

Preparing Young Adults Through Multiskilling to Meet Industry 4.0 Needs and Beyond

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Abstract

The rapid development of technology is moving faster than human skills. Wisconsin employers in manufacturing industries are experiencing the shortfalls in multiskilling that create challenges in being active players in not only the U.S. economy but also the global economy. The purpose of this case study was to examine and investigate how Wisconsin's postsecondary Career and Technical Education (CTE) curricula and programs are preparing students for the future of work through multiskilling to meet current, emerging, and future workforce needs. In addition, this study identified methods of instruction used to ensure students acquire the necessary skills to be successful in the ever-changing workplace. The results of the study could lead to recommendations in instrumental practices in Wisconsin's postsecondary CTE curriculum and program design. Improved teaching practices would allow young adults to be prepared to enter the modern work world of Industry 4.0 and beyond. The methodology of the research was a case study and narrative research that included semi-structured interviews, classroom observations, document review, and course artifacts (i.e., syllabus and rubric). The focus of the case study was a Wisconsin technical college's manufacturing program.

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Chapter I: Introduction

The importance of preparing young adults through postsecondary career and technical education (CTE) through multiskilling is becoming more apparent for the manufacturing workplace. Multiskilling is horizontal in nature and pertains to having the ability to adapt to changing needs by de-skilling and re-skilling technical skills development (National Centre for Vocational Education Research, 2013). Non-technical competencies, such as critical thinking, communication, and problem-solving, which fosters adaptability and lifelong learning also pertains to multiskilling (Stewart et al., 2016). Grenčíková et al. (2020) expressed that education today needs to change its character as the modern workforce needs to have the ability not only to deal with the rapid changes of technology but to have resiliency from stress due to uncertainty. Uncertainties in the modern workforce include rapid changes due to the development of communications or information technologies (Grenčíková et al., 2020). Further doubts regarding the need to prepare the modern workforce include questions on how and what to teach tomorrow's workers becomes paramount to student career success (Grenčíková et al., 2020).

An and Reigeluth (2011) noted that the traditional factory model of education is not compatible with the growing demands of the information age. Schools using more learner-centered models would allow for more focus on developing life skills (An & Reigeluth, 2011). These life skills, such as collaboration, higher-order thinking, and problem-solving would meet the expectations of the modern age of work (An & Reigeluth, 2011). John Dewey stated that education should not be viewed as quantitative increases of skills and facts, but rather by expanding and refining one's knowledge as learning becomes an ongoing process (Stoller, 2015).

Stoller (2015) noted that American teachers are teaching under what may be considered the New Taylorism, where their teachings are controlled by testing and pre-packaged corporate

curricula that focus on set tests. The teaching method mirrors the Taylor principles regarding industrial systems, where, for the systems to function well, practices must be ridged, defined, and quantifiable (Stoller, 2015). Furthermore, Taylor's principles for compliance to set tasks lack respect for individuals' needs, skills, and talents (Stoller, 2015). The Taylor principles operate on the assumption that the proper approach to workers is to make them conform to pre-determined ends that are narrowly defined (Stoller, 2015). The above-mentioned practices hinder multiskilling that not only hurts the student but also impedes the advancement of society.

The mission of the Wisconsin Technical College System (WTCS) is to provide wide-ranging educational opportunities to both students and employers that allow them to succeed in the current changes of the workplace (WTCS, 2021b). The fundamental role the WTCS plays in manufacturing workforce development creates economic vitality that serves individuals and communities throughout Wisconsin (WTCS, 2021b). The current manufacturing employment situation in Wisconsin is holding steady at 15.89% as production rates are active, whereas the rest of the U.S. manufacturing companies are declining in production rates (Conroy et al., 2018; National Association of Manufacturers, 2021). This means that Wisconsin manufacturing continues to be a dynamic driver within the United States.

Conroy et al. (2018) noted that the increased concentration of manufacturing in the state has created opportunity and vulnerability due to future industry instabilities. Uncertainties include the rapid advancement of technologies, but not the rapid advancement of human skills, thus pressuring industries to move towards automation to fill labor gaps. Over time, production will increase but factories will have fewer workers because of automation and smarter systems (Conroy et al., 2018). Bushmaker and Franz (2017) expressed that Wisconsin manufacturers are having challenges in finding talented workers, which has escalated from 29% in 2011 to 80% as

of 2017. The previously stated content shows that general labor tasks are anticipated manufacturing transitions into Industry 4.0 that would require higher-level skills of the worker to keep pace with advancement in technologies (Brougham & Haar, 2018). Carnevale et al. (2019) stated that, in the manufacturing sector, good jobs have transitioned favoring the more educated workers to keep up with advanced globalization.

A shift away from repetitive labor tasks is leaving less-skilled manufacturing workers behind as fewer are needed on factory floors (Carnevale et al., 2019). The view of skills in the projected future is one of conceptual and technical skills. The shift in more advanced skills needs has resulted in 88% fewer manufacturing jobs in the U.S. due to technology-driven productivity between 1990 and 2005 (Carnevale et al., 2019). Further, the idea of robots and artificial intelligence replacing humans becomes a concern as work shifts to robotics rather than humans. This shift would reduce the size of the labor market in the areas of work that are easily automated (Leigh et al., 2019). Such a shift is critical for U.S. manufacturing to remain competitive with other technologically advanced countries.

To meet and compete within the future-forward manufacturing sectors, the current workforce will need to competently problem-solve, communicate, collaborate, embrace ambiguity, understand systems, and demonstrate root-cause analysis (Pilz, 2012). All these skills will become vital for economic sustainability (Pilz, 2012). New hires need to adapt their skills including de-skilling and up-skilling, or out with the old skills and in with the new skills, as needed. In addition, employees would also be expected to have a working understanding of software, information systems, and programs in an effort to integrate with machine learning (Farrell et al., 2020). The ability to de-skill and up-skill would demand human resource development, teaching, and training (Grenčíková et al., 2020). The advanced skills will ensure

the workforce in manufacturing is prepared to offer continual growth and willing to morph into the future of work (Grenčíková et al., 2020).

Industry 4.0 has become the new industrial age where the integration of systems of manufacturing technologies is merging with information and communication technologies (Dalenogare et al., 2018). Emerging from developed countries forward-thinking manufacturing was consolidated in a German public/private initiative that would build smart factories by combining physical objects with computer technologies (Dalenogare et al., 2018). The integration of technology permits systems to communicate with other systems that allow equipment control through monitoring (Dalenogare et al., 2018; Rübmann et al., 2015). The technology allows manufacturing processes to become more flexible and permits the ability to capture real-time data to make effective decisions (Dalenogare et al., 2018; Rübmann et al., 2015). Incorporating forward-thinking ways of manufacturing will allow the U.S. to be more globally competitive through meeting market demands and keeping production costs low through the ability to produce products at high volumes with consistent quality control (Rübmann et al., 2015).

Another perspective of these technological advances is the creation of skills gaps in human capabilities that are not keeping up with the fast pace of technology (Acemoglu & Restrepo, 2017). These technological advancements further deepen the influences of the qualifications of work, the worker's identity, and worker/employer relations (Kurt, 2019). These critical factors will affect every part of society by creating social disparities for the low-skilled workers (Kurt, 2019). In today's manufacturing sector, the requirement of workers to have higher-level skills to respond to new competitive requirements becomes crucial for job success (Carnevale et al., 2019). Moreover, the incorporation of automation in the industry directly takes

jobs away from low-skilled workers resulting in inequality as high-skilled tasks benefit the more skilled workers (Acemoglu & Restrepo, 2017). It is important that Wisconsin's postsecondary CTE programs prepare students with the needed skills and knowledge to be successful in tomorrow's workforce.

Significance of the Study

The significance of the study is to prepare young adults for future work needs through technical and non-technical multiskilling. However, for these individuals to acquire the needed skills and knowledge, they need competent instructors to guide and shape their learning through effective curriculum, program design, and effective teaching methods. The concern that technology is moving faster than human skills, which creates skills and knowledge gaps, will hinder the ability of the U.S. to be competitive in the global market. Moreover, skills and knowledge gaps in less-skilled workers further drive a divide in social structure. The need becomes apparent for a critical examination and evaluation of the current state of Wisconsin's postsecondary CTE curriculums and programs. The primary focus of the study will be on Chippewa Valley Technical College (CVTC) to ensure alignment to business and industry needs not just for today, but also for the future. The vision of CVTC is that the college is a dynamic partner that empowers students, employers, and the community to learn and succeed together (Chippewa Valley Technical College, 2021). To ensure industry and community requirements are met, it may be beneficial to make needed adjustments and/or alterations. The results of realignment for the unforeseen changes in the landscape of Industry 4.0, and the yet to be visioned future of work, will better prepare new workers.

