Factors That Affect Completion of Employer-Driven Competency-Based Education and Skills-Based Learning Programs

by

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Abstract

In manufacturing, industry leaders increasingly value skills over traditional educational degree programs. Employers are more interested in what a candidate can do rather than what they know, which aligns with the foundation of competency-based education (Perea, 2020). The shift toward automation in the workplace requires workers to acquire advanced technology skills. Abelianski et al. (2020) projected that 37.9 million jobs will be replaced worldwide by 2030. Approximately 305 million jobs will need to be created from 2020-2030. Due to automation and robots replacing low skilled jobs, workers will need advanced technological skills. Additionally, industry technicians are now performing tasks once reserved for engineers. As technological advancements continue, technician roles are expected to require complex skills traditionally associated with college graduates (Cormier et al., 2022). The purpose of this study was to determine the impact of an industry-led, competency-based manufacturing curriculum in the Manufacturing Mobilizing Alabama Pathways (MAPs) program (Alabama Community College System, 2023). This study analyzed variables such as age, gender, ethnicity, education level, and employment status in relation to whether participants earned a Manufacturing MAPs credential. Understanding these associations may provide insight into innovative strategies for designing noncredit skills training programs that could close or significantly reduce Alabama's skills gap through competency-based education (Beverley et al., 2024).

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Chapter 1: Introduction

An increase in automation and robotics is creating a demand for training and hiring skilled workers for effective management, operation, and maintenance globally (Bashar et al., 2024). The workplace is being transformed through these automation processes, thus, requiring workers to acquire advanced skills such as programming, operating, and maintaining robots and other forms of automation (Abeliansky et al., 2020). Although automation and robots are replacing jobs, it is estimated that over 300 million jobs will be needed between 2020 and 2030 for the anticipated increase in available workers during the decade. A study by Abeliansky et al. (2020) forecasted that upper-middle and high-middle-income countries will retain older workers as they are expected to remain working after age 65. Manufacturing companies are expected to return to the U.S. and other countries as automation replaces low-level jobs, making reshoring more feasible. Companies with low-level skilled worker positions are expected to remain in low-income countries (Bolden et al., 2020).

Globally, advancements in digitalization and automation are transforming the nature of work by eliminating certain roles and raising the skills demands for others (Gouda, 2022). An estimated 90% of future jobs will require strong technical and digital competencies. In response, employers are increasingly turning to alternative credentialing systems that meet specific workplace skill requirements (Clements et al., 2020). These automation changes are ushering in demographic shifts that are shown to decrease opportunities for low-income workers globally (Abeliansky et al., 2022). Worldwide, shifts in the number of workers among age groups are changing. The labor force participation among workers in the 15–24-year-old group decreased, while the 65 and older workforce population increased in upper-middle and high-economic countries. Also, gender imbalances are expected to continue to widen during 2020-2030. The

number of females in the workplace is decreasing and is not likely to narrow by the end of 2030 (Bates et al., 2024). Labor participation among males is 74.5% and only 47.5% for females (Abeliansky et al., 2020). These demographic trends provide important insights into the anticipated workforce participation across the world.

Changes in Preparation for the Workplace

A shift has occurred across the United States as fewer students pursue traditional postsecondary degrees, signaling a change in educational preferences related to career preparation (Verougstraete et al., 2021). In fact, around 62% of individuals in the U.S. sought non-degree credentials over traditional degrees in 2020 (Verougstraete et al., 2021). According to the Committee for Economic Development of The Conference Board (CED) (2021), two-year college enrollment declined in the fall of 2020 among men (-14.7%) and first-year students (-21%). In comparison, four-year universities saw smaller declines in men (-5.1%) and first-year students (-13.1%). As perceptions continue to move away from conventional degree pathways, postsecondary and higher education institutions must adapt by redesigning student learning outcomes and integrating a skills-based approach to curriculum development (Bozik et al., 2021). This includes expanding noncredit training opportunities that are flexible, competency-focused, and aligned with real-world industry needs.

Strengthening communication between educators and employers is essential for aligning workforce training and academic programs with business and industry demands. The issue is not skills versus degrees but rather recognizing that we are now operating in a skills-based economy, where specific abilities (e.g. adaptability and flexibility)are increasingly valued by employers (Verougstraete et al., 2021). Therefore, developing noncredit programs that target the specific

skills required in industry is crucial to preparing a workforce ready to meet current and future job demands.

Reskilling and upskilling workers to meet the challenges of digital transformation in the post-COVID-19 era is also imperative (Li, 2022). Technological change and demographic shifts continue to reduce opportunities for low-income workers (Bolden et al., 2020). While non-traditional training programs are typically used for reskilling upskilling, efforts are often embedded within formal education pathways for entry level employees (Cronen & Murphy, 2013). In partnership with business and industry, colleges and universities should consider updating course curricula to ensure that new graduates are equipped with the skills necessary for today's evolving job market (Yazdanian et al., 2022).

Background on Credentials

Earning credentials through skills-based learning and competency-based education is a new and emerging topic globally, throughout the United States, and in Alabama (Bolden et al., 2020). Limited empirical research exists on employer driven training programs, especially in Alabama. This study examines how demographic factors affect course completion and credential attainment in adult education programs that focus on workforce training credentialing. By identifying potential barriers in these training programs, educators can provide the support needed to close the skills gap and meet the workforce demands (Assi & Raju, 2020). To meet student needs, it is essential for adult education leaders and training providers to adapt to the changing job market that increasingly values skills-based hiring and credentials, specifically non-degree credentials (Gaston & Van Noy, 2021). While this study focuses on Alabama, the credential initiative is part of a national and global movement (Thorne et al., 2023). Third-party, non-degree credentials, offered by professional organizations, companies, or occupational

groups, are gaining momentum (McGreal et al., 2022). These organizations identify key career-related competencies and develop certification programs tailored to industry needs (Javdekar et al., 2016). Therefore, workers are pairing non-traditional certification programs with traditional educational credentials such as degrees and certificates to highlight skills that align with new technologies required by Industry 4.0 (DeMark & Kozyrev, 2021).

Industry 4.0

Although this topic is emerging, extensive literature supports the need for credentials, skills-based competencies, and competency-based education (Clements, 2020). According to Hussin (2018), organizations are entering a new industrial revolution, referred to as Industry 4.0. Technological advancements associated with Industry 4.0, such as artificial intelligence and advanced robots, have redefined instructional strategies and program design by promoting the integration of soft skills development within education frameworks (Gouda, 2022). The purpose of Industry 4.0 is to enhance efficiency in product creation through the integration of new business models and advanced technologies (Johri et al., 2021). This shift focused on competencies such as problem solving, critical thinking, and collaborative teamwork in alignment with workforce needs (Ghonim & Corpuz, 2021).

Industry 4.0 evolved from previous industrial revolutions (Johri et al., 2021). In the first industrial revolution, Industry 1.0, water and steam were used to drive innovation. Electricity was the main element for mass production in Industry 2.0. Electronics and information technology brought automation to Industry 3.0. Subsequently, Industry 4.0 advanced these new information and electrical technologies. Although the lines are beginning to blur from one industrial revolution to the next, Singh et al. (2021) reported that manufacturing is moving into Industry 5.0. In Industry 5.0, there is more interaction between humans and robots or artificial

intelligence. Due to the partnership between people and computers, the new robots in Industry 5.0 are expected to be called cobots (Johri et al., 2021). It is predicted that 37.9 million jobs will be replaced by industrial robots, worldwide by 2030 (Abeliansky, 2020). Therefore, some are worried that robots will displace workers in job roles (Hollenbeck, 2023). Abeliansky (2020) reported that between 2020 and 2023 there needed to be over 305 million jobs created for the expected labor force participants across the globe. Yet only 5 million jobs were created in the United States even though this exceeded pre-pandemic levels (Di Battista et al., 2023). According to Li (2022), approximately 50% of the workforce will still need reskilling after 2025. Training and education programs will need to prepare this anticipated workforce for Industry 4.0 and 5.0 jobs (Johri et al., 2021).

Education 4.0

The advanced technologies and automation processes in Industry 4.0 impacted education, which is labeled, Education 4.0 (Hussin, 2018). New educational strategies, referred to as Education 4.0, provided opportunities for new learning strategies rather than simply skills and knowledge (see the learning strategies and descriptions in Table 1).

Table 1

Learning Strategies in Education 4.0

	Learning Strategies	Description
1	Asynchronous Learning	Learning occurs at different times and locations, allowing flexibility for students to learn at any time or place.
2	Individualized Learning Based on Mastery of Skills	Student progresses based on competencies rather than a time-based model.
3	Student Choice Regarding Learning Tools	Students choose tools and resources that fit their learning style and preferences.

4	Implementation Of Project-Based Learning to Develop Workplace Skills	Real-world projects develop practical skills needed in the workplace.
5	Data Analysis to Assess Theoretical Knowledge Moving to Applied Knowledge	Competency-based performance data shows gap in practical knowledge needed for success in the workplace.
6	Student Feedback Considered in Course Design and New Deployments	Student feedback drives course improvements and future implementation.
7	Teachers Become Facilitators and Students Become Independent Learners	Instructors support learning and allow for students to complete tasks at their own pace, implementing self-directed learning.

These strategies encourage students to take ownership of their learning. In Education 4.0, instructors create learning opportunities for students to become more independent and self-directed learners that does not focus on using the traditional lecture model. These new educational strategies prepare students through learning activities based on competencies to be successful in Industry 4.0 and, eventually, Industry 5.0 (Johri et al., 2021).

To integrate Industry 4.0 workforce needs with Education 4.0 learning strategies, a collaborative ecosystem of employers and educators is needed (Li, 2022). Education 4.0 was developed in response to the needs of Industry 4.0 (Hussin, 2018).According to Flores et al., (2020), one of the top challenges in Industry 4.0 is having a trained workforce. Two main ideas were presented by Li (2022) regarding how to reskill and upskill potential and current workers. First, college education can be focused on reskilling and upskilling through degree and non-degree programs. Second, employers can upskill and reskill workers through non-traditional training options such as on-the job training, conferences, re-certification, and professional

organization certificate programs.. Within five years, almost two-thirds of skills are expected to change, therefore, workers need to embrace lifelong learning through both traditional education and non-traditional training methods (Li, 2022).

Community colleges have embraced workforce development and training since the 1960s (Gregson & Ruppel, 2017). Career and Technical Education (CTE) in the community college systems have supported career paths culminating in a CTE degree or certificate (U.S. Department of Education, 2018). The federal government has funded grants aligning workforce development efforts to the needs of industry with legislation such as *The American Recovery and Reinvestment ACT of 2009* and the *Pathways Out of Poverty* grants for green jobs (U.S. Department of Labor, Employment and Training Administration, 2010).

According to Gouda (2022), both governments and other stakeholders need to participate in higher education to achieve workforce goals. Education is a means of preparing for future employment and to advance in careers. Therefore, instructors at all levels need to be trained on digital skills.

Statement of Problem

This study examined data derived from the Alabama Community College System's (ACCS) Manufacturing Mobilizing Alabama Pathways (MAPs) course to determine whether demographic factors affect course completion, which results in earning a credential (ACCS, 2023). Understanding how variables such as age, gender, ethnicity, education level, and employment status affect course completion is essential for identifying potential barriers to success and ensuring availability of appropriate workforce training opportunities. Employers have increasingly recognized that relying solely on traditional degrees does not sufficiently address the existing skills gap in the labor market (DeMark & Kozyrev, 2021). According to

Wagner and Jarrett, (2020), there were 500,000 unfilled manufacturing positions and projected that there will be more than 4.6 million jobs available by 2028. By analyzing these demographic trends, the study hoped to provide insight into creating effective strategies for credential attainment and workforce development to fill these open positions

This study examined a specific noncredit training program offered by ACCS. Within the educational community om Alabama, there has been considerable discussion regarding the differences in noncredit training and traditional education programs in terms of addressing the skills gap issue. Oft times, employers view worker's skill sets as more important than completion of an associate or bachelor's degree. According to Yazdanian et al. (2021), middle skills jobs are growing due to automation and robots. However, most of these middle skilled jobs do not require a bachelor's degree. Therefore, alternative credentials are being considered to prepare students for employment opportunities in place of the traditional degree. Also, only one-third of students who enroll in the community college usually complete a certificate or degree (Gregson & Ruppel, 2017). Therefore, community colleges are looking for opportunities to combine noncredit workforce training with traditional educational programs to encourage retention and completion.

As well as concerns with degree completion, other problems identified in the workplace literature included lack of skilled workers, an aging workforce, wellness issues, the increase in learning new processes, and resource allocation shortages (Flores et al., 2020). All of these issues involve the need for higher levels of soft skills in the workplace (e.g., critical thinking, problem solving, and communication skills); and the need to develop skills-based job descriptions to match specific technical skills. Thus, alternative skills based programs that can be attained

through non-degree credentials, licenses, certificates, and apprenticeship programs are needed in the educational systems (Office of the Governor of Alabama, 2018).

Aim of Research and Purpose of Study

This study sought to determine the impact of a skills-based, employer-driven competency-based education program by analyzing data from the Manufacturing MAPs course. The program awards a noncredit credential through ACCS which is valued by manufacturing employers across the state (Alabama Community College System [ACCS], 2023). The focus on competency-based education was selected in response to Alabama's growing skills gap, which is defined as a gap between competencies employers demand and those held by job seekers (Rikala et al., 2024). According to the Alabama Department of Labor (2022), this gap is expected to widen, with projected shortages increasing from 111,452 workers needed in 2020-2030 to 231,610 by 2045. This study analyzed whether demographic variables such as age, gender, race, educational background, and employment status, are associated with completion and credential attainment (see Figure 1 in Appendix A).

The findings of this study may inform future workforce development strategies by identifying who is most likely to complete the noncredit training programs like the Manufacturing MAPs or other credentialing programs offered by ACCS. Because the course is free and available to all Alabama residents, regardless of age, race, gender, or high school graduation status, it has the potential to reduce barriers and to expand credentialing opportunities. The Manufacturing MAPs credential is used by employers in hiring decisions, making it a practical solution to address Alabama’s manufacturing workforce shortage (AlabamaWorks!, 2023). By identifying factors related to credential attainment, this study

contributes to the broader discussion on how competency-based, skills training programs can bridge the gap between skills training and employment in high-demand sectors.

Research Questions

The central research question of this study was: To what extent do demographic factors affect if a participant will complete or not complete the Manufacturing MAPs course? This study focused on the Manufacturing MAPs non-degree credential that provides the competencies identified by employers who designed, developed, and implemented the ACCS Manufacturing MAPs course. Chi-Square Tests of Independence were used to examine whether there is a statistically significant association between participant demographic variables such as age, ethnicity, gender, education level, and employment status, and completion of the Manufacturing MAPs course and earning the credential. This statistical method is appropriate because it examines associations among variables to determine whether they are related, or statistically significant. The following sub-questions will also guide the study:

1. To what extent does a participant's age relate to whether she/he completes or does not complete the Manufacturing MAPs course?
2. To what extent does a participant's gender relate to whether she/he completes or does not complete the Manufacturing MAPs course?
3. To what extent does a participant's ethnicity relate to whether she/he completes or does not complete the Manufacturing MAPs course?
4. To what extent does a participant's education level relate to whether she/he completes or does not complete the Manufacturing MAPs course?
5. To what extent does a participant's employment status apply in relation to whether she/he completes or does not complete the Manufacturing MAPs course?

Scope and Delimitations

The Manufacturing MAPs course was selected because of the current research and Alabama State government initiatives to move towards competency-based education and skills-based learning (National Skills Coalition, 2023). The manufacturing leaders in the State developed a set of core competencies that every entry-level worker should have to be successful on the job. As manufacturing in Alabama has increased over the past 20-30 years with automobile and aerospace manufacturing (Bolden et al., 2020), there are many entry-level positions in these manufacturing plants.

