs/Video recordings:

As part of this research, we are requesting your permission to create and use photographs, video recordings, audio recordings. Any images and recordings of the training sessions or out of class activities will not be used for advertising or non-study related purposes.
You should know that:

- You may request that the photographs, video recordings, audio recordings be stopped at any time.
- If you agree to allow the photographs, video recordings, audio recordings and then change your mind, you may ask us to destroy that imaging/recording. If the imaging/recording has had all identifiers removed, we may not be able to do this.

Please indicate your decision below by checking the appropriate statement:

☐ I **agree** to allow the study to make and use photographs/video recordings/audio recordings of me for the purpose of this study.

☐ I **do not agree** to allow the study team to make and use photographs/video recordings/audio recordings of me for the purpose of this study.

_____ _____
Participant Signature Date

How long will you be in the study?
The training will take place over ten weeks.

4. What are the risks or discomforts of the study?

You may feel nervous or uncomfortable participating in some of the activities if you are not used to speaking to groups or in an online format.

You may get tired or bored when we are asking you questions, or you are completing the online lessons. You do not have to answer any question you do not want to answer. Participation in this study may involve risks that cannot be foreseen at this time.

The risks associated with participation in this study are no greater than those encountered in daily life.

5. Are there benefits to being in the study?

Participants will learn skills desired by employers potentially leading to a better job performance. They will meet other MTs from their company and from other companies. Participants will increase their knowledge of how to succeed in the workplace including how to communicate better and how to work with others.

Participants may or may not benefit from being in this study.

This study may benefit if the results lead to a better understanding of the gap in skills that impacts employers' ability to grow and be competitive in the current economic environment.

6. What are your options if you do not want to be in the study?

Your participation in this study is entirely voluntary. You choose whether to participate.

If you decide not to participate, there are no penalties, and you will not lose any benefits to which you would otherwise be entitled.

7. Will it cost you anything to be in this study?

There is no cost to participating in this study.

8. Will you be paid if you join this study?

There is no payment associated with participating in this study.

9. Can you leave the study early?

- You can agree to be in the study now and change your mind later, without any penalty or loss of benefits.
- If you wish to stop, please tell us right away.
- If you want to withdraw from the study, please advise the training facilitator.

10. Why might we take you out of the study early?

You may be taken out of the study if:

- You fail to follow instructions.
- The study is cancelled.
- There may be other reasons to take you out of the study that we do not know at this time.

If you are taken out of the study early, Johns Hopkins may use or give out your information that it has already collected if the information is needed for this study or any follow-up activities.

11. How will the confidentiality of your biospecimens and/or data be protected?

Any study records that identify you will be kept confidential to the extent possible by law. Your employer will only be notified of whether or not you completed the study. All other information including your work product from the training and all quizzes and evaluations will be stored in a password protected computer and only accessed by the research team. Your name will not be used or appear in any publicly released document.

12. What other things should you know about this research study?

What is the Institutional Review Board (IRB) and how does it protect you?

This study has been reviewed by an Institutional Review Board (IRB), a group of people that reviews human research studies. The IRB can help you if you have questions about your rights as a research participant or if you have other questions, concerns, or

complaints about this research study. You may contact the IRB at 410-516-6580 or hirb@jhu.edu.

What should you do if you have questions about the study?
Call the principal investigator, Dr. Elizabeth Brown a[redacted]you wish, you may contact the principal investigator by email. The address is on page one of this consent form. If you cannot reach the principal investigator or wish to talk to someone else, call the IRB office at (410) 516-5680.

You can ask questions about this research study now or at any time during the study, by talking to the researcher[redacted]

If you have questions about your rights as a research participant or feel that you have not been treated fairly, please call the Homewood Institutional Review Board at Johns Hopkins University at (410) 516-6580.

13. What does your signature on this consent form mean?

Your signature on this form means that: You understand the information given to you in this form, you accept the provisions in the form, and you agree to join the study. You will not give up any legal rights by signing this consent form.

WE WILL GIVE YOU A COPY OF THIS SIGNED AND DATED CONSENT FORM

Signature of Participant	(Print Name)	Date/Time
Signature of Person Obtaining Consent	(Print Name)	Date/Time

NOTE: A COPY OF THE SIGNED, DATED CONSENT FORM MUST BE KEPT BY THE PRINCIPAL INVESTIGATOR; A COPY MUST BE GIVEN TO THE PARTICIPANT.

Curriculum Vitae

Ana Greif

[redacted]

[redacted]

PROFESSIONAL EXPERIENCE

JOBPATH, Tucson Arizona
Chief Executive Officer 2020-Present

Provides leadership and direction to further JobPath's vision, mission, business strategy, and annual goals and objectives. Reports to the Board of Directors, and is responsible for all organizational operations including operational effectiveness and efficiency as well as fiscal management. Sets clear strategies and performance goals developed in an environment of professional collaboration and trust with the Board of Directors and staff. Acts as JobPath's lead contact in the community and is responsible for increasing and enhancing educational funding, as well as business and community partnerships.