Statement of the Problem

The problem that is being addressed in this study is that technology is moving faster than human skills, thus creating a skills and knowledge gap (Pilz, 2012). Concurrently, education and training systems may not be equipped to change at the rate needed to meet future work needs as the defined systems may only have the capability to meet immediate needs. It is important that young adults learn the needed skills and knowledge to be successful in today's workforce along with ensuring the U.S. continues to be a top global competitor. The uncertainties of rapid changes due to the development of communications or information technologies that cannot be predicted lead to questions in postsecondary CTE course curriculum and programs (Grenčíková et al., 2020). The questions include how to educate and what to teach tomorrow's workers for them to become successful in their chosen careers (Grenčíková et al., 2020). If young adults are not school-to-work ready, the gap in preparedness will hinder the manufacturing industry's ability to meet market demands and forecast the market's future needs.

It is necessary to examine and evaluate the current state of Wisconsin's postsecondary CTE curricula and programs to ensure they are aligned to business and industry needs (Pilz, 2012). If they are not, it will be beneficial to make the needed adjustments and/or alterations for realignment to future work demands. The adjustments/alterations will prepare young adults to be skilled in the areas of collaboration, innovation, problem-solving, technology literacy, and adaptability to the changing conditions of business and industry through multiskilling. Jandrić and Randelović (2018) noted that there was a link between the level of development and skills adaptability where there was a strong relationship between cognitive skills and economic outcomes. Jandrić and Randelović (2018) further explained that the ability of the workforce to

adapt to changing conditions of needed skills and knowledge was a key element that determines if a particular country's labor market would positively react to technological changes.

According to the Wisconsin Manufacturers and Commerce (WMC) Foundation (2019), Wisconsin's employers noted that job applicants lack technical skills and workplace readiness or soft skills. These skills are important and add to workforce concerns as the lack of vital skills stalls company growth (Wisconsin Manufacturers & Commerce, 2019). According to the survey that was presented to Wisconsin businesses, 30% of respondents stated that their hiring issues stemmed from applicants' lack of skills (Wisconsin Manufacturers & Commerce, 2021). These hiring concerns further illuminate the problem of skills gaps and the need to close those gaps with effective education strategies.

Purpose of the Research

The purpose of the research is to investigate how Wisconsin's postsecondary CTE curricula and programs are preparing students for the future of work through multiskilling to meet current, emerging, and future workforce needs. In addition, this study will seek to identify methods of instruction used to ensure students acquire the necessary skills to be successful in the changing workplace. The results of the study can lead to recommendations in instructional practices in Wisconsin's postsecondary CTE curriculum and program design. Improved teaching practices will allow young adults to be prepared to enter the modern work world of Industry 4.0 and beyond.

Research Question(s)

The following research questions have been designed to understand postsecondary CTE manufacturing programs and their curricula through the lens of the current, near future, and the yet to be envisioned future as it relates to the knowledge, skills, and dispositions being taught:

1. How are postsecondary CTE instructors designing their curriculum and programs to move at the pace of technological change?
 - a. What is the process for program development and revision within the Wisconsin Technical College System?
 - b. How do technical college programs keep pace with technological change?
2. What methods of instruction do teachers employ to ensure students are able to work and adapt to unpredictable environments and other changes in the workplace?

Assumptions of the Study

Regarding the study, the following two assumptions are declared. The first assumption is that the respondents answered interview questions honestly and to the best of their knowledge and ability. The second assumption is that young adults only acquire multiskilling through formal education.

Definition of Terms

Career and Technical Education (CTE)

Career and technical education courses focus on the development of skills and knowledge to prepare individuals to enter the work world and to create the basic awareness of technological literacy (Ojimba, 2012).

Industry 4.0

Industry 4.0, or the Fourth Industrial Revolution, has become the new industrial age where the integration of systems of manufacturing technologies is merging with information and communication technologies (Dalenogare et al., 2018).

Multiskilling

Multiskilling is horizontal in nature and pertains to having the ability to adapt to changing needs by de-skilling and re-skilling technical skills development (National Centre for Vocational Education Research, 2013). Multiskilling also pertains to non-technical competencies, such as critical thinking, communication, and problem-solving, which fosters adaptability and lifelong learning (Stewart et al., 2016).

Programs

Programs pertain to the clusters of activities, and each program is connected with a flow of activities and outputs of learning (McDavid et al., 2019). Chippewa Valley Technical College programs are a series of courses that lead to a technical diploma or associate degree (J. Furst-Bowe, personal communication, December 22, 2021).

Young Adult

Young adult pertains to individuals who are between the ages of 18 to 25 years old who complete a major part of their education, establish their independence, add more roles to their lives i.e., work and/or marriage, and are likely to have the least interesting and challenging jobs along with job dissatisfaction (Bee & Bjorklund, 2000).

Limitations of the Study

Limitations in studies are conditions that the researcher cannot control. In the study, four limitations will be addressed:

- Interview participants openly and honestly answer questions
- Sample is limited to this population of students (convenient sample of students)
- Possible challenges regarding the class observations due to students and instructors knowing they are being observed thus altering their behaviors

- Some documents may not be current

Proposed Methodology

The proposed methodology used in the study will allow for the triangulation of data to discover themes between the findings by applying a case study and narrative research. By analyzing college documents regarding processes and procedures for program and curriculum development, observing teaching methods, and performing open-ended semi-structured interviews questions, the researcher will have the opportunity to use qualitative data analysis. In addition, evaluation, both formative and summative, will also be used to evaluate the effectiveness of CTE curricula and programs, and determine where potential learning gaps may exist. The administration of open-ended questions through the semi-structured interview approach will use common themes of participant responses that will allow for the emergence of trends and patterns. The results will allow for data-based decisions on what approach to take regarding effective recommendations to aid CTE curriculums and programs to meet the multiskilling needs for Industry 4.0 and beyond.

The individuals or groups that will be invited into the study are CTE leaders and instructors at Chippewa Valley Technical College as the study will focus on one institution. From an analysis perspective, it will be optimal to have between six to eight interviewees to capture a diverse population of individuals (Lichtman, 2013). Capturing the experiences of these key individuals will validate and create trust with the readers of the research due to the participants being the closest to the main area of study which is programs and curriculum (Creswell & Creswell, 2018; Lichtman, 2013).

Theoretical Framework

The partnership between philosophy and theory is paramount as philosophy influences how one views the world, and theory identifies one's understanding of that world through their own connections (Himes & Schulenberg, 2013). Himes and Schulenberg (2013) expressed that philosophy has an impact on vital issues as they define problems, whereas theory provides effective strategies to solve the issues. The theoretical framework that guides the study is driven by the following learning theories: experiential, constructivism, and cognitive. Table 1 below addresses the key tenets of each learning theory.

Table 1

Learning Theory Tenets

<p>Experiential</p>	<ul style="list-style-type: none"> • Knowledge is a process, as reality is constantly changing, and one must adapt to those changes (Scott, 2014) • Critical thinking is paramount, and all relate to the pattern of the whole (Scott, 2014) • Cultivate social living and democratic society with the ability to reconstruct for the better (Scott, 2014) • Hands-on teaching methods help the student to understand the teachings through effective demonstration (Scott, 2014)
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Constructivism	<ul style="list-style-type: none"> • Connecting learnings with previous experience (Mahmud, 2013) • Learnings become an active process where processes become individualized (Fernando & Marikar, 2017) • Teacher takes on the role of a guide and resource (Mahmud, 2013) • Teacher is knowledgeable of teaching material at a mastery level (Fernando & Marikar, 2017)
Cognitive	<ul style="list-style-type: none"> • Internal and external factors influence the learner about the way people think is considered (Ruiz-Martín & Bybee, 2022) • Students have control of their learning when the student understands how thinking drives their behavior (Ruiz-Martín & Bybee, 2022) • Raw information is transformed into meaningful information through perception (Çeliköz et al., 2019) • Re-organization of information is unique per student and enhances the learning as the student makes connections to understand new material (Çeliköz et al., 2019)

Experiential Learning Theory

When students take control of their own learnings through performing tasks, it helps them retain facts and information (Sikandar, 2015). John Dewey was a great influencer of experimental learning as concrete learning and reflective observation are key components in learning from experience (Sikandar, 2015). In experimental learning, the teacher takes on the role of designer of the lesson, consultant (or resource), advisor, and deflects and directs the student in the learning environment (Ozar, 2015). Ozar (2015) noted that the learning

arrangement of experiential learning provides the elements for the student to have a stronger identification of their role and the teacher's role as the teacher becomes the facilitator of experience. The process of learning through one's experience is a direct connection to learner and environment; the function of the teacher is paramount due to the teacher arranging the learning activities and identifying what experiences are of value (Ozar, 2015).