This study's use of the secondary dataset, the Manufacturing MAPs course is delimited by the data collected from only between March 2023 to December 2023. The secondary database provided demographic factors obtained during the enrollment process by each applicant. Additionally, the data collection included course completion resulting in credential attainment. Although limited in date, using a secondary database has advantages including data accuracy (Vartanian, 2010).

This study was focused only on the manufacturing sector, which may limit the ability to apply the findings to other industries since credentialing, skills, and competencies may vary in other sectors. Other MAPs courses were available, such as Architecture and Construction, Healthcare, Hospitality and Tourism, Information Technology, and Transportation and Logistics, but the MAP dataset was best suited for the research questions that focused on the need to fill manufacturing positions in Alabama. When dealing with non-degree credentials, it is important to be aware of all the certifications completed by individuals in Alabama, which can be found in the Alabama Talent Triad (see Figure 1, Appendix B). The Alabama Talent Triad is in its infancy and is being used as a credential registry, job description generator, and digital wallet.

Credentials, skills, and experiences can be housed in the digital wallet section of the Alabama Talent Triad (Beverley et al., 2024) and provide a record for training experiences for individuals.

Limitations

A key limitation of the study involved participants who did not complete the Manufacturing MAPs course and did not earn the credential. Although the study examined whether demographic variables such as age, ethnicity, gender, education level, and employment status are associated with course completion and credential attainment, it did not include data on why participants did not complete the course or the modules. The lack of data regarding non-completion factors limits the ability to understand barriers that may prevent participants from completing the course (Vartanian, 2010). Barriers to completion may include personal, academic, work responsibilities, family responsibilities, etc. If fully understood, the factors may provide results and implications regarding course design, support services needed, or other strategies that may result in successful course completion. In addition, there was not data to differentiate between participants who voluntarily withdrew from the course and participants who completed the modules, but did not earn a qualifying score.

Additionally, the study was limited to one state, Alabama. Therefore, the findings may not be the same in other states due to different labor market participation rates, workforce needs, and noncredit programs available to residents. Despite these limitations, the study provided valuable insight into competency-based noncredit training programs and may provide a foundation for future research in other states or in other industry sectors.

Definitions of Terms

Apprenticeships: Structured training programs that are registered at the state or federal level that combine paid on-the-job training with related technical instruction (AlabamaWorks!, 2023).

Certifications: Credentials typically issued by third-party organizations such as industry associations, occupational groups, or professional organizations to validate skills and competencies (Gaston & Van Noy, 2022).

Certificate: A credential awarded by educational institutions, employers, labor unions, or industry organizations upon successful completion of a course, training program, or exam often signifying proficiency (Business Roundtable et al., 2022).

Credential: Formal recognition issued by a credible authority confirming an individual's knowledge, proficiency, or readiness to continue education/training or to enter the workforce (Bozick et al., 2021).

Competency-based education: An educational model in which students advance based on mastery of skills, abilities, and knowledge rather than time spent in a course or classroom setting. (Voorhees, 2001).

Demographics: Characteristics of a study's population used to identify and analyze groups. Variables may include age, gender, ethnicity, education level, employment status, and socioeconomic background. Trends, patterns, and disparities may be analyzed through research methods.

License: A legal authorization granted by the state licensing board that permits an individual to practice a regulated occupation or profession (AlabamaWorks!, 2023).

Microcredentialing: A short term, focused training programs that certify the attainment of specific competencies learned. Students may earn multiple microcredentials as evidence of skill progression or specialization.

Non-degree credentials: Flexible, often short-term credentials developed in response to workforce demands. These credentials are generally more affordable and targeted toward specific skills and knowledge (Gaston & Van Noy, 2022).

Seat Time: The amount of instructional lab or lecture time required per credit hour, as determined by accrediting agencies such as the Southern Association of Colleges and Schools Commission on Colleges (SACS-COC) (Bozick et al., 2021).

Skillify: The process of translating traditional course content (e.g., course descriptions, syllabi) into skill-based terminology that aligns with business and industry (Verougstraete et al., 2021).

Skills based hiring: An employment practice that emphasizes matching job requirements with verified skills, competencies, certificates, or credentials rather than only academic degrees (DeMark & Kozyrev, 2021).

Organization of the Study

This dissertation is organized into five chapters. Chapter 1 introduces the study, provides the rationale, and presents the study's research questions. Terms relating to the topic are also provided. Chapter 2 is the literature review, where the relevant literature builds a case for why this study is needed and what research is currently available on the topic. Sources included peer-reviewed journals, government websites, and scholarly books. Chapter 3 covers the methodology used for the study. In this chapter, the research design and analysis methods are discussed. Chapter 4 presents the results and analysis of the study, and Chapter 5 is the conclusion,

providing insights into the relationship between the findings from the research and the current literature. Recommendations for further research are included in the last chapter.

Chapter 2: Literature Review

The COVID-19 shutdown caused a disruption in the workplace (Yazdanian et al., 2021). This shutdown ushered in continuous growth within the fourth Industrial Revolution, known as Industry 4.0. To improve operational effectiveness, Industry 4.0 was implemented in 2013. Further implementation and advances in Industry 4.0 accelerated advanced manufacturing automation and artificial intelligence (AI) use. An example of an automated task replaced through technology includes delivering parts via autonomous vehicles inside a plant (Hussin, 2018). As a result of the shutdown, companies looked for alternative ways to maintain production, turning to advanced automation technology that was readily accessible, replacing low-level entry level jobs.

There is a skills gap in the United States. According to the Association for Career and Technical Education (ACTE), 89% of manufacturing companies have a shortage of skilled workers (Tobenkin, 2021). The lack of qualified workers is one of the top three challenges faced by manufacturing companies as they adopt advanced technologies such as automations and industrial robots included with Industry 4.0 processes (Flores et al., 2020). The skills gap includes soft, technical, digital, and cognitive skills. Up to 60% of manufacturing employers indicated that the skills gap will significantly impact production (Tobenkin, 2021). Alabama also reports a skills mismatch. According to a 2018 report, 58% of the jobs in Alabama require skills training, but not a four-year degree (National Skills Coalition, 2018). Only 47% of the workers have skills training needed for these jobs (NSC, 2018). To fill the high demand jobs, Alabama needs to focus on education and training for these manufacturing companies.

Technological advances brought automation processes through Industry 4.0 (Johri et al., 2021). The technological changes require upskilling and reskilling new and incumbent workers (Li, 2022). Businesses and industries have shifted their efforts to recruit and develop current employees' workforce skills to meet the needs of Industry 4.0 processes. As a result, changes in education were required to prepare students to be equipped with advanced technology tools. The new education model is called Education 4.0 (Hussin, 2018). This educational model focuses on the flexibility of content delivery such as learning that can take place anytime and anywhere, personalized learning opportunities to develop mastery, students having the opportunity to determine how they will learn (blended, flipped classroom model, etc.), project-based learning opportunities, field experiences, data interpretation, applied assessments, student feedback in curriculum design and updates, and the student will become an independent learner. The means of learning include problem-solving using soft and technical skills. Students may discover new knowledge through hands-on learning opportunities in field experiences that may include collaborative projects, mentoring opportunities, internships, and apprenticeships. These learning opportunities provide opportunities to develop new skills (Hussin, 2018). The new assessment methods may include competency-based education, which leads to degree and non-degree credentialing and may culminate in work-based learning (DeMark & Kozyrev, 2021). These Education 4.0 strategies align with the competency-based education and skills-based learning frameworks.

This chapter provides a comprehensive review of the literature related to competency-based education and skills-based learning. It outlines the methodology used for conducting the literature review, presents an overview of the theoretical framework guiding the study, identifies

the themes that emerged from the literature review, and highlights existing gaps that the study seeks to address.

Literature Review Methodology

A systematic literature search was conducted to collect a comprehensive analysis of peer-reviewed, English language articles from 2014-2024 related to credentials (Gough et al., 2017). Google Scholar, Academic Search Premier, APA PsycArticles, APA PsycINFO, Education Research Complete, Educational Resource Information Center (ERIC), Professional Development Collection, and Vocation and Career Collection academic databases were perused. The following terms were used to access scholarly peer-reviewed articles: adult learning theory, skills training, skills-based learning, skills-based hiring, Industry 4.0, Education 4.0, skills shortage, skills, reskill, non-degree credentials, competency-based education, skills gap, manufacturing, and workforce needs.

Peer-reviewed journals were accessed as the primary foundation of the literature review. Reports and legislative publications from the Governor's Office provided information regarding the State's progress in workforce training initiatives and its emphasis on increasing the number of credentialed workers. The term "credential" encompasses many areas, such as degrees, certificates, licenses, and completion of short-term training programs. The research integrated key concepts and emerging themes to develop a deeper understanding of the topic and the relationships among those themes to support the need for the study and develop the conceptual framework.

Searching for articles related to credentials in Google Scholar returned about 1.4 million results from all sources, including books, dissertations, grey literature (unpublished research), and peer-reviewed articles. To further refine the results, I searched for credentials and training in

manufacturing. Google Scholar returned approximately 153,000 articles. In the scholarly databases of Academic Search Premier and ERIC, 549 results were provided for the search "demographics" and "workforce development" or "skills training" and "manufacturing." Key search terms for these databases included "demographics on credentials," "training in manufacturing," and "skills gap."

In reviewing the material, I sought relevant literature related to the topic of credentials. My search identified articles specifically focused on credentials for adults in the workforce, including publications related to credentialing and workforce training in community colleges, universities, workforce development programs, and corporate partners. The search was refined, and repeated, resulting in 58 publications related to credentials used in workforce training. These sources provided a foundation for understanding the role of credentials and the importance of using short-term training programs in addressing the skills gap.

Conceptual Framework

This study combined Astin's (1991) Input-Environment-Outcome (I-E-O) Model, Knowles' (1970) Andragogy and Self-Directed Learning, and Kolb's Experiential Learning as the conceptual framework.

Astin's (1991) I-E-O model

Astin's (1991) I-E-O model served as the foundational structure of the conceptual framework to analyze the student demographics as the input, the online course as the environment, and completion of course competencies as the output. The I-E-O model was originally used to assess the input, environment, and output of college courses and higher education professors. In this study, the inputs included age, ethnicity, gender, education level, and employment status. The environment was the noncredit asynchronous Manufacturing MAPs

course. The output was the course competency credential attainment which is driven by self-directed learning.

The I-E-O model was significant to the study because it provided a structure consistent with the competency-based Manufacturing MAPs course (Astin, 1991). The study sought to determine if any demographic factors, or the input, of the noncredit online Manufacturing MAPs course or the environment impacts completion of the course, the output. Using this model as the theoretical framework structured the study to analyze and evaluate the Manufacturing MAPs course properly.

Astin's I-E-O Model Examples from the Literature

While specific studies applying Astin's (1991) I-E-O Model to noncredit programs are limited, the model's principles have been adapted in various contexts. In a book review of "*Promoting Belonging, Growth Mindset, and Resilience to Foster Student Success*," chapter seven applied Astin's I-E-O model (Pridgen et al., 2022) to a learning mindset. With this model, they challenged college entrance exams, encouraging colleges to replace them with a learning mindset (the input). According to Pridgen (2022), the environment includes invisible environments that do not include learning mindsets. The author discovered outcomes related to a learning mindset including degree completion and academic progress. In another study, Brown and Johnson (2018) applied Astin's (1991) I-E-O model to sports clubs. The findings showed that the sports club became a family for the participants (the input). The club provided opportunities for networking with peers, professionals, and faculty. The output was a feeling of belongingness and relatedness. While both studies focus on college students, neither assesses a specific course. Consequentially, Astin's (1991) model presents a reliable framework for a

noncredit, workforce-oriented course. This model may be applied to the important themes in the literature.

Knowles' Andragogy and Self-Directed Learning

Knowles' (1970) theory of andragogy and self-directed learning (SDL) (1975) included important concepts that were applied to the conceptual framework used in this research. These ideas included the importance of self-concept, experience, readiness to learn, orientation to learning, internal motivation, and the need to know for adult learners. The application of this model was applied as follows.

The input of Astin's I-E-O model (1991) is the skills and abilities that students bring to a college course. The professor provides the educational environment through class lectures, assigned reading, course content, and other instructional materials. The output describes the assessment model or how the instructor assesses the student learning outcomes. This format provides a thorough process to review a course and to complete an evaluation of the instructor. The model may also be used to determine if input and environment impacts the outcome (Astin, 2014).

The term andragogy, originally authored by Alexander Knapp in 1833 and Greek philosophers, was redefined by Malcolm Knowles (1970) with a new understanding of andragogy distinguishing the needs of adult learners from pedagogy, a term to identify the childhood education. The key concepts of this new andragogy model include self-concept, experience, readiness to learn, orientation to learning, motivation to learn, internal motivation, and the need to know. The SDL theory distinguishes between childhood and adult learning, emphasizing that adult learners are typically self-motivated to learn due to personal and professional goals (Knowles, 1975). Adults are eager to position themselves to earn more money,

to get a job, to advance their careers, or to continue their pursuit of lifelong learning (Bozick et al., 2021). As such, adults must be internally motivated to learn the competencies needed on the job (Gauthier, 2020). The job seeker may need to enroll in a course or complete a certificate, associate degree, or bachelor's degree to have the credentials needed to secure employment.

The increasing availability of online courses heightens the importance of SDL since students need to be internally motivated to complete these short-term training or for-credit courses. Adult students are eager to learn for their own personal reasons, rather than to earn the respect of their instructor or to be compliant. SDL is an important concept that is integral in helping students complete their learning programs (Wang & Cranton, 2012).

In reviewing the literature, it is important to understand the impact that SDL has on the success and ability of a student to complete a course (Wang & Cranton, 2012). According to Mezirow (1985), adult educators should design activities and learning prompts that encourage and point students toward SDL. Online courses are available on numerous topics or content areas to a wide array of students; however, availability differs from ability. Students must have the ability to complete a course. It may be that a student lacks the required time, childcare, internet access, tools, or equipment (e.g., computer), or the financial support required. Students must have the commitment to complete a course, which is usually internally motivated. Regardless of the issues or obstacles, there is still a link between ability and the SDL model (Wang & Cranton, 2012).

Noncredit courses or programs can benefit from applying the I-E-O Model (Astin, 1991), even though they are not credit-bearing. Students bring inputs such as prior learning and life experiences that align with the concepts of experience and experiential learning recognized by Knowles (1970, 1975), Kolb (1984, 2014), and Dewey (1938). The educational environment is

provided by the course or training, while the outcome evaluates factors such as course completion, certificates of completion, or a micro-credential, demonstrating course competency. Noncredit courses may include internal corporate training sessions, community training, and short-term credentialing options. Outcomes are not consistently measured because accrediting bodies, such as Southern Association of Colleges and Schools Commission on Colleges (SACS-COC, 2020), do not require instructional requirements for noncredit programs. Consequently, noncredit courses may be taught by individuals deemed qualified by the institution or training provider, even if they do not hold the traditional faculty credentials required for credit-bearing courses. This flexibility allows for the inclusion of subject matter experts and industry professionals. Additionally, with the rise of online learning, many noncredit courses are designed for asynchronous completion, allowing students to progress at their own pace. This flexibility underscores the need for consistent evaluation and assessment to ensure that course outcomes align with learning objectives.

Kolb's Experiential Learning

Both John Dewey (1938) and Malcolm Knowles (1970) recognized experiential learning prior to David Kolb's (1984) development of the experiential learning theory. Dewey identified a philosophy of experience. Knowles (1970) included experience, prior knowledge, and recognized adults as active learners in his andragogical assumptions of adult learning. However, Kolb (1984, 2014) is known as the author of experiential learning. According to Kolb's (2014) experiential learning theory, participants learn from activities that evolve over time. Experience transforms into learning. Through experiences on the job, workers learn, adapt to new situations, and may bring prior experiences.