PIMA COMMUNITY COLLEGE, Workforce Development Division, Tucson Arizona
Business Development Program Manager 2016-2020

Developed and maintained relationships with Tucson's business and industry community on behalf of Pima Community College to help companies achieve their workforce development goals. Represented the College at external meetings and events. Analyzed and interpreted economic and employment data to make program recommendations. Worked collaboratively with the various academic areas and internal college divisions to create new programs and support existing ones.

- Led the development and implementation of an initiative to address the need for specialized services for students utilizing tuition reimbursement through their employer. The pilot's outcome was a decrease in invoicing time from 60 days to 19 days, student conversion rate from advising to enrollment of 50%, and an increase in enrollment of 23% from the previous year.
- Implemented the College's redesigned Business and Industry Advisory Committee regimen across all 40 of the College's Career and Technical Education (CTE) programs, resulting in an increase from 38% of CTE programs fulfilling committee meeting requirements to 100% in one year.

VARELA CONSULTING, LLC, Tucson Arizona
President 2010-2016

Provided training and consulting services to universities, governments and economic development organizations around the world on strategies for entrepreneurial development and support. Led the development of comprehensive programs including initial planning, project management, defining team roles and monitoring their progress, executing the service and evaluating outcomes. Oversaw all aspects of the company including marketing and sales, finance, and compliance. Led team of 8, including hiring, mentoring, motivating, training, disciplining and terminating employees.

- Won a competitive US State Department funding opportunity for a $230,000 program. Executed eleven two-week training sessions for 200 entrepreneurs from five Latin American countries. Collaborated with representatives from 10 different partner institutions to deliver the program, coordinating teams from each site, and ensuring compliance with Dept. of State requirements.
- Led the international expansion for Impulsa, a business consulting firm, coordinating interactions between the staff of all the international offices, and heading the development and deployment of the Acceleration 2.0™ consulting program and MiniMBA training program. Expanded the company's business locations from 8 in 2 countries to 12 across 5 countries.

UNIVERSITY OF ARIZONA, McGuire Center for Entrepreneurship, Tucson Arizona
Executive Mentor 2014-2015

Guided, advised, and evaluated multidisciplinary student teams as they refined their innovation idea into viable business or policy plans.

PPEP, Microbusiness and Housing Development Corporation, Tucson Arizona
Director – Border Business Resource Center 2006-2009

Directed operations of a county-wide business development program serving low income, minority populations; managed a $700,000 budget ensuring compliance with multiple grants. Managed center's budget and ensured compliance with government and private funders including grant reporting and documentation. Performed outreach activities to promote the center in the community. Managed staff of 8, including hiring, mentoring, motivating, training, disciplining and terminating employees.

PROFESSIONAL ORGANIZATIONS

- **Arizona Technology Council** – Ambassador Committee member
- **Women in Manufacturing**, - Arizona Chapter board member
- **Tucson Innovation Partnership** – Co-chair and founding member
- **National Council for Workforce Education**
- **National Association for Community College Entrepreneurship**
- **American Society for Training and Development**
- **Project Management Institute**

EDUCATION

Doctorate in Education, Specialization: Entrepreneurial Leadership in Education 2022
Johns Hopkins University

Master of Public Policy and Management, Specialization: Economic Development 2010
Carnegie Mellon University

Bachelor of Science in Business Administration, Major: Human Resources Management 1995
The University of Arizona

ADDITIONAL TRAINING

New Workforce Professionals Academy 2019
National Council for Workforce Education

Supervision in the 21st Century 2019
Pima Community College, Tucson Arizona

Labor Market Information 2.0: Advanced Techniques for Community College Professionals 2018
Workforce Development Institute, New Orleans Louisiana

Lean Innovation Bootcamp 2017
Moves the Needle, Tucson Arizona

Coworking Finance: Crunching the Profit Numbers 2014
Global Coworking Conference, Kansas City Missouri

Business Model Generation Master Class 2013
Strategyzer, San Francisco California

Entrepreneurship Faculty Scholar 2009
McGuire Center for Entrepreneurship, University of Arizona, Tucson Arizona

Incubator Manager Certification, 2007
National Business Incubator Association

RECENT CONFERENCE PRESENTATIONS DELIVERED

National Association for Community College Entrepreneurship National Conference 2019
"The Fundamentals of Business Model Design"

National Coalition for Workforce Education National Conference 2019
"Laying the Groundwork for Industry Input"

National Association for Community College Entrepreneurship National Conference 2018
"Mastering Industry Engagement to Benefit Entrepreneurs and Students"

Incubation Conference, Muscat, Oman 2017
"Accelerating Innovation in the Ecosystem"

National Association for Community College Entrepreneurship National Conference 2017
"Using Business Model Canvas in Entrepreneurship Curriculum"

HonduCamp National Technology Conference , Tegucigalpa Honduras 2017
"Innovative Business Models"

INBIA International Conference on Business Incubation, Denver, CO 2015
"Business Model Generation"

INBIA International Conference on Business Incubation, New Orleans, LA 2014
"Business Plan 2.0"