Experiential or hands-on learning allows students to learn through reflection as they perform the learning task and the opportunity to correct themselves with instructor guidance as the student is actively involved in the learning process (McCarthy, 2016). Experiential learning theory relates to the study by allowing the student to own their learnings and reflect on the new learnings through observation. When students see the connection of the lesson, it allows them to remember and bring meaning to the teaching material that is presented to them. In addition, the hands-on approach to learning is essential, as most CTE courses require demonstration of the tasks being learned, such as welding and machine tool.

Constructivism Learning Theory

When students can link their learnings with previous experience, they are able to make stronger connections (Mahmud, 2013). The learnings become an active process on the individual level and capture the distinct processes that students acquire knowledge (Fernando & Marikar, 2017). When the teacher takes on the role of guide and resource, this creates a learning environment where the student creates their own understanding of the lessons (Mahmud, 2013). Constructivist teaching methods champion a participatory approach where students play active roles in the learning process and the teacher takes on the function of facilitator (Fernando & Marikar, 2017). Furthermore, it is imperative that the teacher is knowledgeable of the teaching material and the area of discipline through their own academic qualifications, as the teacher

transmits vital knowledge to the student (Fernando & Marikar, 2017). Constructivism learning theory connects to the study by creating mental pathways for the student to personalize their learning that helps them deeply understand new ideas and concepts that are presented to them. The active process of learning is how students gain knowledge and apply that new knowledge to different life experiences. In manufacturing techniques, it is essential to scaffold previously learned skills with new technologies, which allows workers to adapt to changing landscapes in industry.

Cognitive Learning Theory

Internal and external factors influence the learner and take into consideration the way people think (Ruiz-Martín & Bybee, 2022). When students understand how their thinking drives their learning and behavior, they can control it (Ruiz-Martín & Bybee, 2022). Learning strategies in cognitive learning theory connect the students understanding of how their thought processes work and use those processes to construct knowledge (Ruiz-Martín & Bybee, 2022). Cognitive processes are mental activities that allow for the transfer of information from short-term memory to long-term memory (Çeliköz et al., 2019). These processes consist of attention, perception, repetition, coding, and the retrieval of information, as the stimulus of raw information is transformed into meaningful information through perception (Çeliköz et al., 2019).

Jean Piaget's theory on cognitive development, or developmental stage theory, pertains to the nature of knowledge itself and how individuals obtain knowledge through environmental experiences and use that knowledge to apply it in mental processes (Ghazi et al., 2016). Piaget felt that cognitive development used a scaffolding system regarding the progressive reorganization of mental processes that originated from biological maturation and experiences within the environment (Ghazi et al., 2016). Cognitive theory compliments experiential theory as

knowledge is a process and the world is in a constant change where one must adapt to those changes (Scott, 2014). Both theories are essential in the future of work by honing skills that align with multiskilling and flexibility.

Çeliköz et al. (2019) noted that in meaningful learning, lessons transfer from whole to part in a deductive manner and become essential for the student to relate and re-organize the learned material. The re-organization that is unique per student enhances the learning and creates crucial connections to understanding. The cognitive learning theory connects to the study by tapping into how the student thinks and sees their world. When lessons are easily understood by the student, it allows for the building of knowledge. The student gains control of the learnings and discovers how to apply those learnings to unpredictable events in their work and lives. In manufacturing, one needs to have concentrated attention and perception as there are multiple stimuli. When a worker has a heightened awareness of their work environment, it allows them to foresee issues and become proactive as they plan around to abate those issues or problems.

Educational Theories

There are many kinds of educational theories to capture the different learning needs of the student. Educational theories pertain to how people learn and retain information through application and interpretation, and how students learn best (Khalil & Elkhider, 2016). The key theories addressed are experiential, constructivism, and cognitive. The intertwining of the different tenets allows for effective teachings that create meaningful knowledge and the ability to connect new knowledge to new situations. The American philosopher and educator John Dewey noted that the methods of learning and teaching should be tailored to the learner to develop higher-order thinking (Leshkovska & Spaseva, 2016). Dewey also expressed to allow the learner to explore their environment that develops the understanding of concepts, skills, and theory of

knowledge, which could be applied to any situation the individual faces (Leshkovska & Spaseva, 2016). The process of inquiry helps individuals to evaluate the information they collect and to make connections of that information to their own lived experiences (Holland, 2017). The engagement of active learning is propelled by questions, seeking out answers, and exploring challenging problems (Holland, 2017).

Chapter II: Literature Review

Teaching methods, teaching content, and close partnerships with industry is a crucial area of study. The purpose of the literature review is to provide an overview of current educational practices that prepares the workers of tomorrow. Moreover, it is important to ensure CTE is keeping up with the pace of technologies and examine best practices in CTE that encourage life-long learning that allows students to flex and adapt to the ever-changing landscape of the industry. An and Reigeluth (2011) argue that the current factory model of education is not evolving to the expanding demands of the information age. Oke and Fernandes (2020) expressed that the inadequate knowledge of learning to evolve with technologies would create disruptive effects on innovation if the education sector does not keep up with new skills and knowledge required for future workers. This perceived shortfall in educational strategies may cause challenges in meeting the needs for the future of work.

A review of literature examined current research on preparing young adults to meet Industry 4.0 needs and beyond that included: Industrial Revolutions and their impacts on society and education. The next section discussed educating students to meet Industry 4.0 needs that included the areas of the goals of PK-12 and technical college education, curricula, Bloom's Taxonomy, problem-based learning, cooperative learning, technology in learning, project-based learning, kinesthetic skills to conceptual understanding, and learner-centered models for learning. The next section discussed technical skills teaching and training in rapid change work environments with the areas of the Developing a Curriculum process (DACUM) to develop competency-based curriculum, hiring criteria for competent technical instructors, the WTCS procedures for program design and curriculum, and the utilization of employer feedback surveys and WTCS surveys for program and curriculum development. The last section discussed

workforce development with the areas of the role of WTCS in manufacturing workforce development and the manufacturing employment situation in Wisconsin.

Industrial Revolutions (Industry 1.0 to Industry 4.0)

The history of the Industrial Revolutions started with the first Industrial Revolution in Great Britain in the 18th century (Melnyk et al., 2019). Sources of energy, such as fossil fuels (i.e., coal, natural gas, and oil), intensified people's ability to work and has transformed human society ever since (Williams, 2022). The steam-powered engine gave life to machines that produced cotton, powered spinning machines, and created improvements for ships and trains (Pilevari & Yavari, 2020). Economists said that steam technology was the nucleus of broader new technological systems of production (Nuvolari, 2019). The new ways of producing goods spread quickly to other countries, such as the United States, as the need to learn about the machines brought people to Britain so workers could take the new techniques back home and help their communities thrive (Simone, 2022). Nuvolari (2019) noted that general-purpose technology provided a positive effect on economic growth as technological change and economic growth moved in tandem. Alin (2019) expressed that the first period of the Industrial Revolution (Industry 1.0) started the business culture that focused on quality, proficiency, and product volume.