Kolb's (2014) learning theory may be applied to the Manufacturing MAPS course by recognizing the value of prior learning experiences applied professionally on the job, or personally through activities. Prior learning may enhance a participant's learning. Additionally, experiential learning opportunities may deepen understanding, recall, and problem-solving abilities. Experiential learning is what you can do, in contrast with pure academic knowledge of what you can see, read about and talk about. In fact, experiential learning is connected to education, work, and personal growth (Kolb, 2014).

Conceptual Framework

The conceptual framework employed in this study combined the three major constructs described above: Astin's (1991) I-E-O model, andragogy (Knowles, 1970) and self-directed learning (Knowles, 1975), and Kolb's (1984) experiential learning. This combined framework was used as the basis to investigate the noncredit online Manufacturing MAPs study. The inputs of age, ethnicity, gender, education level, and employment status are the elements of the framework that was applied to Astin's I-E-O model. Self-concept, experience, readiness to learn, orientation to learning, internal motivation, and the need-to-know assumptions from Knowles (1970) concept of andragogy were applied to the online Manufacturing MAPs course. The Manufacturing MAPs course served the environment that was explored. The output of Astin's (1991) model was course completion based on the achievement of the identified course competencies. The noncredit program could be adapted with the following inputs: age, ethnicity, gender, education level, and employment status.

Table 2

Application of Conceptual Framework to Demographic Variables

Category	Description	Examples/Impact
Age	Includes various age groups that may influence family responsibilities and learning preferences.	Younger adults may be more comfortable with online learning than older adults.
Ethnicity	A person's ethnicity may shape their family support and educational experiences.	Cultural background may influence access to support systems or prior exposure to education.
Gender	A person's gender may affect their background and learning environment.	Career fields like manufacturing and construction are often dominated by male workers.
Education Level	Employment status includes students who are employed full-time, part-time, or not employed at all.	Students with higher education levels may feel more equipped for academic challenges.
Employment Status	Employment status includes students who are employed full-time, part-time, or not employed at all.	Full-time workers may face time constraints, while unemployed individuals might prioritize studies.

Understanding how these inputs of age, ethnicity, gender, education level, and employment impacted student learning provided insight into working with adult learners. The educational environment was the next step in incorporating Astin's (1991) model.

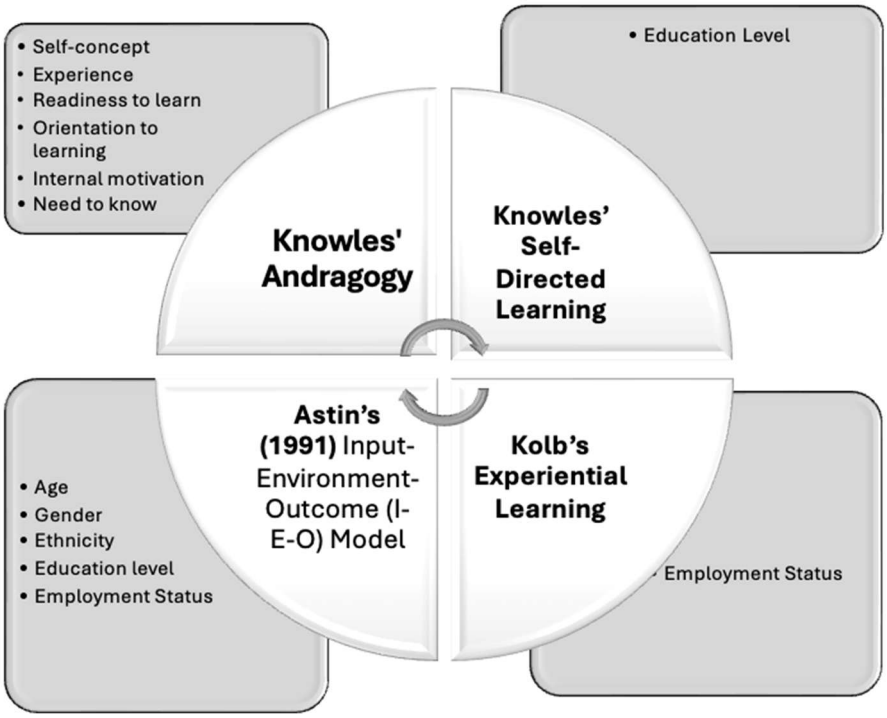
The educational environment may impact student learning through educational delivery, support services, peer interactions, and course content (Astin, 1991). Online, hybrid, or traditional face-to-face delivery may impact student learning since the various educational models appeal to learners differently. If the course is offered online, educators need to identify how support services will be provided to students if needed. Educators may provide office hours so students can meet face-to-face with an instructional advisor or course instructor. Course

evaluations can be conducted to determine if there is an opportunity for peer communication, collaboration, and discussion. Peer support may improve learning outcomes and are essential for noncredit courses. The end-of-course evaluation can include the employment status of the students in the course to determine if the work experience provides students with the required soft or essential skills.

In searching for articles related to Astin's (1991) I-E-O model in noncredit courses, there was limited use in the noncredit environment. The articles retrieved involved remedial courses taken to be eligible for credit-based college coursework, college orientation classes, dual enrollment courses, and other academic coursework. The search did not include studies on an industry-led, competency-based educational model. However, Astin's (1991) I-E-O principles, which are applied to credit courses, may also be used as a framework for a noncredit course.

Figure 1

Conceptual Framework Integrating Astin's I-E-O Model, Knowles' Andragogy and Self-Directed Learning (SDL), and Kolb's Experiential Learning Theory



The combination of Astin's (1991) I-E-O model, Knowles' (1970) theory of andragogy and self-directed learning (1970) (SDL), and Kolb's (1984, 2014) experiential learning theory provided a comprehensive conceptual framework for this study. Astin's model formed the structural framework to analyze how the participant's prior experiences (inputs) and the asynchronous online course (environment) contributed to course completion and credential attainment (outcomes). Knowles' SDL theory (1975) explained the participant's self-directed motivation and how adult learning models impact participation and completion of noncredit, competency-based courses. Kolb's (1984, 2014) experiential learning theory adds the application of the learning through field experiences which are an important final step in workforce training. Incorporating these learning theories into a single conceptual framework provides a strong foundation for understanding how adults engage with noncredit, online, industry-driven training programs such as the Manufacturing MAPs.

Themes in the Literature Review

The literature review revealed four key themes when searching databases related to credentialing and workforce training: (a) Skills Gap in the Workforce, (b) Industry 4.0, (c) Education 4.0, and (d) Credentialing. The literature reveals a growing skills gap and the rapid technological advancements driven by Industry 4.0. The workforce requires employees with verified skills, which can be confirmed through credentialing. Short-term credentials are increasingly important in preparing workers to meet the evolving technical expectations of modern industries. Education 4.0 started due to the need for advanced technical and soft skills in the industry. The new educational model in Education 4.0 was developed to address the need for technical and soft skills, which provided a flexible and personalized learning model. Credentialing was recognized as a strategy to verify needed workforce skills. The following

sections discuss the literature associated with each of the four themes to establish a foundation for the study.

Skills Gap in the Workforce

The workforce skills gap is growing in the United States, meaning there is a significant mismatch between prospective employee's skills and the required skills needed in industry (U.S. Department of Education, 2015). The gap was driven by advanced technology innovations requiring incumbent workers to gain new skills to remain employable. Therefore, companies are developing retention strategies to upskill their existing employees to keep up with the rapid technological changes. Gouda (2022) reported that 75 million jobs will be replaced through advanced technology, robots, and automation processes by 2027; however, 133 million new highly skilled jobs will be added in the same timeframe, requiring potential and current employees to reskill, upskill, or gain new skills to be equipped to be placed in these new positions. Therefore, current and future employees must obtain these advanced skills to remain in the workforce and to meet the needs of business and industry.

Business leaders need to assess their workforce needs by identifying skills gaps (Ahadi et al., 2022). Yazdanian et al. (2021) recommended that business leaders develop a collaborative workforce training plan to upskill incumbent workers and reskill current workers to meet the rapid technological advancements and competencies needed on the job. Other recommendations in the literature included on-the-job training through apprenticeships or pre-apprenticeships to equip workers with the advanced technological skills to meet the workforce needs of industry (Heyward et al., 2021).

Although apprenticeships are more successful than typical training programs, they remain underutilized in the workplace (Dembicki, 2020). Data showed that 94% of apprentices are

retained and hired full time by the company that trained them. Increasing apprenticeships in health care, energy, and cybersecurity may help fill the skills gap. Around 65% of apprenticeships in the United States are in construction, with most of the apprentices white males (Gallop, 2024). Therefore, more work is needed to expand apprenticeships and increase labor force attainment goals among those who are out of the workforce, those who are underemployed, females, and non-whites (Gallup, 2024).

The combination of collaborations with the employers, workforce boards, training providers, and public policy, may necessary to move our economy forward and to provide easier access to employment options for workers who are not typically included (The Conference Board, 2021). According to The Conference Board (2021), minorities, youth, women, and workers with less education, especially those without a high school diploma, were among the highest displaced from their jobs during the pandemic. Most of the job losses were in leisure and hospitality industries that were affected by social distancing and other business restrictions during the pandemic. These jobs were typically lower-skilled and lower wage positions and did not see a return to employment. The workers with more education, though, such as a college degree, were back in the workforce by the end of March 2021 (The Conference Board, 2021).

An example of a workforce that continues to need additional training is the health care industry due to the rapid technology changes in the medical field. The health care industry is one of the largest employment sectors in the country. Employment in healthcare is projected to increase 29% from 2016-2026 (U.S. Bureau of Labor Statistics, 2019). Yet, entry level credentials in health care are in still in high demand. In fact, there is an expectation that upcoming retirements will increase the need for health care roles. These roles include medical assistants, aids in home health, physical therapy, and physical therapy assistants (Perea, 2020).

The data projects the needs in health care to continue to grow over the next 5-10 years not only in the United States but across the world due to the aging population (Acemoglu & Restrepo, 2017).

Another high demand industry is Information Technology (IT), or the Computer Information Systems middle-skill jobs are among the in-demand careers in the United States (Gallop, 2024). The Colorado Community College System created a digital badge certification for the IT pathway with curriculum is designed to prepare students for entry-level positions with an industry-recognized credential (Perea, 2020). The college system provides the ability for students to continue the program after hiring and gain a degree (Bozick et al., 2020). Students in the IT pathway are more likely to complete an associate degree than in other fields.

Another high wage, high demand area for jobs is manufacturing. Manufacturing is affected the most through the improvement of automation and digital processes (Flores et al., 2020). The continuous modifications in technologies changes the skill sets needed for modern manufacturing is driving change in the model for skill development The skills gap and the lack of awareness about Industry 4.0 among current and prospective employees present a significant challenge, as many do not recognize the urgent need to upskill and reskill. Thus, although training providers need to focus on technical (hard) skills regarding manufacturing processes, soft skills, such as human interaction in person and online, are just as important skills.

In addition to the changes in skill sets, Tobenkin (2021) noted that approximately 89% of manufacturing companies report a shortage of skilled workers. This shortage creates challenges for the economy, and for manufacturing companies to comply with their contracts to deliver items as promised. Therefore, manufacturing companies are looking for ways to recruit and retain talent to maintain profits. The lack of skilled workers presents an opportunity for

manufacturing companies to invest in training to upskill and reskill workers to enhance efficiency to be competitive in the skills-based, technology-driven economy.

As workers returned to the workplace following the COVID-19 shutdown, many lacked the advanced technology skills required to meet new job demands (Yazdanian et al., 2021). Lower-level tasks were replaced with automation and robots, disrupting the workplace and requiring more advanced technical skills. In response to the lack of external training opportunities available, almost 70% of manufacturing companies created internal training programs to address the skills gap (The Manufacturing Institute, 2020). Incumbent workers needed upskilling and reskilling to perform essential job tasks and adapt to the new technologies (The Conference Board, 2021). As a result, employers began shifting their focus towards a skills-based approach by focusing on identifying and developing the specific competencies needed now and the future.

Skills Gap in Alabama

In the 1990s, Alabama offered tax incentives to attract manufacturing companies to invest and relocate to the state. As a result, major corporations such as Mercedes Benz, Honda, Mazda, Toyota, Hyundai, Airbus, General Electric Aviation, and Remington built manufacturing plants in Alabama (Bolden et al., 2020). To support this industrialized growth, a skilled workforce was crucial. According to the National Skills Coalition (2018), almost 58% of jobs in Alabama required skills training beyond high school but less than a bachelor's degree. However, there was a misalignment between the workforce and employer. Fewer workers were completing skills training, while more workers completed bachelor's degrees than the jobs market needed (National Skills Coalition, 2018). This imbalance contributed to the state's growing skills gap in the past decade.

The skills gap in Alabama suggests that changes are needed in corporate and educational training for the workforce (DeMark & Kozyrev, 2021). Employers need to train new and incumbent employees; in response, Alabama has continued developing initiatives to increase non-degree postsecondary attainment and labor force participation through skills-based hiring and competency-based learning (AlabamaWorks!, 2023). These initiatives include Act 2019-506 (Senate Bill 295), which created the Alabama Office of Apprenticeship in Alabama (Alabama Secretary of State, 2019), and Alabama Act 2023-539 (Senate Bill 175), which established the ReEngage Alabama Grant Program to provide scholarship grant funding for short-term credentials for Alabama residents (Alabama Secretary of State, 2023). These programs were designed to provide skills-based learning opportunities, which should provide the skilled workers needed in the State in the coming decade (AlabamaWorks!, 2023).

According to Bolden, et al. (2020), our country has gone through three distinct economic changes in the past 75 years: the industrial period, from 1945-1979; deindustrialization, from 1980-2000; and the reindustrialization, from 2000 to present. During the deindustrialization period, Alabama lost the textile industry production and steel production dropped. High paying jobs were lost during the deindustrialization period that have not been fully replaced with the reindustrialization in Alabama (Bolden, et al., 2020). The increase in manufacturing organizations has not filled the workforce positions lost from the changes as has affected employment across the State.

ACCCP and the Creation of ACE and Manufacturing MAPs

In 2018, Governor Kay Ivey developed a plan to fill open job vacancies with Alabamians (Office of the Governor of Alabama, 2018). Ivey proposed the *Success Plus* program to develop credentialed workers by 2025 to reduce the number of vacancies for skilled labor positions.

Credentialed workers would receive a certification based on completion of occupational or educational programs developed through the community college system. The credentials included certificates and degrees that verify proficiency in various jobs and sectors. The *Success Plus* program planned to track the number of credentialed workers from 2018–2025. Because of *Success Plus* and the need for credentials, Governor Kay Ivey created the Alabama Committee on Credentialing and Career Pathways (ACCCP) to determine credentials of value (Office of the Governor of Alabama, 2020).

The manufacturing industry defined the exact competencies needed for entry-level workers. Alabama manufacturing companies still faced a shortage of skilled workers to fill technical positions requiring specific training, such as machinists, maintenance technicians, and welders (AlabamaWorks!, 2023). Eventually, ACCCP added sector committees to each career cluster area to determine the exact skills and competencies needed for the jobs and placed them on a tiered system (see Figure 1 in Appendix C). The ACCCP defined the competencies and skills required for entry-level positions, which defined the need for short-term training aligned with industry needs (Alabama Department of Commerce, 2023).

The State of Alabama researched why workforce needs were high when unemployment rates were low (Alabama Talent Triad, 2023). The research conducted by the Alabama Talent Triad team (2023) found that upskilling adults with credentials would be necessary to meet the needs for a skilled workforce . Thus, state legislation was passed to elevate skills in Alabama to fill these positions (see House Bill 2023-109, Senate Bill 2019-295, Senate Bill 2023-175) (Alabama Secretary of State, 2023, 2019). These initiatives and organizations aim to address issues that have emerged in Alabama, working to stabilize the economy and make stronger, more competitive companies flourish.