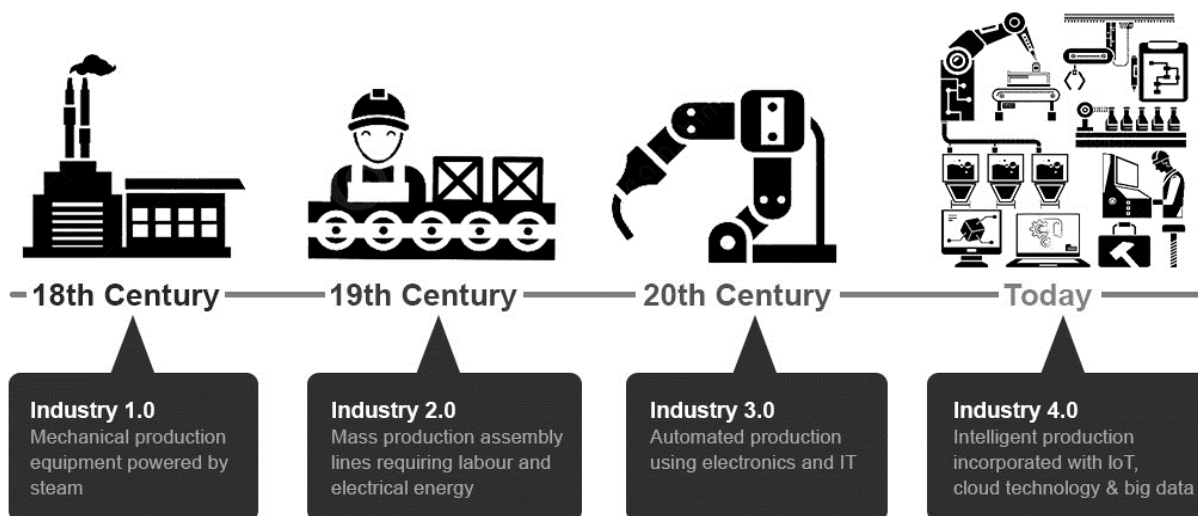
Industry 2.0, which started in the 19th century and lasted until the early 20th century, introduced the innovative idea of the assembly line (Melnyk et al., 2019; Ward, 2019). Michigan's automobile manufacturing company, Oldsmobile, was the pioneer of mass production, which utilized an assembly line. Henry Ford enhanced the practice using conveyor belts that would carry automotive parts from the work area to further assembly operations (Michigan State University, n.d.).

Industry 3.0 began in the 20th century and was the age of automated production (Ward, 2019). There were ways to evaluate and examine processes to adjust for enhancements in production (Cruz, 2020). The utilization of measurement and analysis demonstrates a drastic advancement in the use of technologies as the introduction to electronics and information technology further advanced automated production (Profit Coaching International, 2021). Each phase of the Industrial Revolutions displayed characteristics of technical achievements and created immense effects on the economy (Prisecaru, 2016).

The emergence of Industry 4.0, which started in the 21st century, incorporated the intelligent side of production by not only information technology but also cloud technology and big data (Dima, 2021; Profit Coaching International, 2021). Cruz (2020) noted that Industry 4.0 has the capacity for impacting manufacturing companies by computational power and conductivity, incorporating human and machine collaboration, concentrating on intelligence and analytics for decision-making, and championing advanced methods in production. Incorporating these elements into today's manufacturing would allow for better financial stability and technical capabilities, quick adaptation to market needs, and championing the organization to learn and grow with technology advancements (Cruz, 2020). As of now, Germany leads in manufacturing as the country has maintained leadership in forward-thinking manufacturing technologies through innovative initiatives (Iyer, 2018). This forward-thinking shows that if the U.S. wants to be a top global competitor, it will need to keep up with education and training to meet the demands of an evolving global economy. Figure 1 below is an illustration of the development of Industrial Revolutions through the centuries.

Figure 1

The Progression of Industrial Revolutions by Century



Note. Adapted from “4IR,” by Profit Coaching International, 2021, Profit Coaching International. <https://www.profitcoachinginternational.com/index.php?id=948>

Societal Impact

The consequences of aggressive advancement in technologies were that individuals and social systems struggled to keep pace (Melnik et al., 2019). Iyer (2018) illuminated this point by noting that the key differentiators regarding human resources would be education and the development of skills as business and industry would need qualified workers to effectively manage complex global supply chains. Furthermore, updating course content with the collaboration of not only educational institutions, but also the support from policymakers, would ensure the new workforces emerging would have the skills and knowledge to meet the needs of modern industries (Iyer, 2018). Prisecaru (2016) expressed that to successfully adapt to technology challenges, that result in unemployment or lower wages, one should concentrate on education and reskilling to combat negative income distribution. The imbalance could result in a further divide in a society’s social structure (Kurt, 2019). Furthermore, the emergence of robotics

and artificial intelligence may push dehumanization of individual lives that could affect empathy, sensitivity, inspiration, and illuminate ethical and moral challenges (Prisecaru, 2016). Morrar et al. (2017) exclaimed that when seeing how technological progress could be utilized to resolve issues, one must also not lose sight of the social perspective regarding these innovative technological advances.

Educational Impact

The progression through each Industrial Revolution not only impacted how we produce goods but also impacted the labor market and resulted in phased-out professions and job loss (Benešová & Tupa, 2017). Benešová and Tupa (2017) noted that the function of the human would be imperative for the future of manufacturing and that their skills and qualifications would be paramount for the success of future-forward factories. Further, needed competencies could fall into four categories that include technical, methodological, social, and personal (Benešová & Tupa, 2017). Sharhroom and Hussin (2018) further illuminated this point by expressing that to prepare people for the future of work, education should encompass abilities that cannot be accomplished by robots. Moreover, educators need to develop more cutting-edge approaches that foster modern educational practices to upgrade future learning (Sharhroom & Hussin, 2018). Sharhroom and Hussin (2018) further noted that instructors need to re-examine their known ways of teaching and learning for students to meet the demanding requirements for the future of work. Pereira and Romero (2017) proclaimed that education initiatives should also include social and technical domains as future workers would need to quickly adapt to new tasks as technology progresses. The above examples show that the educational system needs to keep up with the present and future demands of manufacturing.

Educating Students to Meet Industry 4.0 Needs

Educating students to meet Industry 4.0 needs is becoming more important as technology moves forward (Grenčíková et al., 2020). Technology is not only changing work regarding automation, but also in cooperation, communication, and knowledge creation (Altass & Wiebe, 2017). The importance for students to be flexible and resourceful ensures students would be the future innovators that would keep industries on the cutting-edge of modernization (Alismail & McGuire, 2015). Vaughan (2014) expressed that not only was it critical for teachers to keep students engaged in the learning, but also to have awareness of the changing nature of education and prepare students for the future of work.

Goals of PK-12 Education

One of the main goals of the PK-12 system was to prepare students for tomorrow's jobs (Klein, 2021). The Wisconsin Department of Public Instruction (2021) noted that their goals were to adopt academic standards in each area of study that would best serve their local communities. Further, offering high-quality education programs allow students to acquire essential skills and knowledge to be successful beyond their school years was one of Wisconsin's academic standards (Wisconsin Department of Public Instruction, 2021). Setting high standards allows students, parents, teachers, and community members to have awareness regarding what is being taught in their schools (Wisconsin Department of Public Instruction, 2021).

Klein (2021) stated that the school's main priority was preparing students with the capabilities and skills required to be successful in future job roles. Klein (2021) further noted that there may be fewer people needed to do certain jobs, such as tasks that could be replaced by automation. Incorporating technologies into the curriculum would help students be better prepared for the future of work through using applications in math, and other courses so students

understand how to apply technology to everyday problems (Klein, 2021). A report from Public Agenda found that the American public believes the focus of PK-12 education should be on career and interpersonal skills that would prepare students for jobs and being active participants in society (Silliman & Schleifer, 2018). The report also revealed that new standards of assessments need to be in place that measure student growth in development and interpersonal skills (Silliman & Schleifer, 2018).

The outlook from employer studies regarding PK-12 education and what students need to be prepared for found that working well with others, problem-solving, and critical thinking were vital for the workplace (Silliman & Schleifer, 2018). Yet, employers are having difficulties finding viable candidates with these needed skillsets (Silliman & Schleifer, 2018). Further, employers also noted that writing proficiency, public speaking, and data analysis skills are also hard to come by (Silliman & Schleifer, 2018). Employers in focus groups expressed that they could play a pivotal role in PK-12 education through job shadowing, mentoring, internships, and allowing students to work on projects (Silliman & Schleifer, 2018). The focus group showed that employers desire a viable pipeline of competent workers so they could support industries and the communities they serve.

Goals of Technical Colleges

The goals of technical colleges are to offer career-orientated training for students so they can be successful in their job roles. Chippewa Valley Technical College's (CVTC) mission is to deliver innovative, applied, and flexible education that is supportive to students in the community and enhances their lives, and adds community value (Chippewa Valley Technical College, 2021). CVTC's vision is to be a dynamic partner that empowers students and employers along with the community so everyone can learn and be successful (Chippewa Valley Technical

College, 2021). The mission and vision demonstrate that CVTC is committed to creating a learning environment that inspires students to attain their professional and personal goals and aspirations. WTCS has goals of alignment with both the needs of the students and employers through collaboration, so graduates are school-to-work ready (WTCS, 2021b). In addition, the WTCS engages policymakers, educators, employers, workforce development partners, and community organizations to ensure sustained economic stability and continued growth (WTCS, 2021b).

Curricula

Curricula standards need to progress with the advancement of technologies and move away from the model of reading, writing, language, social studies, and mathematics through content repetition to keep up with the requirements of the ever-fluctuating landscape of industry (Alismail & McGuire, 2015). Curricula focused on the principles of scientific management, rather than growth areas, such as social, intellectual, emotional, and moral areas, hinders the student's ability for explorative thinking (Bailey, 2016). When a thinking-based curriculum was created, the curriculum provides students with a deeper understanding of subject content and the ability to apply learned concepts to real-world problems they may face in their future careers (Alismail & McGuire, 2015).

Bloom's Taxonomy

Bloom's Taxonomy is both an evaluation tool and a teaching-learning process that incorporates six stages of cognitive skills from low to high order thinking: remembering, understanding, applying, analyzing, creating, and evaluating (Chandio et al, 2016). Remembering creates the capacity to recollect learned information, such as events, dates, or ideas (Crompton et al., 2018). The remembering stage connects to the cognitive learning theory

as cognitive processes are mental activities that allow for the transfer of information from short-term memory to long-term memory allowing for information retrieval (Çeliköz et al., 2019). Regarding the understanding stage, higher-order thinking creates the ability to understand the value behind the information and explain it through one's own words (Crompton et al., 2018). The understanding stage connects to the cognitive learning theory as the student transforms raw information into meaningful information (Çeliköz et al., 2019). Applying consists of incorporating newly learned information to solve problems or perform another task (Crompton et al., 2018). The applying stage connects to the cognitive learning theory as the learnings prepare students to become better problem-solvers to reach better solutions (Scott, 2014).

Analyzing creates the ability to chunk or break down knowledge into parts and demonstrate the relationship of those segments (Crompton et al., 2018). The analyzing stage connects to the constructivism learning theory as the learnings become an active process where those processes become individualized, and students process new information in their own way (Fernando & Marikar, 2017). Creating ensures the capability to merge all parts of knowledge to create a new whole and develop redefined relationships for situations that one has never experienced (Crompton et al., 2018). The creating stage connects to the experiential learning theory as critical thinking abilities allow the student to relate information to the pattern of the whole that creates newly honed relationships (Scott, 2014). Lastly, evaluating creates the ability to assess the true meaning of material and methods for a specific function (Crompton et al., 2018). The evaluation stage connects to the cognitive learning theory as the student links their learnings to new information so they can apply it to different purposes (Çeliköz et al., 2019).

Incorporating Bloom's Taxonomy into teaching-learning processes engages higher-order thinking skills, such as analyzing, evaluating, and creating that are needed for cause-and-effect

relationships and problem-solving (Chandio et al, 2016). These approaches to the teaching-learning processes would improve assessment systems rather than focusing on simple memorization, rote-learning, and the production of factual knowledge that student's parrot back to their teachers (Chandio et al, 2016). Furthermore, elements of Bloom's Taxonomy ignite the critical and analytical thinking processes that are vital for career success in Industry 4.0 (Chandio et al, 2016). Armstrong (2016) noted that incorporating Bloom's Taxonomy in teaching methods helps in establishing learning goals. Learning goals assist both teachers and students to understand expectations, and teachers could use the framework to organize learning objectives that help with clarification for both themselves and their students (Armstrong, 2016). Furthermore, having established, organized objectives aid in planning and delivery of instruction, design validation for assessment tasks and strategies, and ensures alignment of instruction and assessment with the learning objectives (Armstrong, 2016).

Problem-Based Learning

Problem-based learning allows students to discuss and dissect relevant issues and topics that are real-world issues as students investigate problems, provide explanations, generate ideas, analyze data, and make sound judgments to form appropriate resolutions (Alismail & McGuire, 2015). Problem-based learning aligns with the cognitive learning theory as it teaches students to use different thinking strategies to make sense of new issues and make connections to apply to new material (Çeliköz et al, 2019). Incorporating problem-solving in teaching allows the students to hone their critical thinking skills through creative thinking to break down potential barriers to effective solutions (Alismail & McGuire, 2015). Furthermore, problem-based learning strategies support student capabilities in critical thinking, allow for self-directed learning, promote cooperation within their student group, and enhance social interaction (Alismail & McGuire,

2015). When group work, or cooperative learning, was incorporated into the curriculum, this type of learning used students' strengths and talents to produce an end product (Alismail & McGuire, 2015). Problem-based learning becomes beneficial in manufacturing as new products are introduced as customer needs evolve that requires workers to apply multiskilling characteristics. Problem-based learning connects to the cognitive learning theory as students scaffold knowledge and join how different factors influence learning (Ghazi et al., 2016; Ruiz-Martín & Bybee, 2022).

Cooperative Learning

Cooperative learning allows students to operate in diverse groups that have different abilities and interests that promote creativity, deepen learning, and allow each student to bring something to the table (Alismail & McGuire, 2015). These activities enhance the needed skills to work in diverse groups that allow for mutual respect, collective action to accomplish tasks and help with learning to compromise to meet a common goal (Alismail & McGuire, 2015). Further, when students contributed to the construction of their own knowledge and produce value and meaning of the lessons through group collaboration, students would see the connection to real life and what they are learning that aids in the success of their future careers (Alismail & McGuire, 2015). Learning to work in a diverse work environment through the multiskilling of collaboration allows for innovative ideas to emerge. Cooperative learning connects to the constructivism learning theory as students can personalize their learning that allows deep understanding and apply the new learnings to new situations (Mahmud, 2013).

Technology in Learning

When technological tools are incorporated into learning, these tools could support different skills in non-technical multiskilling, such as problem-solving, collaborative learning,

critical thinking, and the learning environment itself (Alismail & McGuire, 2015). Altass and Wiebe (2017) expressed that providing students with the opportunity to work with technologies would become fundamental in future education plans. Furthermore, using tools, such as multimedia, provides an avenue of effective feedback to student peers that helps improve the team efforts (Alismail & McGuire, 2015). Multimedia could also develop academic and social skills as students communicate and convey information, express their thoughts on a project, and organize their ideas as a group (Alismail & McGuire, 2015).

Vaughan (2014) noted that the incorporation of technology in teaching higher education presents opportunities to transform outdated pedagogy, so learnings reach the millennial student. Learning how to learn would be fundamental in future work as modern technologies and ways of doing things will be forever changing. By incorporating multimedia tools into instruction, teachers could foster learning environments that allow for discussion, collaboration, problem-solving, and innovative thinking while fostering cognitive processes and building knowledge that would aid the student past their school years (Alismail & McGuire, 2015).

Project-Based Learning

Project-based learning allows the student to connect learning with meaningful experience (Handrianto & Rahman, 2018). Project-based learning is a student-centered learning approach that allows the student to investigate, apply decision-making, and collaborate with others to solve problems (Handrianto & Rahman, 2018). In addition, project-based learning ignites the multiskilling of soft skills, such as socialization, teamwork, communication, problem-solving, life-long learning, critical thinking, and leadership (Handrianto & Rahman, 2018). Handrianto and Rahman (2018) noted that project-based learning connects to the constructivism learning theory as the student learning process connects meaning to previously learned experiences

through reflection on their interactions with ideas and objects. Constructivist learning involves student activities that develop their experiences that make real-world relationships become deeper established (Handrianto & Rahman, 2018). Project-based learning could be interchangeable through either individual projects or group projects (Handrianto & Rahman, 2018). However, applying project-based learning in a group learning environment allows the students to collaborate through teamwork to solve complex problems (Handrianto & Rahman, 2018).

Guo et al. (2020) conducted a study that applied project-based learning with a focus on student outcomes, such as perceptions of benefits and perceptions of experience. The researchers measured these factors through interviews, observations, questionnaires, and journals of self-reflection (Guo et al., 2020). Other outcomes measured were cognitive and behavioral outcomes that were measured by project rubrics, interviews, observations, student artifacts, and log data (Guo et al., 2020). The results of the study concluded that the area of student readiness to work received the most attention as basic knowledge and skills are crucial for employers (Guo et al., 2020). All student artifacts were assessed by utilizing the rubric. Rubrics allow students to have a guideline of instructor expectations and how to complete projects successfully. This helps learners connect and reconstruct their knowledge through the development of professional skills and their ability to work with others (Guo et al., 2020).