There remains work to be done to meet the goals of *Success Plus*, but Alabama is on track to make this happen with House Bill 109 was signed by the Governor on June 1, 2023, becoming ACT 2023-365 (Alabama Secretary of State, 2023). This bill created the Alabama Credential Quality and Transparency Act which authorized the creation of the Alabama Terminal on Linking and Analyzing Statistics on Career Pathways Act. The purpose was to create a public database for educational and occupational credentials. The Alabama Talent Triad was also developed to connect prospective workers who hold credentials with companies who need workers with those credentials (AlabamaWorks!, 2023). A new database was developed by Alabama Talent Triad that is divided into three important sections: (a) Alabama Credential Registry; (b) Alabama Skills-Based Job Description Generator; and (c) Alabama Digital Wallet (AlabamaWorks!, 2023).

The credential registry section consists of the educational and occupational credentials of value identified by the Alabama Committee on Credentialing and Career Pathways (ACCCP). Companies in Alabama are encouraged to rewrite job descriptions based on skills and post positions in the Alabama Talent Triad database. The job description generator then links skills with competencies. The database creates a Alabama Digital Wallet allowing users to enter earned credentials in the Learning and Employment Record section.

Another issue in the Alabama economy is the labor force participation rate. Alabama is working to determine why some individuals do not enter the labor force. According to the U.S. Bureau of Labor Statistics (2023), the labor participation rate in Alabama was 56.7% in March 2023. Some of the initiatives and non-degree credentials put into place by the ACCCP committee were developed to encourage Alabamians who do not work to enter or reenter the labor force after leaving a job or losing employment. The grant program created in Alabama Act 2023-539

(SB 175) is designed to help increase both college degrees and the completion of short-term credential programs in the state (Alabama Secretary of State, 2023). The grant covers tuition, fees, books, materials, and supplies for any Alabama Community College System institution (Alabama Secretary of State, 2023). The skills-based and competency-based programs are designed to help build the future workforce (Flores et al., 2020). Understanding how the ACCCP committee aligns with Success Plus and the Alabama Talent Triad offers insight into the resources available for addressing workforce issues in Alabama (C-BEN, 2023).

Industry 4.0

The advances in technology caused the skills gap to accelerate which led to the fourth Industrial Revolution, Industry 4.0. (Flores et al., 2020). In 2011, the German government conceptualized and created a core policy of Industry 4.0 (Johri, 2021). Industry 4.0 was implemented in 2013 and is a highly researched topic (Flores et al., 2020). The digital revolution has caused four distinct disruptions: (1) the increase in data and information; (2) an advanced level of analysis; (3) a complex intensity of connectivity; and (4) greater computational power (Johri, 2021). Hussin (2018) reported that Industry 4.0 growth is at an exponential pace and is more than an advancement of Industry 3.0, as people, governments and businesses are all impacted by this new industrial revolution. This new industrial revolution led to a greater need for noncredit manufacturing training. Technological advances in Industry 4.0 brought about changes need to upskill and reskill within and across industries.

Education and local, state, and national government offices are also concerned about the economic impacts of a lower-skilled workforce and the difficulty in filling open positions and jobs. Therefore, government officials need to plan strategies for training the workforce in advanced technology and automation processes (Bolden et al., 2020). The key technologies in

Industry 4.0 include linking computers to accomplish goals within the Internet of Things (IoT), 3D printing, artificial intelligence systems, virtual reality, connectivity for the supply chain, and interactive robotics (Johri et al., 2021). One of the top three challenges with Industry 4.0 is the skills gap, compounded by the availability of qualified workers, an aging workforce, chronic illness, volatility, uncertainty, complexity, ambiguity (VUCA), and resource utilization (Flores et al., 2020). To prepare a workforce and to accomplish the goals of Industry 4.0, workers need a combination of soft, hard (or technical), digital, and cognitive skills. Also, a focus on emotional intelligence is becoming a key component due to the impact of chronic illness and disease that is associated with stress and mental workload; for instance, the U.S., UK, Australia, and New Zealand report an increase in suicide, loneliness, and anxiety in adults (Flores et al., 2020).

In Industry 3.0, production was automated through electronics and Information Technology (Hussin, 2018). Now, Industry 4.0 impacts skills requirements due to the advanced technological advances in modern manufacturing. We see physical, digital, and biological changes evolving simultaneously. There is not a clear distinction among these concepts as these concepts are disrupting technologies, including advanced autonomous vehicles, quantum computing, and bio and nanotechnologies (Li, 2022). This disruptive technology drives evidence for the need in competency-based, cognitive learning processes that allow for quicker adaptation.

Automation improves the workplace by replacing redundant low-skilled positions. However, this change comes at a cost for the industry. The economic consequence of automation includes the capital investment required to purchase new tools and machinery and integrate the new systems (Flores et al., 2020). Additionally, companies must invest in training their employees to utilize the new machinery. The post-pandemic economy is driving the need for faster growth in innovative skills (The Conference Board, 2021). In a study from Egypt, the

trends show that automation will replace over 75 million jobs worldwide over the next five years (Gouda, 2022). In an earlier study in 2017, the forecast model showed that 2 billion jobs would be removed or replaced as early as 2030 (Frey, 2012). The total loss of jobs from the shift towards advanced automation in the workplace requires workers to be equipped with increased technology skills to continue to function in the workplace. Learning these skills must come at a quicker pace to keep up with the changes.

According to the *Future of Jobs Report* (World Economic Forum, 2016), global supply chain issues are minimized with 3D printing since parts can be created on demand. The emergence of 3D (3-dimensional) printing provides opportunities for parts to be created quickly to keep equipment operational with the changes in technologies. Highly skilled technicians are required to scan, design using AutoCAD or similar software, and print the model parts using 3D technologies. This technology is also being used in the healthcare industry to print prosthetics and other parts needed for the human body. Through Industry 4.0, improvements to 3D printing through additive manufacturing allow the joining of materials, including metals, to get a better part or product (Prashar et al., 2022). This improvement is advancing the use of 3D printing and is ushering in 4D printing models that may require additional skills (World Economic Forum, 2023).

The Internet of Things (IoT) in Industry 4.0 provides data analytics that management uses for decision-making and supply chain processes (Johri et al., 2021). Utilizing web-based internet connections provides automatic ordering and logistics tracking. The next industrial revolution, Industry 5.0, will improve working conditions and company profits by using IoT processes to collaborate between man and computer. IoT and Industry 4.0 automations may result in reshoring or bringing production back home rather than offshoring (Abeliansky et al., 2020).This

new era may see the need for merging of human skills and artificial intelligence (AI), robotics, and computer skills. Although AI is a new and emerging technology, it is not yet mastered or understood by most workers (Aghion et al., 2022). AI is "the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings" (Li, 2022, p. 4). Li (2022) reported that AT&T investigated the use of AI in drone technology to repair base stations for cellphones. Another area AI is being utilized now analyzing big data and developing algorithms that provides a competitive tool for companies. They can use data to forecast and prepare for emerging market trends (Li, 2022). The technology is expected to grow and improve, and according to Aghion (2022), companies that use and invest in AI processes see higher sales and profits.

The International Federation of Robotics (IFR) reported that 2.1 million industrial robotics were used in the industry in 2017 globally (Abeliansky et al., 2020). That number grew significantly from only 400,000 industrial robotics in 1990, where robots replace workers in low-skilled positions. Human workers need to have skills that cannot be replaced with automation. A study by Acemoglu and Restrepo (2017) showed that 47% of workers are at risk from automation in the United States, and Germany are risk for automation at 41%. Other countries, such as China and Vietnam, are expected to invest heavily in robots and automation processes by 2030. Brazil, India, Indonesia, and Russia are expected to see a lower rate of labor replacement due to a lower investment in robots (Abeliansky et al., 2020).

Education 4.0

The innovations in Industry 4.0 brought about the need to restructure education, which created a need to reform educational models with the elements of Education 4.0. Most adults are familiar with traditional education models and programs, which are often viewed as seat time

with a teacher lecturing in the front of the classroom (Gauthier, 2020). Yet, this method of instruction is not meeting the needs of today's workplaces and industries. Thus, educational methods have attempted to change to increase interest, raise the academic rigor, and to use critical thinking and problem-solving techniques needed in industry and the workplace (DeMark & Kozyrev, 2021). Most of these changes have derived from business and industry professionals requesting changes to education in the form of skills-based instruction rather than degree programs. According to Hussin (2018), nine trends have shaped Education 4.0 (see table 2 for details).

Table 3

Nine Trends Shaping the New Educational System

Trend	Description
E-Learning	Learning can occur anytime and anywhere, providing flexibility beyond the traditional classroom.
Personalized Learning	Instruction is tailored to individual student needs, interests, and learning styles.
Student Choice in Learning	Students select their preferred learning format, such as flipped classrooms, blended learning, or BYOD (Bring Your Own Device).
Project-Based Learning	Students engage with real-world problems or case studies from business and industry, developing time management, organizational, and collaboration skills.
Field Experiences	Practical learning opportunities through internships and cooperative education experiences.
Data Analysis	Students analyze and interpret data to support decision-making processes.
Assessment	Evaluation occurs through application of learned concepts during field experiences, simulating real-world job assignments.
Curriculum Design	Course design is guided by student feedback to improve course layout, accessibility, and clarity.
Students as Independent Learners	Students assume responsibility for their own learning, with instructors acting as facilitators; learning is experiential rather than lecture based.

To effectively integrate these emerging learning trends, instructors must be equipped with the abilities to utilize Education 4.0 and different learning tools. According to the World Economic Forum (2023), the top 10 skills in 2020 were complex problem-solving, critical thinking, creativity, people management, coordinating with others, emotional intelligence, judgment and decision making, service orientation, negotiation, and cognitive flexibility. Curricular change is needed with corporate and educational training to provide workers with these skills that are needed to be successful on the job. According to Hollenbeck (2023), two main issues in the United States workforce are the barriers that underrepresented populations encounter and how to address the significant number of people in this category. As education evolves from traditional models toward innovative approaches such as e-learning, personalized instruction, project-based instruction, and experiential field experiences, there is an increased emphasis on cultivating graduates who are prepared to meet the demands of the workforce (Verougstraete et al., 2021). Notably, it is more difficult to impact youth with these new methods and skills-based learning due to state and federal requirements for primary and secondary education. Therefore, skills-based instruction is typically seen in adult education and training programs with work-integrated learning and apprenticeship opportunities (Jackson, 2015).

According to Hawkins (2019), approximately 27% of adults 25 and older in the United States do not hold an academic credential beyond a high school diploma. In Alabama, 87.4% of the population has earned a high school diploma or higher, yet only 26.7% have a bachelor's degree or beyond (Alabama Department of Labor, 2023). Remedial course requirements for college students present a significant barrier to postsecondary success (D'Amico, 2017). In response, many community colleges have implemented noncredit courses to assist students in

building the skills necessary for college-level work. Committing to one year of education or training beyond high school may lead to a 3% increase in wages (Cronen & Murphy, 2013).

Despite these opportunities, students who graduate from high school and enroll in community college demonstrate only a 25% graduation rate within a three-year period. Low-skilled workers, with a high school diploma or less, also display distinct patterns of workforce participation. Hawkins (2019) found significant ethnic and gender differences among lower-skilled workers, noting that 57% were male. Additionally, low-skilled young adults aged 16 to 24) represent approximately 5.8 million individuals who are neither employed nor enrolled in school (U.S. Department of Education, 2015). Approximately 66% of the young adults are male and identify as African American, Hispanic, or American Indian. Given that nearly two thirds of new jobs require training beyond high school, it is critical to develop programs that expand educational and workforce training opportunities for this population.

Training and Education

The next section focuses on the importance of credentialing and how it is transforming education and hiring in the workplace. Although the terms training and education are often used interchangeably, they serve distinct purposes in workforce development. Training typically refers to short-term noncredit instruction for skill building and competencies related to job performance (Assi & Raju, 2020). Training is an important part of human resource development for workers to improve performance of specific tasks related to job requirements and performance. Overall, effective training is designed to grow the individual and the organization.

In contrast, education is often time-based, credit-bearing, and reflects broad academic courses rather than job-related skills (Peasley, 2022). There are specific start and end times, and interested students must enroll in the course and commit to completing course activities, tests,

and assigned readings. These courses are not always job specific and may give the student the opportunity to acquire knowledge rather than skills. Peasley (2022) introduced traditional education as topics of common knowledge that all college students should acquire. We consider these classes to be the core academic courses that every student takes during their first two years of college. The overall issue is encouraging students to see the value of this core academic education in relation to their careers and work**.** According to Gouda (2022), education is an important aspect of development and growth for learning across the lifespan and work. It provides an opportunity for students to gain abilities that transfer into future employment opportunities and career advancement. However, the Generation Z (born from 1997 to 2012) are not as interested in attending college as previous generations (Gouda, 2022).

Credentialing

Although there are clear distinctions between education and training, more short-term training is being embedded into traditional credit-bearing educational courses (Bozick et al., 2021). Many terms are related to the topic of credentialing including certifications, certificates, micro-credentialing, and meso-credentials. Credentialing is a widely discussed topic among state leaders and employers nationwide (Heyward et al., 2021). The federal Perkins V legislation that detailed the appropriate uses of Carl Perkins funds for career and technical education prioritized credentials to ensure graduates have documentation of verifiable, workforce-ready skills that align with workforce needs (Hyslop, 2018). Bozick (2021), defined *credential* as formal recognition by a credible body that confirms the knowledge, skills, and readiness to continue education or to enter the workforce. Adults must be internally motivated to learn needed competencies on the job (Gauthier, 2020). A job seeker may need to complete a course,

certificate, associate degree, or bachelor's degree to meet the credential requirement for employment.

According to Gaston & Van Noy (2021), students need to become familiar with credentialing options, providers, and access (i.e., traditional and online) in order for them to be desirable. Postsecondary institutions normally rely on traditional degrees and certificates, though. Gaston & Van Noy, (2021) discussed the differences in credentials such as certifications and certificates that need to be understood. Educational degrees and certificate options are credentials, whereas nontraditional, occupational options include bootcamps, state certifications or licenses, and third party-credentialing. For-credit programs are governed by accrediting bodies such as SACS-COC (2023), which sets guidelines for student learning outcomes in discipline programs. Degree and certificate requirements are an important part of the SACS-COC review to maintain accreditation for postsecondary and collegiate institutions (Gaston & Van Noy, 2021).

Community colleges are uniquely equipped to meet the workforce needs. According to Cronen & Isenberg (2018), approximately 45% of workers held a postsecondary degree in 2016. Credentials such as Cisco Certified Network Associate are considered non-degree credentials and may be held by candidates with or without degrees. When non-degree credentials are added, as many as 58% of the labor force have a credential (e.g., a certificate, degree, or an industry-recognized credential). State licenses accounted for 56% of credentials in 2016 for workers without a postsecondary degree, whereas the non-degree certification (i.e., third-party certifications) was the lowest held at 21% (Cronen & Isenberg, 2018).

Employers need a trained workforce, therefore prospective workers also look for a lower cost, quicker way to gain the skills required for the job (McGreal et al., 2022). Postsecondary programs have integrated credentialing into the curriculum so students may earn industry-

recognized credentials concurrently with their coursework. Retention rates among employees are higher for workers who earn institutional credentials along with their micro credentials (McGreal et al., 2022). A second study involved looking at the aging and retiring workforce that is 50+ years old (Flores et al., 2020). The advanced skills vary from those of the adolescent group. Both studies showed that prospective and current workers could benefit from skills-based training. The presented model shows that innovation impacts Industry 4.0, which impacts learning. Following this model, it is recommended that management create skills-based training to improve workers' skills and capabilities to work.

Shortage of Skilled Manufacturing

Manufacturing groups such as the Association for Manufacturing Excellence and National Advanced Manufacturing are creating awareness regarding manufacturing employment opportunities through collaborating with school districts across the country to highlight Manufacturing Day celebrating on the first Friday in October. Manufacturing companies and educational partners are encouraged to allow tours to provide current information on career opportunities in every community.