In other words, the final projects are an intertwining of various students' competencies, ideas, and expressions to complete an end result (Guo et al., 2020). Guo et al. (2020) noted that the application of project-based learning encourages students to construct new knowledge, test, and achieve their ideas regarding the fashion that works best for them as this champions innovation competence. Project-based learning connects to the study by incorporating the

qualitative data analysis of interviews, classroom observations, course artifacts, and scoring rubrics for student projects that allow for a holistic approach to student learning outcomes and experiences. Project-based learning also connects to the world of manufacturing by preparing students to collaborate with others to meet a shared goal. Goals could be new products per customer requests or collaborating within cross-departmental groups to successfully complete large customer orders.

Kinesthetic Skills to Conceptual Understanding

The ability to process information from a physical sense through touch or vision through sensory perception allows for multi-sensory learning (Pinzon et al., 2016). Multisensory learning incorporates the whole brain by adding auditory or visual elements to lessons (Waterford.org, 2019). The key is to connect and transfer that learning into new situations that aid in adaptability, high-level thinking skill development, and learning how to learn (Andayani et al., 2018). All these skills are crucial in the future of work in manufacturing and are key areas of non-technical multiskilling.

Evagorou et al. (2015) performed a study of the role of visual representations in scientific practices that aided students from conceptual understanding and knowledge production to experiencing the inter-workings of science. In the research, there were three case studies performed that encompassed the working practices of scientists. The first two case studies relate to the research as it connects to cognitive learning theory as raw information is transformed into meaningful information through perception (Çeliköz et al., 2019). The blend of the case studies allowed for a representation of how visualization aids scientists in all stages of science. Visualization also aids in other areas other than science, such as manufacturing techniques that require multisensory strategies.

For case study one, visual data representations of the history and discovery of DNA were applied to show students how visual data was used as scientific evidence, as this was crucial for knowledge generation and reliant on the findings of new technologies (Evagorou et al. 2015). Three-dimensional models were also employed that allowed for visual images that could be connected to evidence that was offered by other sources to show that the theory could be defended (Evagorou et al. 2015). The analysis based on the role of visual information played was found that it was important to ask questions and define problems, understand how to analyze, and interpret data, experimentation to predict possible outcomes, and lastly, modeling that did not meet the needs of the real-world application (Evagorou et al. 2015). The study showed that visual representations could be used in many ways that allow for an understanding of reality (Evagorou et al. 2015).

Case study two utilized Faraday's visual method that focused on images and illustrations from experimental devices and setups that reviewed his theoretical ideas that allowed for analysis and replication (Evagorou et al. 2015). The examination of Faraday's experiment with magnetic force allowed students to directly observe magnetic fields that showed how visual imagery and reasoning connect to the natural world (Evagorou et al. 2015). These visual images permitted students to connect learning with the world around them that made them meaningful and relevant to their applications. This connects to John Dewey's theory on experiential learning as students observe what is presently happening and reflect on those observations to enhance the learning experience and connect it to the real world (Sikander, 2015).

These case studies demonstrated how visualization played a pivotal function in scientific detection that granted students the ability to transfer knowledge into practice (Evagorou et al. 2015). Moreover, the case studies showed the importance of visual representations in science

teaching in the curriculum as a critical factor of knowledge acquisition that engages students and encourages appreciation in scientific practices (Evagorou et al. 2015). Evagorou et al. (2015) expressed that deep cognitive understanding comes from visualization and that teachers and curriculum designers could create engaging materials and learning environments for students. Engaging materials and environments generate social and epistemic content that steers the student towards reasoning, experimental procedures, or a way to communicate that allows for the reflection of the practices learned (Evagorou et al. 2015).

Learner-Centered Models for Learning

Learner-centered models for learning allow students to develop real-life skills, such as collaboration, higher-order thinking, and problem-solving that meet today's industry requirements and reflect characteristics of multiskilling (An & Reigeluth, 2011). The new version of pedagogies would require alterations between the relationship of the teacher and the student (Dole et al., 2015). In learner-centered models for learning, the teacher would take on the role of the facilitator while the students would take lead in their learning which would result in the paradigm of the teacher losing control of the school environment (Dole et al., 2015). However, this shift in control to the student drives the learning, giving the student the opportunity to self-evaluate their progress and offering the students the opportunity of selection in subjects and assignments (Dole et al., 2015).

Further, learner-centered models allow the teacher to be a guide in student learning as the students learn through independence, collaborative critical-thinking, self-exploration, and self-discovery strategies that may mirror their potential life experiences (Dole et al., 2015). The learner-centered teaching model shows that the teacher takes on a steward leadership role as they become the main supporter of the students' needs, tools, and resources for their learning projects

(Lussier & Achua, 2016). Dewey expressed that learning growth was present throughout one's life and that learning was simply expanded and refined as new experiences were added (Stoller, 2015). Further, the curriculum should be tailored around the distinctive experiences of the students while being partnered with the knowledgeable resources of the teacher (Stoller, 2015).

In learner-centered classrooms, trust is established through teacher confidence, independent instruction that allows students to teach themselves, strategies in problem-solving, and learning to ask relevant questions to identify and solve problems (Dole et al., 2015). Student growth stems from an experimental inquiry that encourages students to voice their own opinions and experiment freely (Stoller, 2015). Stoller (2015) noted that when teachers administer pre-packaged learning outcomes, the teachings limit the student's own learning process resulting in lower levels of thinking. Added enhancements to students in learner-centered classrooms are the ability to work as a group, become responsible and accountable, and practice their leadership skills (Dole et al., 2015). Dole et al. (2015) noted that teachers felt they were better listeners, observers, and communicators when they incorporated learner-centered instruction. Learner-centered classrooms connect to the constructivism learning theory as lessons are related to students' previous experience, the teacher takes on the active role of resource, and teacher mastery of learning material (Fernando & Marikar, 2017; Mahmud, 2013). Learner-centered models also teach students multiskilling characteristics that would become a necessity in the workplace as workers need to be able to work with diverse groups and collaborate to reach common industry goals.

Technical Skills Teaching and Training in Rapid Change Work Environments

The continuous advancement of curriculum based on meeting rapid changes in skills and knowledge acquisition is vital in advanced manufacturing work environments. Updating CTE

curriculum standards, program evaluation of existing programs, and introducing new programs would aid in alignment with manufacturing industries (Kantrov, 2014). Kantrov (2014) expressed that it was essential to align CTE programs and curricula to respond to workforce needs within the community as strong workforce development would support future work demands. Manyika et al. (2017) noted that currently, six out of ten occupations have more than 30% of their activities at risk of becoming automated thus driving some employees out of work. The future skills and capabilities that would be needed to avoid job displacement are social and emotional skills and advanced cognitive abilities that support logical reasoning and creativity (Manyika et al., 2017). The shift in technical education has redefined the partnerships between education, industry, and government (Baumann et al., 2014). Working together, these partners create competency-based, industry-driven education on the levels of local, state, and national to enhance forward-thinking educational approaches and best practices (Baumann et al., 2014).

The DACUM Process to Develop Competency-Based Curriculum

Baumann et al. (2014) conducted a case study regarding stakeholder partnerships that are moving away from traditional curriculum and assessment models by incorporating industry subject matter experts who developed a competency-based curriculum. The curriculum utilizes the methodology of assessments using the DACUM process. The DACUM process combines a focus group that captures the main duties of an occupation, such as set tasks, knowledge, skills, and traits needed to be competent in a certain profession (DACUM International Training Center, 2021). The learning model would entail a methodology that would capture learning analytics, such as performance, completion rates, and learning gaps that would further shape teachings in manufacturing (Baumann et al., 2014).

Baumann's case study tapped into the expertise of the Michigan Advanced Technician Training (MAT) program who has developed a competency-based curriculum for its students. MAT's main objective was to create an industry approach to education that produces able employees to add to the pipeline of talented, skilled workers (Baumann et al., 2014). The core elements of the objectives of the program were in four areas: 1) industry-driven/competency-based curriculum and assessment, 2) standardized curriculum elements utilizing the DACUM process, 3) assignment of instructors in both development of program and management of the program, and 4) standardized reporting and evaluation (Baumann et al., 2014).

The Baumann case study approaches taken for the program's success consisted of both academic and program management (Baumann et al., 2014). For the academic approach, this ensured concept, content, design, development, and execution met the standards of up-to-date competency-based education where industry and education played equal roles (Baumann et al., 2014). The program management approach ensured the program was planned, executed, and monitored professionally and concurrently with the management of partners who brought knowledge, approaches, expectations, and experiences that created alignment (Baumann et al., 2014). The process and development for the academic approach used industry tools and techniques that joined communication and cultural differences between all stakeholders that championed accountability (Baumann et al., 2014). The curriculum and assessment process to the instructional design resulted in a systematic curriculum that aligned with a variety of technical programs to industry-identified standards and industry-created certification tests (Baumann et al., 2014). The significance to have defined standards that were developed by both industry and educators would attain quality and relevancy (Baumann et al., 2014).

In the case study, credentialing and assessment standards were designed to collect and use data results for continuous improvement efforts along with the implementation of a standardized process of assessment (Baumann et al., 2014). The collected data would be used for program improvements, best practices for teaching methods, and design enhancements (Baumann et al., 2014). The assessments would provide information regarding student progress by utilizing industry-defined standards (Baumann et al., 2014). The standardized assessment would signal the successful completion of the skill mastery of key industry standards that were identified by industry professionals (Baumann et al., 2014). Utilizing these assessment standards ensured the program learning outcomes were met that allowed students proof of mastery in competencies, quality validation for employers, and a benchmark for quality, skills, and knowledge (Baumann et al., 2014). All these areas align with occupational standards and reflect multiskilling characteristics needed in the future of work (Baumann et al., 2014).

The program management approach of the case study ensured expectations and interests were met by the organization's stakeholders along with accountability (Baumann et al., 2014). The partnerships were important as they offered understanding regarding human behavior and decision-making principles that allowed for the understanding of others' expectations (Baumann et al., 2014). These expectations included competency-based learning outcomes and objectives, a statewide system that teaches a standardized set of occupational standards, ongoing student and program development support, and the incorporation of competency-based education, assessment, and instruction within the work environment (Baumann et al., 2014).

The study concluded that every industry plays a pivotal role in the future of work and that every worker needs more education and better skills to be successful in future-forward industries (Baumann et al., 2014). When common industry standards are agreed upon by all stakeholders

through competency-based education models, the program could adjust and adapt to current and future needs (Baumann et al., 2014). The increase in the demand of the manufacturing workforce technical skills would require problem-solving abilities to sustain modern technologies because success would rest on them (Baumann et al., 2014). The case study connects to the experiential learning theory as knowledge is a process due to the constant change of the world around us, where individuals must adapt to the changes (Scott, 2014). The technology advancing nature of manufacturing must flex and modify to continue to be competitive. When all stakeholders (i.e., education, industry, and state) work in tandem, it creates alignment of expectations and accountability for each sector along with meeting the individual needs. The strong partnerships allow transparency and trust that results in effective relationship building and successful strategies in education.

Hiring Criteria for Competent Technical Instructors

The importance of shaping tomorrow's workers starts with the competency, skills, and knowledge of the instructors. Stephens (2015) noted that instructors with a strong background in industry are valued in CTE classrooms. Instructors that have an industry background bring the rich reality of experience and expectations that aid students in developing their skills and competencies when they start their careers (Stephens, 2015). In 2016, there were six million open positions in the labor market with 46% of employers facing challenges of filling those positions with competent workers (Rosen et al., 2018). However, some schools were reluctant to bring in industry seasoned instructors due to financial barriers and enrollment concerns (Stephens, 2015). This creates an academic tug-of-war between what is best for student success and what best meets the financial needs of the institution.

Stephens (2015) expressed that CTE instructors are expected to design instruction to nurture the development of technical skills and knowledge that pertain to a certain field's academic aptitudes, social growth, and school-to-work preparedness. Moreover, the instructor is expected to propel student learning outcomes through a series of research-based teaching strategies, facilitate student assessment, and lastly, reflect and revise teaching strategies and best practices to enhance the learning experience (Stephens, 2015). To ensure quality education for Wisconsin's technical colleges, the Faculty Quality Assurance System (FQAS) is a Wisconsin Statute that ensures technical instructors meet academic, occupational, and teaching requirements (Wisconsin State Legislature, 2015). Instructors are required to have credentials, such as transcripts from an accredited post-secondary institution, copies of professional licenses required by the state, and verifications for both appropriate teaching experience and occupational experience (Wisconsin State Legislature, 2015). To ensure compliance with the FQAS, districts are required to provide annual reports regarding their faculty, such as hiring practices, professional development activities, performance evaluations, and plans that focus on mentoring all instructors (Wisconsin State Legislature, 2015).

Stephens (2015) expressed that proper instruction, developed by competent instructors who have a professional background in the industry, ensures that students are equipped with relevant knowledge and skills to be successful in their job roles. In addition, instructors that have a passion for teaching and their fields of expertise affect student learning and achievement (Jeswani & Jaiswal, 2014). Jeswani and Jaiswal (2014) noted that non-committed faculty have high levels of turnover or put less effort into their teachings resulting in lower student performance and commitment.

WTCS's Process and Procedures for Program Design and Curriculum

In the WTCS, new program development starts with local employment needs and how that program would support those needs by analyzing employer surveys (WTCS, 2021a). When existing programs need alterations due to changes in job functions, a program advisory committee would oversee these changes and apply best practices (WTCS, 2021a). When these practices are applied, it creates alignment with regional employment demands.

To ensure students gain proper technical skills that are industry-validated, the WTCS has implemented a Technical Skills Attainment (TSA) process (WTCS, 2021a). The TSA is the process that outlines the development of core competence in each program and ensures the student could demonstrate those skills in relationship with the program outcome summaries (WTCS, 2021a). In addition, the WTCS (2021a) administers a second phase of the assessment through a summative assessment, student portfolio, or industry-validated third-party assessment. These assessments ensure that graduates leave the college armed with the skills and knowledge to meet the expectations of their employers.

Utilization of Employer Feedback Surveys and WTCS Surveys for Program and Curriculum Development

The rich information that employer feedback surveys offer technical colleges results in improvements in programs and curriculum. Employer feedback creates a pulse check for technical colleges to ensure what they are teaching students is relevant to employer needs, such as vital skills and knowledge to be successful in job roles. Jankowski et al. (2018) noted that employer survey feedback helps colleges on what courses to add, change requirements, and student projects that would help develop and hone needed skills for the workplace. Sarkar et al. (2016) addressed a study about graduate employability skills that was performed by *The*

Graduate Employability of Monash Science Project regarding graduate employability skills through the employer's eyes. Employers expressed feedback concerning the shortfall in certain skills and attributes of graduates; the research showed that employer feedback was important for design interventions that would hone needed skills through an effective curriculum (Sakar et al., 2016). When institutions work in tandem with employers in establishing clarity for needed skills, new programs and updating existing programs could create effective talent strategies that are crucial for forward-thinking industries (Venkatraman et al., 2018). The close partnerships between employers and industry create alignment in needs and skills that employers are looking for in graduates that result in higher employability and added talent for area industries and communities.

The WTCS also administers surveys that highlights the outcomes of graduates. The key driver of the surveys was to ensure employers receive high quality employees through positive graduate outcomes (WTCS, 2022). The survey, conducted every four years, results in a summary report that gauge's employer satisfaction of the WTCS programs and the skills graduates acquire (WTCS, 2022). The partnership through the employers allows for continuous improvement of WTCS programs that would result in school to work readiness for graduates (WTCS, 2022). Employers play a pivotal role in the development and delivery of WTCS programs to ensure needed skills and knowledge keep relevant to business and industry needs. According to the 2018 survey report, 9 out of 10 employers stated that the technical college graduates met or exceeded their expectations in the areas of technical skills, mastery of knowledge and skills relevancy in their fields, effective communication, and job readiness (WTCS, 2022).

Workforce Development

Relationships between schools and workforce development go hand in hand regarding preparing students for the future of work. Workforce development applies to job training for workers that could enhance their skills and employment opportunities. This training could be offered through technical colleges or be employer-sponsored (Bauman & Christensen, 2018). However, some programs utilize workers just starting their careers, such as work-based learning programs. The purpose of work-based learning is to build student awareness of possible career paths, explore new career opportunities, and effectively prepare the student for their career (North Dakota Regional Education Association, 2020). Engagement between students and industry allows for students to make better decisions on what courses they need to take or programs to pursue different career paths (North Dakota Regional Education Association, 2020). The partnership between technical colleges and industry creates alignment in present and future work needs through work-based learning and workforce development programs.