According to the Alabama State of the Workforce Report XV (2021), one of the significant challenges in the workforce is the aging workforce and recent and upcoming retirements (Alabama Department of Labor, 2023). In Making Skills Everyone's Business, business and industry spends approximately $450 billion to train and upskill employees (U.S. Department of Education, 2015). This amount is almost 25 times the amount of federal dollars that are dedicated to workforce training (U.S. Department of Education, 2015). Flores et al. (2020) indicated that innovation has resulted in a lack of skilled workers. The challenge is: how to maintain production levels which utilize the current skills of the workforce, and at the same

time, train existing workers in new areas of technologies. These new technologies include designing and creating 3D parts and materials, maintaining interactive robots, and interacting with Internet of Things (IoT) technologies.

Due to the challenges and opportunities in the manufacturing industry, a partnership was created between MassBay Community College and Northeastern University (Javdekar et al., 2016). The two institutions created a Computer-Aided Design (CAD) Certificate program because 82% of U.S. employers had unfilled manufacturing positions and needed workers with advanced manufacturing skills. These skills include scanning and creating 3D models in a CAD program. The program is designed to prepare students for further study in manufacturing. Students may continue learning to gain skills in Computer Numerical Control (CNC) machining and programming, geometric dimensioning, and statistical process control. The hands-on training introduces skills needed to work with robots such as coding and data processes. Due to the partnership between the community college and the university, the courses may lead to short certificates and eventually to degrees if students continue their study. The program combined experiential learning coursework with direct experience in a co-op or internship program (Javdekar et al., 2016).

One strategy to equip the workforce, as reported by Dembicki (2020), is to align job training issues among federal partners such as the Department of Defense, Education, Health and Human Service, Housing and Urban Development, and Veterans' Affairs to focus collaboratively on barriers that arise for workers. If these federal partners can work together to address these issues, we should see an increase in training programs and reskilling of incumbent workers. Collaboration between state and federal agencies and other stakeholders is essential to

developing the workforce. Overall, the lack of skilled workers slowed the economy and created barriers to growth since companies could not find workers to fill these positions.

Competency-Based Education (CBE)

Competency-based education (CBE) is gaining traction as an emerging educational model. CBE originally began in the 1970s in Postsecondary Vocational Education and is now being used in higher education and academic areas (Burnette, 2016). Voorhees (2001) states we need a common language regarding competencies. Competency-based education is a method of learning that combine skills, abilities, and knowledge needed to perform a specific task focused on outcomes or mastery, rather than time (Clements et al., 2020). The Southern Association of Colleges and Schools Commission on Colleges (SACS-COC) defines competency as "clearly defined and measurable statement of the knowledge, skill, and ability a student has acquired in a designated program" in the Direct Assessment Competency Based Education Policy Statement (SACS-COC, 2020, p. 9). Two separate programs are approved by SACS-COC: Competency-Based Educational Programs and Direct Assessment Competency-Based Educational Programs. The difference is that a direct assessment may be used in lieu of hours, such as clock time or credit hours. Both programs involve an assessment of competency-based identified outcomes.

Competency-based educational programs lead to skills, and students earn credentials that are critical to obtaining employment (Morgeson et al., 2009). Competency-based education requires adult students to learn based on competencies rather than simple completion or time-based courses (Gauthier, 2020). To complete a course, a student must demonstrate proficiency (Johnstone & Soares, 2014). These competencies relate to the actual skills needed on the job. Education programs do not always produce skills connected to job requirements. According to Peasley (2022), employer-driven training programs are the solution to solve skilled worker

shortages and fill vacant positions in the workplace. Employers benefit from competency-based programs that center on skills needed on the job. Time-based programs developed by academia are not of interest to employers due to the time required to complete the credential, such as degrees and certificates (McGreal et al., 2022). Companies use apprenticeships as learn and earn models to secure employees in highly technical fields such as information technology automation, artificial intelligence, and other advanced manufacturing positions (The Conference Board, 2021).

As third-party credentials increased in postsecondary and higher education, faculty and educational leaders are considering shifting to a competency-based model (Burnette, 2016). Credentialing influenced the growth of competency-based education (CBE) by shifting the focus from traditional education, such as time or credit hours, to the validation of specific skills and proficiencies (Johnstone & Soares, 2014). To accomplish the goal of aligning educational outcomes and student preparation with the needs of business and industry, competencies were identified as the most relevant model to implement. Credentialing became the basis for CBE, to identify mastery of key proficiencies rather than traditional theory-based and time-based educational models. Credentialing led to the development of competency-based education (CBE) by prioritizing the measurable proficiency of skills. There is a shift taking place moving from traditional time-based learning to evidence of specific skills. The increasing demand from employers to have a skilled workforce encourages higher education institutions to move towards credentials and competencies to align courses with real-world applications which prepares students for business and industry needs.

Most competency-based educational programs lead to skills, and students earn credentials that are critical to getting hired (Morgeson et al., 2009). Meeting the goal of measuring

competencies with required skills and matching learners to employers that value competencies may present challenges for both educators and employers. Western Governors University (WGU) accomplished this task by creating a skills-based framework for high-demand skills and competencies (DeMark & Kozyrev, 2021). The skills-based framework design includes technical, social-emotional intelligence, and other essential skills such as creativity, critical thinking, and working with others. The components of the WGU framework included a competency-based curriculum, learning opportunities for identified skills gaps, regional workforce development needs, technology tools to connect employers with skilled worker talent, and career coaching to help students identify and promote their comprehensive workplace skills portfolio. Using current skill demands to drive the curricula has made the skills-based approach at WGU successful for students and employers. It is expected that future hiring practices will include technology platforms to connect skills-based hiring practices with digital badges and skills-based competencies held by incumbent and potential workers. Through innovative practices and new technology platforms, skills-based hiring practices are expected to continue to grow to meet the demand for new talent (DeMark & Kozyrev, 2021).

According to McClarty and Gaertner (2015), competency-based assessments may verify credentials, degrees, credits, or other certifications. In developing competency-based assessments, the goal of the measurement tool is to link skills and competencies. Critical thinking and problem-solving skills are typically involved with competency-based assessments. Skills-based hiring practices are being developed because companies realize that theoretical knowledge alone is insufficient to prepare for the workplace. Therefore, students and prospective employees must focus on skill attainment and verifying competencies achieved (McClarty & Gaertner, 2015).

Competency-based education, skilled-based competencies, and employer-driven educational models are increasingly emerging in the United States and worldwide (National Skills Coalition, 2023; Peasley, 2022). Flores et al. (2020) observed that educators frequently fall short by emphasizing technological or subject specific skills over competency-based skills. Flores et al. (2020) identified five main models: (a) self-awareness, (b) cognitive functioning, (c) interaction with others, (d) hard or technical skills, and (e) digital skills to be digitally interactive. Community colleges, universities, and other training providers that focus on competency-based models thrive with this new generation of learners and with the existing employment needs driven by the technological changes that brought about Industry 4.0, the fourth industrial revolution (Hussin, 2018). Industry 4.0 provides a new way of thinking and a new educational model. Student learning outcomes must focus on competencies that match employer needs rather than traditional educational methods and models (Hussin, 2018).

Skills-Based Learning

A shift in training and education has emerged across the United States (Flores et al., 2020). As the COVID-19 shutdown disrupted most workplaces, employers were tasked with adapting to rapid technological changes and the continued need for skilled workers (The Conference Board, 2021). These employers could not wait for prospective employees to earn degrees or certificates, they needed workers immediately to address the skills gap (Yazdanian et al., 2022). Companies also developed partnerships with community colleges and other organizations for short-term noncredit training programs to prepare workers for entry-level positions. These programs were conducted either in-house or at local community colleges. The short-term training programs presented a solution for job vacancies and aided in training the workforce during an unprecedented period (Abeliansky et al., 2020). Companies are shifting to

skills-based hiring practices instead of certificates and degrees to meet the industry needs (The Conference Board, 2021).

Credentialing for the Workforce in Alabama

According to Cygnal's (2023) research in Alabama, 74% of employers look for non-degree credentials in candidates. Almost half of the employers will pay for credentials, especially for short-term training programs that are 6 months or less in duration. According to a jobs report from the U.S. Department of Labor Statistics (2023), payroll records show that manufacturing employment grew in most states across the country from February 2022 to February 2023 (U.S. Department of Labor Statistics, 2023). In Alabama, manufacturing jobs grew from 270,000 in February 2022 to 278,900 in February 2023. The number is slightly more than 10% of all jobs in Alabama. In February 2022, Alabama had 2,097,900 workers on the payroll. By February, employment increased to 2,139,400 workers (U.S. Department of Labor Statistics, 2023).

Alabama is part of the National Skills Coalition's (2019) *Expanding Opportunities: Defining Quality Non-Degree Credentials for State*. The program provided guidance to each participating state. The National Skills Coalition provided guidance in developing quality credentials (Moore, 2022). Each participating state and its educational partners are tasked with the accountability measures involved with credentialing students and/or employees annually (National Skills Coalition, 2023). Reporting is included from colleges and universities awarding associate and bachelor's degrees, certificates, and third-party credentials from the 2020-2021 and 2021-2022 cohorts. State-licensed apprenticeships through the Alabama Office of Apprenticeship and state-issued licenses are also reported as credentials. Credential Engine (2022) is a nonprofit company that collects credentials from each state across the United States. Their work is related to the federal Perkins V legislation and other initiatives such as the

Workforce Innovation Opportunity Act funds (Hyslop, 2018). It was estimated that around 1.9 trillion dollars (about $5,800 per person in the United States) were spent on training in educational programs with around 1 million credentials in 2021 (Everhart et al., 2021). Transparency among these credentials has become important to stakeholders (DeMark & Kozyrev, 2021). Credential Engine subsequently emerged to explore credentials and to bring transparency to the reporting process of credentials. The organization introduced the Credential Transparency Description Language, which provided open-source metadata results for these credentials. Through this database, business owners and human resources personnel determine the best candidates for the positions to acquire a trained workforce (Credential Engine, 2022).

The Mobilizing Alabama Pathways (MAPs) for Manufacturing course was created as a noncredit credentialing course to train entry-level workers on specific skills needed in manufacturing (Alabama Community College System, 2023). According to the U.S. Department of Commerce (2022), the sixth largest sector in the country was manufacturing as of 2022. In Alabama, according to the State of the Workforce Report XVII, manufacturing made up 13.8% of the jobs in the first quarter of 2022 (Alabama Department of Labor, 2023). As one of the top five largest employers, manufacturing was noted as being the highest paid. The other high wages were earned in smaller businesses. Thus, the need for manufacturing workers led to the creation of the Manufacturing MAPs course in Alabama and was designed to address the needed skills identified by the ACCCP committee. The MAPs course provides a route to make sure workers have the critical workplace skills identified by employers. The manufacturing leaders on the ACCCP committee provided input on the development of the course (Alabama Community College System, 2023).

Credentialing validates a student's skills and abilities for education and workforce development that leads to future employment (Clements et al., 2020). Rather than simply validating learning through time spent in a classroom, credentials recognize skills achieved often from a credible third-party resource which may be required for employment opportunities. Credentialing inspired the increased interest in competency-based education (CBE), which highlights the attainment of identified proficiencies needed in the workplace rather than conventional time-based educational measurements that are defined by the credit hour and calculated based on accreditation standards (Gomez, 2014). Employers encouraged educational partners to align student learning outcomes with relevant competencies for related employment opportunities to ensure graduates acquire skills valued by employers. Moreover, the importance of credentialing increased as employers implement skills-based hiring practices. To fill needed positions, employers embraced short-term, non-degree training programs that quickly prepare workers for employment vacancies. CBE is observed in manufacturing, where credentialing programs helps enable prospective workers to obtain and validate mastery of the essential skills needed for entry level manufacturing positions (McClarty & Gaertner, 2015).

Literature Gaps in Competency Based Education and Skills Based Learning

The literature review demonstrates the changing landscape of competency-based education (CBE) and skills-based learning, particularly within the context of employer-driven programs. This change is reflected in rapid technological developments, particularly with the arrival of Industry 4.0. The increasing demand for a workforce equipped with technical and soft skills, Education 4.0 has emerged as a new educational paradigm designed to prepare learners for the complexities of modern work environments (Li, 2022).

CBE is a critical model in this new educational environment, focusing on the development of specific skills and competencies rather than traditional time-based outcomes. This model is particularly appealing to employers of the alignment of learning with the practical skills needed in the workplace (McClarty & Gaertner, 2015). According to Gauthier (2019), employers valued experience and credentials over degrees. However, while CBE is becoming more prevalent in non-academic settings, the literature reveals several gaps, mainly in understanding how these programs can be optimized to improve completion rates and effectively integrate soft skills.

The literature review identified significant skills gaps in the current workforce, which have been amplified by the technological advancements of Industry 4.0. This gap has led to a growing emphasis on short-term credentialing and non-degree training programs, which can quickly upskill workers to meet industry demands (Flores et al., 2020). These programs, often developed in collaboration with employers, are designed to be flexible and responsive to the needs of the labor market. However, there is still limited research on the successful completion of these credentials by adult learners and their impact in the workplace.

Employer-driven CBE programs represent an important intersection between training and industry. These programs are designed to meet specific workforce needs, often incorporating elements of apprenticeship and on-the-job training. The literature suggests that while these programs are effective in theory, their success in practice is contingent on several factors, including learner engagement, demographic considerations, and the integration of both hard and soft skills (Gauthier, 2020).

The review also explored how demographic factors affect learner success in CBE and skills-based programs. Variables such as age, ethnicity, gender, and prior education level

significantly influence program completion (Abeliansky et al., 2020). However, further studies are needed to better understand these influences and develop strategies that support diverse learner populations. This study will examine the impact of demographic factors on age, ethnicity, gender, and education level with the successful completion of a CBE program. Addressing these gaps is essential for optimizing CBE programs to meet learner and employer needs in a rapidly changing labor market.

Chapter 3 provides the research methodology, Chapter 4 shares the results of the analyses, and Chapter 5 completes the dissertation with the discussion, implications, and recommendations for future research.

Chapter 3: Methods

This chapter outlines the methodology used to conduct the research study. It provides an overview of the research design, population, sampling procedures, data collection instruments, and statistical methods used for data analysis. These components were explored to ensure a comprehensive study of the factors that may affect course completion and credential attainment in the Manufacturing MAPs course.

Purpose of the Study

This study sought to determine the impact of a skills-based, employer-driven competency-based education (CBE) program by analyzing data from the Manufacturing MAPs course. The program awards a noncredit credential through the Alabama Community College System (ACCS) which is valued by manufacturing employers across the state (ACCS, 2023). The focus on competency-based education was selected in response to Alabama's growing skills gap, which is defined as a gap between competencies employers demand and those held by job seekers (Rikala et al., 2024). According to the Alabama Department of Labor (2023), this gap is expected to widen, with projected shortages increasing from 111,452 workers needed in 2020-2030 to 231,610 by 2045. This study analyzed whether demographic variables such as age, gender, race, educational background, and employment status, are associated with completion and credential attainment (see Figure 1 in Appendix A).

The findings of this study may inform future workforce development strategies by identifying who is most likely to complete the noncredit training programs like the Manufacturing MAPs. Because the course is free and available to all Alabama residents, regardless of age, race, gender, or high school graduation status, it has the potential to reduce barriers and to expand credentialing opportunities. The Manufacturing MAPs credential is used

by employers in hiring decisions, making it a practical solution to address Alabama's manufacturing workforce shortage (AlabamaWorks!, 2023). By identifying factors related to credential attainment, this study contributes to the broader discussion on how competency-based, skills training programs can bridge the gap between skills training and employment in high-demand sectors.

Research Questions

The central research question of this study was: To what extent do demographic factors affect if a participant will complete or not complete the Manufacturing MAPs course? This study focused on the Manufacturing MAPs non-degree credential that provides the competencies identified by employers who designed, developed, and implemented the ACCS Manufacturing MAPs course. The following sub-questions also guided the study:

1. To what extent does a participant's age relate to whether she/he completes or does not complete the Manufacturing MAPs course?
2. To what extent does a participant's gender relate to whether she/he completes or does not complete the Manufacturing MAPs course?
3. To what extent does a participant's ethnicity relate to whether she/he completes or does not complete the Manufacturing MAPs course?
4. To what extent does a participant's education level relate to whether she/he completes or does not complete the Manufacturing MAPs course?
5. To what extent does a participant's employment status apply in relation to whether she/he completes or does not complete the Manufacturing MAPs course?

The research on this topic was accessed using the ACCS Manufacturing MAPs database. The questions directed the analysis of demographic factors with course completion.

Research Design

This study used secondary data collected from a noncredit course administered through community colleges in Alabama. The data were collected to study participants enrolled in the online manufacturing course from March 2023 to December 2023 and focused on the Manufacturing MAPs non-degree credential. The course delivered the competencies identified by the Alabama Committee on Credentialing and Career Pathways (ACCCP). The ACCCP identified the competencies needed in the high demand career pathway of manufacturing (see the Competency Model in Appendix B).

The study analyzed the demographic factors in the Manufacturing MAPs database to determine if they are associated with course completion and credential achievement. To pass the course and earn the credential participants must achieve a score of 80% or higher on each module. The modules must be completed in sequential order. Completion of all modules within the course leads to credential attainment (ACCS, 2023).

Rationale for Method

The study used quantitative research methods to analyze the ACCS database of Manufacturing MAPs participants. Quantitative research analyzes numerical data and affects and/or analyzes differences and relationships between groups (Salkind & Frey, 2020). The participants' demographic factors and the Manufacturing MAPs course completion data were analyzed using Chi-square Tests of Independence, to determine if a statistically significant association existed between two categorical variables. The study sought to analyze the association of the factors of age, ethnicity, gender, education attainment level, and employment status with participants who earned or did not earn a Manufacturing MAPs course credential.

The research questions guided the analysis of demographic factors on course completion resulting in credential achievement.

Study Participants

The participants were enrolled in the online and self-paced Manufacturing MAPs course as part of ACCS. The online Manufacturing MAPs course is free for all Alabama residents who enroll in the course through a local community college. Approximately 1,000 participants were estimated to be enrolled in the Manufacturing MAPs course from March of 2023 to December of 2023. The participants were adult students aged 18 to 61 years seeking entry-level manufacturing employment. A high school diploma was not required to register for the course. During the course registration process, students entered and self-reported their age, ethnicity, education level attained (grades 1-12, high school diploma or equivalent, some postsecondary, postsecondary credential or degree), and their current employment status (employed, not employed). The course was available at no charge for Alabama residents at their local community college due to the recognition of the credential by the Alabama Committee on Credentialing and Career Pathways (ACCCP). If the credential is not on the ACCCP list, public money could not be used to pay for the credential.

Data Collection

Data were collected using secondary data from the ACCS Manufacturing MAPs database which contained the demographic information and course completion status for each participant. The ACCS provided the Manufacturing MAPs database for this study via an Excel spreadsheet (see Appendix C for permission letter to use database). Applicants agree to their data being used for research purposes when applying and enrolling in the MAPs course.

The following seven modules are included in the Manufacturing MAPs course in the Canvas Learning Management System (LMS). The course delivers manufacturing-specific job-related skills, which were validated by the ACCCP and integrated into both the curriculum and the final course credential. Participants must complete the modules in sequential order, earning at least an 80% on each module in order to advance and progress to the next module. The seven modules of the MAPs course are:

- Module 1 – Learning Techniques and Approaches
- Module 2 – Manufacturing Sub Industries; Green and Sustainable Manufacturing; and Technological Impact
- Module 3 – Manufacturing Evolution
- Module 4 – Quality Control and Best Practices; How to Read a Tape Measure
- Module 5 – Manufacturing Processes
- Module 6 – Customer Service
- Module 7 – Workplace Safety; Safety Basics & Best Practices; Bloodborne Pathogens; Visual Signs; Work Surface Safety; Emergency Preparation; Weather Safety; Spills, Threats, and Outages; Safety Hazards; Lockout/Tagout & Electrical Hazards

The content of each module was identified by the ACCCP and available from the ACCS website. The primary objective for completing this noncredit course is to earn a certification that facilitates employment, addressing the demand for skilled workers in Alabama.

Data Analysis

The IBM Statistical Package for the Social Sciences (SPSS, Version 30) software was utilized to analyze the data and answer the research questions using chi-square (IBM Corp,

2022). The Chi-square Test of Independence is used to determine if two categorical variables are independent of each other in a single sample (Turhan, 2020) and used to compare associations among variables. The analyses looked to see if there was a statistically significant association between demographic variables of age, ethnicity, gender, education level, and employment status and completing the Manufacturing MAPs course and credential attainment. After computing the chi-square, the degrees of freedom (*df*) were identified, which is based on the number of categories organized in the data, and determine the appropriate distribution (Turhan, 2020). The *p*-value was used to determine if there was a statistically significant association. If $p<.05$, there is a statistically significant association, and unlikely due to random chance. (Turhan, 2020).

Variables

Table 4 below provides an overview of the variables in this study. The Manufacturing MAPs credential variable was coded as 1=yes, 0=no. The student either completed the course with an 80% or higher on each module and earned the Manufacturing MAPs credential or they did not earn the credential. The age groups were recoded using the transform feature in SPSS: 1 = 18–24, 2 = 25–34, 3 = 35–44, and 4 = 45 and older. 17-25 = 1, 26-40 = 2, 41-55 = 3, and 55 and older = 5. Gender was coded as 1=male, 0=female. The education levels were recoded to 0 = no high school diploma, 1 = high school diploma, 2 = some postsecondary, and 3 = associate's degree or higher. Ethnicity was recoded into 0=other, 1= Black or African American, and 2= White. The education levels were recoded to 0 = no high school diploma, 1 = high school diploma, 2 = some postsecondary, and 3 = associate's degree or higher.

Table 4

Variables Used in the Chi-Square Test of Independence

Variable	Categories
Age	18-24 years 25-34 years 35-44 years 45+ years
Gender	Male Female
Ethnicity	African American White Other
Education Level	No High School Diploma High School Diploma Some College Associate's Degree or Higher
Employment Status	Employed Unemployed
Course Completion	Completed Not Completed

Conclusion

This research study analyzed the variables of age, ethnicity, gender, education level, and employment status with the completion of the Manufacturing MAPs course, resulting in credential attainment. The industry-led, short-term training program may assist students in obtaining proficiency in the basic requirements for entry-level manufacturing positions in the

State of Alabama. Chapter 4 shares the results and findings from the analyses. Chapter 5 provides the conclusion, and insights into the relationship between the findings from the research and the current literature. Recommendations for further research are also included in the last chapter.

Chapter 4: Results

The results of the study are presented in chapter 4. Each research question is analyzed in this chapter, and the results are reported. The data were analyzed to address the research questions with tables to share the quantitative results. A Chi-square Test of Independence was selected to explore associations among the demographic variables of age, ethnicity, gender, education level, and employment status. These variables were compared to the participants who completed or did not complete the Manufacturing MAPs course to determine if there was a statistically significant relationship between the demographic variables and course completion.

Sample

The secondary data sample was retrieved from the Alabama Community College System (ACCS). Upon reviewing the data, it was discovered that there were 1285 records from August 2021 to December 2024. These records were filtered to include the dates of enrollment in the Manufacturing MAPs course from March 2023 to December 2023. Approximately 1,000 participants were estimated to be enrolled in the Manufacturing MAPs course during this period. Further filtering within these dates returned 419 complete records of participants in the manufacturing pathway throughout Alabama. Out of the 419 records, seven records had an education level unknown. These seven participant records with missing data were removed from the database. After removing the seven records, 412 participant records from March 2023 to December 2023 remained for analysis. These data were analyzed to make sure there were not any duplicates.

Demographic Characteristics

Table 5 shows the demographic frequency counts for the Manufacturing MAPs participants. Of the 412 participants, 68% were male (n = 280) and 32% were female (n = 133).

In the Manufacturing MAPs course, 51% (n = 210) of the participants self-identified as Black or African American with 38.8% (n = 160) of participants were identifying as Caucasian students. The remaining ethnicities comprised 10.2% (n = 42) of the sample population and were combined into a category labeled "other" because each category was smaller than 5%. The breakdown of the participants labeled "other" included 3.2% identifying as two or more races, .5% as Asian or Other Pacific Islander, 4.6% Hispanic, and 1.5% American Indian or Alaskan Native. Most Manufacturing MAPs participants (68.2%, n = 281) reported that their highest educational level attained was the high school diploma, alternate credential, or equivalent level. Only 13.8% (n = 57) of participants did not hold a high school diploma or higher. The next level of educational attainment, those with some postsecondary education or training but no postsecondary degree, was slightly less at 13.6% (n = 56). Only 4.4% (n = 18) of participants held an associate's degree, bachelor's degree, or higher. Full-time employees represented 68% (n = 280) of participants, and 6.5% (n = 27) were employed part-time. Around a quarter of the participants, 24.5% (n = 101) were unemployed. The remaining 1% (n = 4) were not in the labor market.

For comparison, the Alabama Commission on Higher Education (ACHE) (2023) reported on demographic data for students enrolled in the Alabama Community College System's traditional credit-bearing courses during Fall 2023. According to the Institutional Student Profiles for All 2-Year Institutions report, the average age was 22; 59.56% (n = 49,658) were females, and 40.22% (n = 33,537) were males. According to the report, 59.05% (n = 49,233) of students were white - non-Hispanic, 26.03% (n = 21,706) were African American or Black, and the remaining 14.92% (n = 12,441) were labeled "other" (ACHE, 2023). These numbers were from all students enrolled in the credit-earning section of the Alabama Community College

System. It is noted that the percentage of females enrolled in Alabama 2-year colleges is higher (59.56%, *n* = 49,658) than males (40.22%, *n* = 33,537). This contrasts with the Manufacturing MAPs course participants, which comprised 32% (*n* = 133) females and 68% (*n* = 280) males. In the Manufacturing MAPs course, the African American or Black ethnicity group represented 51% (*n* = 210) of students. Caucasian or White comprised 38.8% (*n* = 160) of participants. In contrast, the ACHE (2023) data, traditional ACCS credit-bearing students were reported to be 59.05% (*n* = 49,233) white, non-Hispanic, and only 26.03% (*n* = 21,706) African American or Black.

Table 5

Demographic Characteristics of Participants (N = 412)

Characteristic	Frequency (*n*)	Percent %
Age Group		
18–24	187	45.4%
25–34	123	29.9%
35–44	54	13.1%
45 and older	48	11.7%
Gender		
Female	133	32%
Male	280	68%
Educational Attainment		
No high school diploma	57	13.8%
High school diploma or alternate credential	263	63.8%
High school equivalent	18	4.4%
Some postsecondary education (no degree)	56	13.6%
Postsecondary, bachelor's degree or higher	18	4.4%
Ethnicity		
Caucasian	160	38.8%
African American (Black)	210	51%
Other	42	10.2%
Employment		
Full-time	280	68%
Part-time	27	6.5%

Unemployed	101	24.5%
Not in labor market	4	1%

Table 6 summarizes the number of participants who completed the Manufacturing MAPs course and earned a credential, as well as those who did not complete the course and therefore did not receive a certificate. Among the 412 participants, 92.2% (n = 380) successfully completed the course and earned a certificate, while 7.8% (n = 32) did not. This is a high rate of completion. Participants who did not receive a certificate either failed to achieve a minimum score of 80% on each module or did not finish the course. Unfortunately, there was no data available to the researcher about the individual module scores or successful completion of individual modules. Only completion (complete/not complete) of the course was provided in the database.

Table 6

Participants' Certificate Earned (N = 412)

Certificate Earned	Frequency (n)	Percent %
Manufacturing MAPs	380	92.2%
No Certificate	32	7.8%
TOTAL	412	100.0%

Demographics: Ethnicity and MAPs Completion

Table 7 shows the demographic information for participants who earned a Manufacturing MAPs credential and those who did not. Due to the limited number of participants in these categories, the ethnicities of American Indian or Alaskan Native, Asian, Hispanic or Latino, Native Hawaiian or Other Pacific Islander, and two or more races were combined into a field labeled "Other," as noted earlier. After combining these less populated ethnicities, the number of categories was reduced from seven to three. The data show that 94.4% (n = 151) of Caucasians,

90.5% (n = 190) of Black or African Americans, and 92.8% (n = 39) of ethnicities in the "other" category completed the course and earned the Manufacturing MAPs credential. Most participants earned the Manufacturing MAPs credential. Again, only completion rate of the course was provided in the database, not completion of individual modules.

Table 7

Frequencies Used in Chi-Square Test for Manufacturing MAPs Participants' Ethnicity (N=412)

Certificate Earned	Other		Black		Caucasian		Total	
	(n)	%	(n)	%	(n)	%	(n)	%
Manufacturing MAPs	39	92.9	190	90.5	151	94.4	380	92.2
No Certificate	3	7.1	20	9.5	9	5.6	32	7.8
TOTAL	42	100.0	210	100	160	100.0	412	100.0

Research Questions

The results from the analyses of each research question are presented in this section. The central research question of this study was: To what extent do demographic factors affect if a participant will complete or not complete the Manufacturing MAPs course? The research questions were designed to determine if any associations between age, gender, ethnicity, highest education level attained, employment status, and completion of the Manufacturing MAPs course could be identified.

Research Question One

To what extent does a participant's age relate to whether she/he completes or does not complete the Manufacturing MAPs course?

A Chi-square Test of Independence was conducted to analyze the association between age and course completion. Each participant's reported date of birth was used to determine their age, which was then re-coded as a new variable (age). Since age is a continuous variable, the data were divided into age group categories to facilitate chi-square analysis. Each age group was

broken into 6- to 9-year increments, with the last age group being 45 and older. The selected age groups aligned with the U.S. Census data age group divisions, except for the older age groups, which are categorized differently in the census data. For this study, there were not enough participants in the 45 and older category to have additional groups for analysis. To conduct the analysis, the age groups were recoded using the transform feature in SPSS: 1 = 18–24, 2 = 25–34, 3 = 35–44, and 4 = 45 and older. Table 7 presents the results of the chi-square test for age and MAPs completion. Most participants were in the 18–24 age group (45.4%, n = 187). This is near the same average age in the overall population (22 years) (ACHE, 2023). There were 29.9% (n = 123) in the 25–34 age group, 13.1% (n = 54) in the 35–44 age group, and 11.7% (n = 48) in the 45 and older group. The number of participants was highest in the youngest age group (18-24) and declined as the groups increased.

More participants in the 18–24 age group completed the course and earned the credential. Table 8 shows that only 4.8% (n = 9) of participants in the 18–24 age group did not complete the Manufacturing MAPs course and did not earn the credential. Therefore, 95.2% (n = 178) of participants in the 18–24 age group earned the Manufacturing MAPs credential. The 25–34 age group had 90.2% (n = 111) of participants completing the Manufacturing MAPs course and earning the credential. There were 9.8% (n = 12) in the 25–34 age group who did not complete the course. The 35–44 age group had 92.6% (n = 50) who earned the Manufacturing MAPs credential and 7.4% (n = 4) who did not complete the course and earn the credential. The lowest percentage was in the 45 and older age group, at 85.4% (n = 41) who earned the Manufacturing MAPs credential. There were 14.6% (n = 7) participants in the 45 and older age group who did not complete the course. Again, overall, 92.2% of participants in all age groups completed the

course and earned the credential. Only 7.8% of participants in all age groups did not earn the credential.

Table 8

Manufacturing MAPs Participants by Age Group (N = 412)

	18-24		25-34		35-44		45+		Total	
	(*n*)	%	(*n*)	%	(*n*)	%	(*n*)	%	(*n*)	%
Manufacturing MAPs	178	95.2%	111	90.2%	50	92.6%	41	85.4%	380	92.2%
No Certificate	9	4.8%	12	9.8%	4	7.4%	7	14.6	32	7.8%
TOTAL	187	100.0%	123	100.0%	54	100.0%	48	11.7%	412	100.0%

To test whether age was associated with completing or not completing the Manufacturing MAPs course and earning the credential, a chi-square was conducted with a $\alpha = .05$ as the criterion for significance. The resulting chi-square statistic was χ^2 (3, N = 412) = 6.08, p = .108 leading to the conclusion that there was no statistically significant association observed between a participant's age and success in earning the Manufacturing MAPs course credential (see Table 9 for results).

Table 9

Chi-Square Test for Age Groups by Course Completion (N=412)

	Value	df	*p*-value
Pearson chi-square	6.08[a]	3	.108
N of Valid Cases	412		

Note. [a] = 2 cells (25.0%) have expected count less than 5. The minimum expected count is 3.73.

Research Question Two

To what extent does a participant's gender relate to whether she/he completes or does not complete the Manufacturing MAPs course?

Table 10 shows participants according to gender and credentials earned. Since gender was recorded as a dichotomous variable, it was coded as 1 = male and 0 = female. Males represented 68.4% of the total participants, while females made up only 31.6% of the participants in the course. There were slightly fewer males (7.5%, *n* = 21) than females (8.3%, *n* = 11) who did not complete the Manufacturing MAPs course and did not earn the credential. Similarly, the percentage of credential earners for males (92.5%, *n* = 259) was slightly higher than for females (91.7%, *n* = 121). This MAPs course dataset (March 2023 – December 2023) had more male participants at 67.9%.

Table 10

Participants by Gender and Certificate Earned (N=412)

	Gender				Total	
Certificate	Female (*n*)	Female (%)	Male (*n*)	Male (%)	(*n*)	(%)
Manufacturing MAPs	121	91.7	259	92.5	380	92.2
No Certificate	11	8.3	21	7.5	32	7.8
TOTAL	132	100.0	280	100.0	412	100.0

Table 11 shows the results of the chi-square test of gender. The statistic is $\chi^2(1, N = 412) = .087$, $p = .768$. Using $\alpha = .05$ as the criterion for significance, the chi-square results support the conclusion that no statistically significant association existed between the participant's gender and their success in earning the Manufacturing MAPs credential.

Table 11

Chi-Square Test for Participants by Gender (N=412)

	Value	df	*p*-value
Pearson chi-square	.087[a]	1	.768
N of Valid Cases	412		

Note. [a] = 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.25.

Research Question Three

To what extent does a participant's ethnicity relate to whether she/he completes or does not complete the Manufacturing MAPs course?

The data for ethnicity groups were analyzed to determine if there is an association between a participant's ethnicity and the completion of the Manufacturing MAPs course. See the results of the analysis in Table 12. In reviewing the statistic descriptives, the African-American (Black) category for Manufacturing MAPs course completers was the largest group, representing 50.9% of participants. Only 9.5% of participants in the African American category did not complete the Manufacturing MAPs course. The next largest group was represented by White or Caucasian participants, with 38.8% of the total. Ninety-four percent of the White or Caucasian participants completed the Manufacturing MAPs course.

Table 12

Participants by Ethnicity and Certificate Earned (N = 412)

	Ethnicity Group							
	0 = Other		1 = Black or African American		2 = White		Total	
Certification Status	(*n*)	(%)	(*n*)	(%)	(*n*)	(%)	(*n*)	(%)
Manufacturing MAPs	39	92.9	190	90.5	151	94.4	380	92.2
No Certificate	3	7.1	23	10.7	10	6.1	36	8.6
Total	42	100.0	214	100.0	163	100.0	419	100.0

A Chi-square Test of Independence was conducted to test whether ethnicity was associated with completing or not completing the Manufacturing MAPs course and earning the credential. The chi-square was conducted with $\alpha = .05$ as the criterion for significance. The chi-square statistic is χ^2 (2, N = 412) = 1.952, p = .377. The p-value being substantially greater than

.05 indicated that no significant association was observed between a participant's ethnicity and completion of the Manufacturing MAPs course credential. See the results in Table 13 below.

Table 13

Chi-Square Test for Manufacturing MAPs Completers and Non-Completers by Ethnicity

	Value	df	*p*-value
Pearson chi-square	1.952	2	.377
N of Valid Cases	412		

Research Question Four

To what extent does a participant's education level relate to whether she/he completes or does not complete the Manufacturing MAPs course?

The education level of participants was categorized based on the highest level of education attained. Participants were grouped into four groups according to their highest educational attainment: (1) without a high school diploma, (2) with a high school diploma, (3) some postsecondary (no degree), and (4) an associate's degree or higher. Participants who did not complete a high school diploma were classified as "No Diploma," which included students whose highest level of education was Grades 1-5 or Grades 6-8. There were seven records whose highest level of education was unknown. These records were considered missing values and were not included in the analysis.

The majority of participants earned a high school diploma or equivalent (see Table 14). Among those participants, 95.1% completed the course and earned the Manufacturing MAPs credential. In comparison, 17.5% of participants who did not complete the course had not earned a high school diploma or equivalent. Additionally, 91.1% of credential earners had attained some postsecondary credit, but had not completed a degree. The lowest credential attainment rate (82.5%) was observed among course completers without a high school diploma.

Table 14

Education Level and Completers and Non-Completers of Manufacturing MAPs course (N = 412)

	Education Level									
	No Diploma		High School Diploma		Some Postsecondary (No Degree)		Degree		Total	
Credential	(*n*)	(%)	(*n*)	(%)	(*n*)	(%)	(*n*)	(%)	(*n*)	(%)
Manufacturing MAPs	47	82.5	267	95.1	51	91.1	15	83.3	380	92.2
No Certificate	10	17.5	14	4.9	5	8.9	3	16.7	32	7.8
Total	57	100.0	281	100.0	56	100.0	18	4.4	412	100.0

A Chi-square Test of Independence was conducted to test whether the highest level of education was associated with completing or not the Manufacturing MAPs course and earning the credential. See the results in Table 15. The chi-square statistic is χ^2 (3, N = 412) = 12.743, p = .005. The small p-value, well below $\alpha = .05$, indicated that a significant association between a participant's education level and completion of the Manufacturing MAPs course credential was present within the data. In contrast to the three previous research questions, there does appear to be a relationship between a participant's education level and their success in completing the course and earning the credential. See Table 14 for the results of the chi-square test.

Table 15

Chi-Square Test of Independence for Credential Earned and Educational Level

Test Statistic	Value	df	*p*-value
Pearson chi-square	12.743	3	.005
N of Valid Cases	412		

Research Question Five

To what extent does a participant's employment status apply in relation to whether she/he completes or does not complete the Manufacturing MAPs course?

The participant's employment status was reviewed. The database retrieved from ACCS included the following categories: (1) unemployed, (2) not in the labor market, (3) full-time, (4) part-time, and (5) employed with notice of termination. The following categories, unemployed and not in the labor market, were combined since it was assumed that participants not in the labor market may be searching for employment training opportunities. The employee with notice of termination was combined with full-time employment. It was assumed that these participants were full-time employees because most part-time employees are not guaranteed work hours like full-time employees with wages and benefits.

Table 16 shows the results of the analysis in that most participants were employed full-time. Among full-time workers, 96.4% completed the Manufacturing MAPs course. In contrast, 17.1% of unemployed participants and 14.8% of part-time workers did not complete the course. Non-completers accounted for only 3.6% of full-time employees. Overall, 92.2% of participants completed the course and earned the Manufacturing MAPs credential, while 7.8% did not.

Table 16

Credential Earned by Employment Status (N = 412)

	Employment							
	Unemployed		Part Time		Full Time		Total	
Credential Earned	(*n*)	(%)	(*n*)	(%)	(*n*)	(%)	(*n*)	(%)
Manufacturing MAPs	87	82.9	23	85.2	270	96.4	380	92.2
No Certificate	18	17.1	4	14.8	10	3.6	32	7.8
TOTAL	105	100.0	27	100.0	280	100.0	412	100.0

Table 17 shows the results of the chi-square test. A chi-square test of independence was conducted to test whether employment status was associated with completing or not completing the Manufacturing MAPs course and earning the credential. The test used $\alpha = .05$ as the criterion for significance. See the results in Table 16 The chi-square statistic is χ^2 (2, N = 412) = 21.637, p < .001. The p-value shows a significant association between a participant's employment status and completion of the Manufacturing MAPs course credential. Therefore, the outcome shows that the significant value is less than .05. A participant's employment status was associated with completing the course and earning the credential. The participant's employment status was not independent of completing the course and earning the credential.

Table 17

Chi-Square Tests for Credential Earned and Employment Status

	Value	*df*	*p*-value
Pearson chi-square	21.637	2	<.001
N of Valid Cases	412		

Summary

This study sought to determine if any demographic factors impact completion of an employer-driven competency-based education program. ACCS provided the competency-based secondary dataset for the Manufacturing course. The Manufacturing MAPs data included demographic information and completion or non-completion of the course. Using the Chi-square Test of Independence for each demographic factor, a statistically significant association was found among the demographic characteristics of education level and employment status. The significance level for highest education level attained was p=.005. Therefore, the participant's education level was associated with completion of the course and earning the Manufacturing MAPs credential. The significance level for employment status was p<.001. Therefore, the

participant's employment level was found to be associated with completion of the course and earning the Manufacturing MAPs credential.

Chapter 5 provides insights into the relationship between the findings from the research and the current literature. Recommendations for further research are included in the last chapter.

Chapter 5: Discussion

As presented in Chapter 1, this study sought to determine the impact of a skills-based, employer-driven competency-based education program by analyzing data from the Manufacturing MAPs course provided by the community college system in the State of Alabama. The program awards a noncredit credential through the Alabama Community College System (ACCS) which is valued by manufacturing employers across the state (ACCS, 2023). The focus of the program on competency-based education was designed in response to Alabama's growing skills gap, which is defined as a gap between competencies employers demand and those held by job seekers (Rikala et al., 2024). According to the Alabama Department of Labor (2022), this gap is expected to widen, with projected shortages increasing from 111,452 workers needed in 2020-2030 to 231,610 by 2045. This study analyzed whether demographic variables such as age, gender, race, educational background, and employment status, are associated with completion and credential attainment (see Figure 1 in Appendix A).

Discussion and Implications

The central research question of this study was: To what extent do demographic factors affect if a participant will complete or not complete the Manufacturing MAPs course? The following section discusses the implications and limitations of each research question in terms of the specific demographic factor.

Participants' Age Group and Course Completion

To what extent does a participant's age relate to whether she/he completes or does not complete the Manufacturing MAPs course?

The first research question sought to determine if a participant's age affects completion of the noncredit Manufacturing MAPs course. The results indicated that age was not statistically

significant concerning course completion. The implications of the study provided insight into the different age groups and their ability to complete an online noncredit course. Younger adults are generally expected to have more technical skills than older adults in the workplace (source); however, the overall results show that there was not a statistically significant impact on age and course completion.

According to Hawkins (2019), almost half of adults at least 25 years of age do not have education or additional training beyond a high school diploma. This may have implications for using technologies and adapting to the automation and Industry 4.0. Over half (58%) of the jobs in Alabama require more than a high school diploma but less than a bachelor's degree (National Skills Coalition, 2018). This disparity reflects a gap between the education level of many adults and the qualifications required for employment in the workplace. As a result, many adults may lack the necessary skills to compete for jobs, which may contribute to a shortage of skilled workers in the State. Older workers, in particular, encounter challenges as workplaces adopt advanced technology processes such as automation, robotics, artificial intelligence, and big data (Howcroft & Taylor, 2023). Compared to younger adults who are more familiar with using digital tools, older generations often struggle to adapt to new these new technological demands. With an increasing age in the workplace, this may be a concern for future employment of these older workers..

The labor force participation rate is declining across all age groups. Youth unemployment is projected to be above 8% throughout many regions globally (Bloom et al., 2019). The lower labor force participation rate and an aging workforce are straining industries in terms of finding skilled workers. While the need for skilled labor is increasing, the pool of available workers continues to shrink (Gordon, 2015). As a result, companies may need to offer incentives to

attract younger workers to skilled trades and support their development of the necessary skills to enter the workforce successfully with programs such as MAPs and others.

To be competitive in today's workforce, workers must acquire advanced technical skills (Li, 2022. Therefore, the younger generation needs to recognize the importance of continuing their education beyond high school to earn credentials that validate technical competencies, enabling them to access high-wage, high-demand employment opportunities. These credentials enhance individuals' ability to earn a living wage by validating skills, providing documented evidence of competencies achieved to potential employers (Gauthier, 2020).

Participants' Gender and Course Completion

To what extent does a participant's gender relate to whether she/he completes or does not complete the Manufacturing MAPs course?

The second research question focused on a participant's gender in relation to the completion of the Manufacturing MAPs course. The findings showed that gender was not statistically significant in relation to course completion. It was noted that the data showed there were fewer women enrolled in the course than men in the data set. The implications of the study showed that, despite the low enrollments of female participants, disparities did not exist in relation to gender and completion of the Manufacturing MAPs study. The difference is that enrollment numbers does however illustrate an important broader gender bias to consider. According to Bloom et al. (2019), women are underrepresented in high-paying industries such as manufacturing. Therefore, to increase manufacturing employment for women, companies may encourage women to consider manufacturing as a career opportunity through various initiatives to raise awareness including Women in Manufacturing and Girls Learning About Manufacturing

(Mugyenyi et al., 2020). Both of these programs promote manufacturing careers among women through mentoring and networking.

Participants' Ethnicity and Course Completion

To what extent does a participant's ethnicity relate to whether she/he completes or does not complete the Manufacturing MAPs course?

The third research question explored a participant's ethnicity to determine if it was associated with course completion. The findings showed the participant's ethnicity was not statistically significant when analyzed with course completion. In the Manufacturing MAPs course, the African American or Black ethnicity group represented 51% (n = 210) of students. Caucasian or White comprised 38.8% (n = 160) of participants. In contrast, the ACHE (2023) data, traditional ACCS credit-bearing students were reported to be 59.05% (n = 49,233) white, non-Hispanic, and only 26.03% (n = 21,706) African American or Black. These differences in populations are important to note and may be important to further research on access to education and training. While the results were not statistically significant, the need remains for further research into the specific challenges faced by minority students in technical and vocational fields, as well as the importance of targeted support initiatives to improve educational outcomes. Overcoming the challenges faced by minority workers may help individuals complete the course and earn a higher wage, with opportunities to advance (Organization for Economic Cooperation and Development, 2013.

Participants' Education Level and Course Completion

To what extent does a participant's education level relate to whether she/he completes or does not complete the Manufacturing MAPs course?

The fourth research question investigated whether a participant's education level impacted course completion. The findings showed a statistically significant association between a participant's education level and completion of the Manufacturing MAPs course credential. The findings are consistent with the national skills gap and the need for additional training beyond the high school diploma to be qualified for employment opportunities (Cronen & Murphy, 2013). Hawkins (2019) stated that 27% of adults 25 and older in the United States have only a high school diploma or equivalent, and 12% (approximately 26.5 million individuals) lack a high school diploma. These statistics highlight a substantial portion of the adult population who lack the credentials typically required for employment, emphasizing the need for accelerated, noncredit training programs. Consequently, students are increasingly seeking short-term educational training programs to quicky develop the skills necessary for workforce entry (Gauthier, 2021).

As noted earlier, 58% of the jobs in Alabama require more than a high school diploma but less than a bachelor's degree (National Skills Coalition, 2018). Noncredit courses such as the Manufacturing MAPs are embedding credentialing into education and training curriculum so students may earn industry-recognized credentials concurrently with noncredit or credit-based programs (D'Amico, 2017). These short-term noncredit courses are in alignment with employer workforce needs, to provide entry level workers key skills needed for positions in industry (Javdekar et al., 2016). Retention rates among employees are higher for those who earn institutional credentials such as degrees and certificates along with their non-degree credentials (NDCs) (Van Noy et al., 2024).

Only 4.4% (n = 18) of participants in this study held an associate's degree, bachelor's degree, or higher. The studied showed a significance in that a higher education level was

associated with course completion . This finding also aligns with the literature. The importance of advanced technological skills and the shift in skills-based training through short-term, noncredit courses has been shown in other studies to be critical to success (Flores et al., 2020). Manufacturing industries may consider recruiting high school students for manufacturing jobs since the high school diploma is associated with completing the course and earning the credential. Credentials may serve as valid evidence for Prior Learning Assessment, which is the recognition of experiential or non-traditional learning that meets the requirements or competencies of the course. For example, short-term training programs may be designed to lead to short certificates, which may be stacked to lead to certificates, and ultimately students may progress to an associate's degree. The stackable credential pathway may be an effective recruitment tool to encourage students who complete noncredit programs to use competencies and noncredit training towards credit-based certificates and associate's degrees at the community college (Perea, 2020).

Moreover, low-skilled jobs are being replaced with automation and robotics, which use big data and artificial intelligence to determine needs and forecast outcomes for industry (Howcroft & Taylor, 2023). The more education an employee has, the more likely they are to remain employed as these automation processes and robots begin to replace workers (Bates et al., 2024). High labor costs often drive investments in robots which are seen as cost-cutting measures that may also replace human workers (Aghion et al., 2022). The robots work continuously, and their costs, for the most part, are fixed. In comparison, it is estimated that around 1.9 trillion dollars (about $5,800 per person in the U.S.) are spent on training in educational programs with around one million credentials (Everhart et al., 2021). Globally, 734 million new jobs are expected to be needed from 2010 to 2030 (Bloom et al., 2019). These new

jobs come at a high cost as they may be required due to implementing advanced technological processes. Workers who learn and increase their skill set have the potential to move into higher-paying roles with fewer physical demands (Bates et al., 2024). Employees who see this as a benefit and work to gain new skills will greatly benefit from their new positions (Bates et al., 2024).

As emerging roles in manufacturing increasingly require education or specialized training beyond a high school diploma (Acemoglu & Restrepo, 2020), companies should recognize the potential of older workers and invest in training programs that facilitate reskilling and upskilling. Although advanced technologies and automation may eliminate certain manual or repetitive tasks, they can also extend careers of older employees by reducing physical strain. As automation and robotics replace low-skill, labor-intensive duties, strategic workforce development initiatives will be essential to help both the employers and workers adapt to these technological changes.

Participants' Employment Status and Course Completion

To what extent does a participant's employment status apply in relation to whether she/he completes or does not complete the Manufacturing MAPs course?

The fifth research question addressed whether there was an effect of employment status on course completion. The findings indicated a statistically significant association between employment status and course completion. Therefore, employed participants were more likely to complete the Manufacturing MAPs course and earn a credential than their unemployed counterparts. Research by Mohammadi et al. (2020) supported this finding, showing that employed participants had higher completion rates (98.6%) than unemployed participants. Mohammadi studied engineering and technology students to determine if any women, ethnic

adults or adults over 45 had higher course completion rates. Employment had an impact on course completion. Similarly, D'Amico (2017) highlighted the apprenticeship model that shows the connection to employment and education. Apprenticeships are usually where employers pay tuition for noncredit courses to develop skills that are aligned with industry needs (U.S. Department of Education, 2015). The apprenticeship model assures that related technical instruction that is needed in the workplace is provided, and employees are supported with career growth opportunities.

Other research also supports the relationship between employment and course completion. For example, a study by Douglas et al. (2023) found that around 45% of students at NOVA and 37% at Mt. SAC were already working in jobs. The study combined institutional data with student surveys. The study suggested that individuals enroll in noncredit courses to upskill and advance their careers and maintain employment. Occupational training was the leading reason to enroll in the course, 78% at Mt. SAC and 79% NOVA. Further evidence from Xu et al. (2024) indicated that earning industry-recognized credentials increased earnings by $1,000 on quarterly earnings, representing an 11.5% growth in wages. These benefits, including a 90% course-completion rate and a 68% credential-attainment rate, affirm the value of noncredit workforce programs.

Other studies have shown that employer-supported training programs have significant implications for both employee retention and career advancement. Research indicates that when companies cover training costs and compensate employees for participation, workers are more likely to engage in professional development and complete courses that enhance their skills (Becker, 1993; Carnevale et al., 2015). Structured training programs create a clear pathway for

advancement, increasing the likelihood of employee promotions within the company (Lerman, 2019).

A key implication is that employees are more committed to completing training programs when their job performance is tied to training completion and industry requirements (Committee for Economic Development of The Conference Board (CED). (2021). This alignment fosters a culture of continuous learning and encourages workers to develop skills that align with industry demands (Gauthier, 2020). However, budget constraints often limit companies' investments in workforce training, eliminating necessary training opportunities that could enhance job performance and support career growth (Cappelli, 2012). Therefore, many companies have neglected investing in workforce training over the past twenty years (Gordon, 2015). Investment in more employer-driven credentialing may be necessary with the increasing technological advancements and need for quick upskilling of the workforce needed for today's workplace.

Lastly, employees who acquire new skills build on their existing foundational knowledge may become more adaptable to workplace changes and better prepared for leadership roles in the workplace (Holford, 2016). Companies that invest in workforce development often experience higher retention rates, as employees feel valued and see opportunities for career progression and advancement (Benson et al., 2004). Experience with company operations may also lead to more effective leadership and decision-making in the organization (Noe, 2020). Ultimately, prioritizing training and upskilling opportunities benefits employees and employers by fostering a skilled, motivated, and upwardly mobile workforce while reducing turnover and supporting long-term business success (Organization for Economic Cooperation and Development [OECD], 2019).

Limitations

One of the limitations of the study includes the absence of insight into non-completion data, making it difficult to determine whether differences in barriers exist. For example, a key limitation of the study involved participants who did not complete the Manufacturing MAPs course and did not earn the credential. Although the study examined whether demographic variables such as age, ethnicity, gender, education level, and employment status are associated with course completion and credential attainment, it did not include data on why participants did not complete the course or the modules. The lack of data regarding non-completion factors limits the ability to understand barriers that may prevent participants from completing the course (Vartanian, 2010). Barriers to completion may have included personal, academic, work responsibilities, family responsibilities, etc. If fully understood, the factors may provide results and implications regarding course design, support services needed, or other strategies that may result in successful course completion. Additionally, the study was limited to one state, Alabama. Therefore, the findings may not be the same in other states due to different labor market participation rates, workforce needs, and noncredit programs available to residents

Despite these limitations, the study offers valuable insights into the factors that influence course completion and highlights the need for future research to explore non-completion more comprehensively, including potential gender-related challenges that may not have been revealed in the Manufacturing MAPs data sample.

Recommendations for Future Research

Based on the findings of this study, four key recommendations for future research emerged:

1. Explore the relationship between work-based learning opportunities, such as apprenticeships, and educational outcomes to determine if the experiences effectively align with course completion, and how they prepare workers for positions based on industry needs.
2. Replicate this study across other MAPs courses in the ACCS database, including Construction, Healthcare, Hospitality and Tourism, Information Technology, or Transportation and Logistics, to assess whether similar trends exist among these high wage, high demand industry sectors and the use of credentials.
3. Analyze employment outcomes to examine whether Manufacturing MAPs completers secure new or advanced positions within six months of course completion. Future study may include conducting a data match with the Alabama Department of Workforce to determine if Manufacturing MAPS completers are working six months after completing the course. The study could also seek to determine if wages have increased at different time intervals (longitudinal studies) Alabama collects wage information on a quarterly basis and this would allow see if course completion leads to increased earnings.
4. Research into student motivation, self-efficacy, course experiences, and career progression, shedding light on factors that influence course completion and workforce advancement. Further study could be conducted to interview participants who completed or who did not complete the course to determine factors that impeded success or that made the course challenging to complete.

All of these research opportunities would contribute to a deeper understanding of noncredit workforce training and workforce development and that evaluate critical success factors that improve learning outcomes.

Conclusion

This study examined a single dataset from one state's noncredit workforce training to address the skills gap within the manufacturing industry. As advanced technical workforce skills are needed at an accelerated pace, noncredit training provides flexible and effective solutions. Unlike traditional academic educational programs, noncredit courses allow workers and prospective employees to enroll in online, self-paced workforce training programs anytime, without waiting for the start of a new semester or term. The insight obtained from this study will be used to further assist manufacturing companies in improving the Manufacturing MAPs course, or a similar course, to aid in filling open entry level positions which may help close the skills gap in Alabama.

Employers increasingly value occupational credentials, which have become a type of "currency" in the job market (Beverley et al., 2024). As manufacturing evolves, competency-based education is emerging as a transformative model, integrating the Education 4.0 model into workforce training. The expansion of competency-based education and skills-based learning in noncredit courses reinforces the importance of credentials in today's workplace and economy. These models are now being integrated into credit-based courses in postsecondary institutions, higher education, and high school curricula, ensuring that educational programs align with workforce needs (Perea, 2020).

Workforce development faces several challenges within the manufacturing sector. Rapid industry changes may quickly render data collection and research outdated, making it essential

for decision-makers to be innovative in providing needed skills to workers. While automation processes are being introduced into manufacturing processes, certain companies remain slow to adopt new technologies often due to implementation challenges and workforce interests (Aghion et al., 2022).

Additionally, the aging workforce presents another significant challenge, as older workers often struggle to adapt to new technological processes (Abeliansky et al., 2020). Even though automation may reduce the physical strain of manufacturing jobs, and allow for longer employment, the upskilling may be difficult and costly (Flores et al., 2020). Therefore, to retain this older talent in the workplace, companies need to develop opportunities to upskill this sector of the workforce. This would keep companies from losing this knowledgeable population in workforce due to retirements and help provide stability with the increase of new staff being added to the workforce due to automation (Gouda, 2022).

In conclusion, competency-based and noncredit workforce training programs may offer critical solutions to the skills gap and technological shifts through focusing on education and employment opportunities within the manufacturing industry. Education and employment appear to be crucial in equipping students with the skills and knowledge to advance their careers through programs aligned with industry workforce needs. Strengthening education and industry partnerships, expanding upskilling training initiatives, and providing data to foster a highly skilled workforce supports economic growth in the manufacturing sector.

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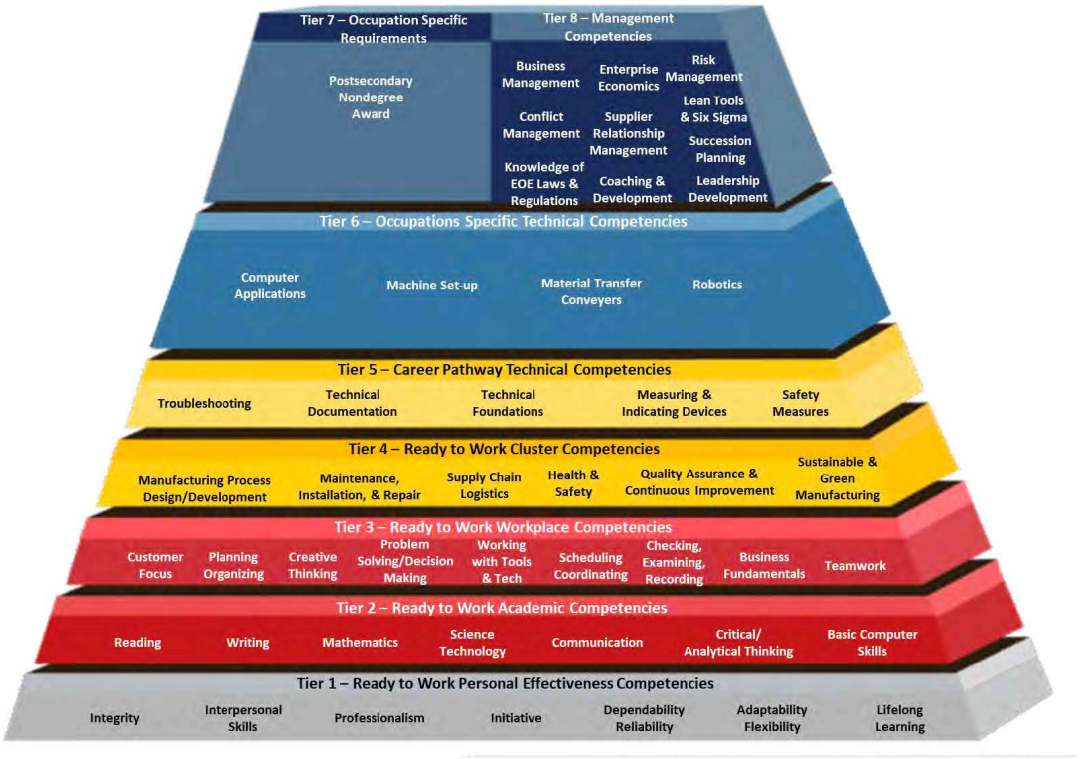
Appendix A

Manufacturing MAPs Certificate

(Alabama Adult Education System for Accountability and Performance, 2023).

Appendix B

Alabama Committee on Credentialing and Career Pathways Competency Model



Competency Model created by the Alabama Committee on Credentialing and Career Pathways

Appendix C

Authorization Letter from the Alabama Community College System to Use Data

JIMMY H. BAKER
Chancellor

July 2, 2024

Deana Goodwine
437 Green Glade Road
Birmingham, AL 35244

SUBJECT: AUTHORIZATION FOR DATA USE IN DISSERTATION RESEARCH

Dear Ms. Goodwine:

The Alabama Community College System (ACCS) agrees to grant Deana Goodwine, a Ph.D. student and researcher, authorization for conducting research related to adult education. ACCS will provide Deana Goodwine with access to the ACE and MAPs database file for use in your dissertation research at Auburn University. Both ACE and MAPs courses collect student consent for the utilization of their information for research purposes during course registration. This authorization extends to the use of the data for publication and/or conference presentations. We request that the Alabama Community College System be acknowledged as the data source in any resulting publications or presentations.

We are excited about the potential impact of the research and eagerly anticipate the contributions it will make to the Alabama Community College System.

Best regards,

Dr. Courtney Monnette
Special Programs Project Director
Alabama Career Essentials
Adult Education Specialist
courtney.monnette@accs.edu

135 South Union Street
Montgomery, AL 36104-4340

334.293.4500
www.accs.edu

P.O. Box 302130
Montgomery, AL 36130-2130

Permission letter from the Alabama Community College System granting permission to use data from the Manufacturing MAPs program for this dissertation research study.

Appendix D

IRB Approval

AUBURN UNIVERSITY
Institutional Review Board

EXEMPT DETERMINATION

January 7, 2025

Leslie Cordie
Haley Center 4036
Auburn Univ, AL 36849
334-844-3089
lak0007@auburn.edu

Dear Leslie Cordie:

On 1/7/2025, the IRB reviewed the following submission:

Protocol Information	Submission Details
Type of Review:	Initial Study
Title:	Factors That Affect Completion of Employer-Driven Competency-Based Education and Skills-Based Learning Programs
Investigator:	Leslie Cordie
IRB ID:	STUDY00000276
Funding:	None
Grant Title:	N/A
Grant ID:	None
IND, IDE or HDE:	None
Documents Reviewed:	• HRP-900, Category: IRB Protocol; • Revised HRP-503a, Category: IRB Protocol;

The IRB determined that this protocol meets the criteria for exemption from IRB review.

In conducting this protocol you are required to follow the requirements listed in HRP-103 - INVESTIGATOR MANUAL.

Ongoing IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities impact the exempt determination, please submit a new request to the IRB for a determination.

Sincerely,
IRB Administration
540 Devall Drive
Auburn, AL 36849
irbadmin@auburn.edu
(334) 844-5966

Institutional Review Board (IRB) approval for the dissertation research study.