Analysis from the National Skills Coalition concluded that middle-skilled jobs account for 53% of the U.S. labor market; however, only 43% of the current labor force was competent in middle-skilled jobs, resulting in \$160 billion yearly in unfilled labor output, which strains productivity (Bauman & Christensen, 2018). Workforce development partnerships were important in keeping industries competitive and creating a healthy, productive workforce that would create strong communities and companies sustainably.

Role of WTCS in Manufacturing Workforce Development

CTE, keeping in alignment with industry needs, becomes essential for sustainability and success. Industry/technical college alignment creates a viable pipeline of competent workers needed to create a strong local community (Pilz, 2012). Pilz (2012) noted that CTE programs and

courses are a direct reflection of the communities they serve. The role WTCS plays in manufacturing workforce development creates economic vitality that serves individuals and communities throughout Wisconsin (WTCS, 2021b). The connection of WTCS and industry shows that there is a shared partnership between the processes for developing programs that has local needs at the forefront of priorities (WTCS, 2021b). The relationship shows through as WTCS performs local needs assessments and consultations to ensure Wisconsin's manufacturing workforce development is armed for success (WTCS, 2021b).

According to the WTCS 2020 outcomes report for 2020 graduates a two-year technical diploma in manufacturing resulted in 91 individuals, or 95%, that are active in the workforce (WTCS, 2021c). The annual income for graduates was \$45,205 for 2020 that creates a sustainable living for individuals and creates a tax revenue stream for the state of Wisconsin (WTCS, 2021c). In addition, with financial securities, workers have a greater chance of supporting their community through the purchase of area goods and services resulting in stronger communities and more employment opportunities.

Manufacturing Employment Situation in Wisconsin

The manufacturing employment sector in Wisconsin accounts for 18.79% of the total output for the state (National Association of Manufacturers, 2021). The manufacturing sector employs 15.89% of the total workforce with a total yield of \$63.31 billion in 2018 from manufacturing (National Association of Manufacturers, 2021). Conroy et al. (2018) noted that Wisconsin has an elevated chance that a large number of manufacturing positions would become automated and computerized to keep up with technology and market demands. The shift to modernization would aid the sector in solving labor shortage issues but would result in displaced workers as the drive to reshape skills would become imperative for manufacturing companies

(Conroy et al., 2018). Moreover, as manufacturing becomes more complex, labor needs have changed that reflect structural alterations to education and skills achievement as lower-skilled positions have become more volatile and higher-skilled positions are more stable (Conroy et al., 2018). Bushmaker and Franz (2017) expressed that Wisconsin manufacturers have challenges in finding talented workers, which has escalated from 29% in 2011 to 80% as of 2017. Wisconsin technical colleges have a great opportunity to evolve their programs to meet the future needs of industry. The Wisconsin economy would only become stronger and more resilient to the unforeseen landscape of tomorrow's industries.

Summary

There is a vast amount of information regarding how secondary and post-secondary education could prepare young adults for the future of work. Oke and Fernandes (2020) found that technology would shift and replace humans in jobs that entail a lower level of skills that would result in negative effects, such as social and economic stability. This shift in work would lead to the realization that the educational sector needs to ensure they are teaching the workers of tomorrow the skills and knowledge that allows them to be successful in their job roles for today and into the future. Further, the need to continually develop current workforces that allows for industry to be competitive in rapidly changing work environments would result in stability and longevity for Wisconsin manufacturing.

The review of literature examined current research on preparing young adults to meet Industry 4.0 needs and beyond that included: 1) the history of the Industrial Revolutions and its impacts, 2) educating students to meet Industry 4.0 needs, 3) technical skills teaching and training in rapid change work environments, and 4) workforce development. In addition, the

review of the literature showed a connection to the theoretical frameworks that drive the research. Chapter Three will discuss the methods, procedures of the study, and a summary.

Chapter III: Method and Procedures

The methods and procedures of the study will examine the understanding of how CTE is preparing the workers of tomorrow through a case study and narrative research. Proper methods and procedures are paramount in establishing credibility. The research approach to the study is qualitative data analysis. Patten and Newhart (2018) expressed that qualitative data analysis uses words of the study participants to deeply understand the perspectives of the people who are closest or directly involved in an issue. Qualitative research does not generalize results to large groups or institutions but represents the experiences, behaviors, opinions, and other elements about the group that is the focus of the study (Patten & Newhart, 2018).

The research methodology used in the study will be a case study partnered with narrative research that will allow for the triangulation of data. To further illuminate this method, Philpott (2014) noted that narrative research captures knowledge regarding people's meaning to the world around them, the cause-and-effect of interactions among humans, and how these interactions develop over time. Further, having the courage to flex into newly learned methods of study permits the researcher to further develop their skills and knowledge in the world of academic exploration where discoveries are yet to be revealed (Lyon, 2017).

Research Methodology

The qualitative approach chosen will be a case study partnered with narrative research through semi-structured interviews. Fraenkel et al. (2012) define a case study as a version of qualitative research where individuals are studied through broad data collection, including interviews, classroom observations, artifacts, or documents. Case study research was chosen due to the core elements of the research pertaining to CTE programs preparing students for the future of work. Creswell and Creswell (2018) expressed that case studies are used in the evaluation of

programs as the researcher develops an in-depth study to an issue or problem. Lichtman (2013) stated that case study approaches to qualitative research allow the identification of a single entity to study, such as an individual or an institution. Utilizing the case study approach allows the researcher to capture a comparative approach through school leaders' eyes and through school instructors' eyes to see if there are common goals, expectations, and alignment. Furthermore, case study research allows the researcher to include classroom observation, document review, and relevant course artifacts that help in the understanding of the essence of the manufacturing program.

An added element to this approach will be to utilize components of the qualitative approach of narrative inquiry. Narrative inquiry approaches capture the personal stories and experiences of humans through interviews (Lichtman, 2013). The purpose of adding this element to the research methods will allow for a capta reduction process that extracts key components that result in enduring themes about the human experiences of CTE leaders and instructors (Lichtman, 2013). Furthermore, incorporating narrative approach techniques in a case study from a social sciences inquiry allows for an added layer of validity to the research that encourages buy-in from the reader through the rich data of human experiences, which allows for another element to triangulate data results (Lichtman, 2013).

Setting

The research site is CVTC in Eau Claire, Wisconsin. The college serves an 11-county area and is one of 16 WTCS colleges within the state of Wisconsin (Chippewa Valley Technical College, 2021). The college offers 119 programs, 38 certificates, and 13 apprenticeships (Chippewa Valley Technical College, 2021). As of the 2020 school year, there were 17,298 students enrolled (Chippewa Valley Technical College, 2020). According to the CVTC fact

book, the student graduation rate for two-year programs is 46 %. The program of study will be the Machine Tooling Technics. As of the 2020 school year, the enrollment for the program was 57 students with 20 students graduating in 2020 (Chippewa Valley Technical College, 2020).

Subject Selection and Description

Subject selection is paramount regarding acquiring effective results. The individuals or groups that will be invited to participate in the study are CTE leaders, (the Curriculum Director) and CTE instructors in the Machine Tooling Technics program. The purposeful sampling of the individuals is due to their knowledge and rich resources that will be a valid source of information (Patten & Newhart, 2018). Furthermore, the selection will also be a sample of convenience due to studying in one geographic location with a focus on the Machine Tooling Technics program. From an analysis perspective, having between six to eight interviewees to capture a diverse population of individuals will be effective (Lichtman, 2013). Capturing the experiences of these key individuals would validate and create trust with the readers of the research due to the participants being the closest to the main area of study (Creswell & Creswell, 2018; Lichtman, 2013).

Instrumentation

The case study method will use multiple sources of data, including semi-structured interviews, observation through the recording of the interviews, and close examination of documents pertaining to program and curriculum design, assessment, and employer surveys. The study location will be Chippewa Valley Technical College and the program of study will be the manufacturing program of Machine Tooling Technics. The processes will be semi-structured voice recorded interviews that will allow for the execution of a reduction table developed from the interview transcripts that will extract common themes (Lichtman, 2013). The procedure for

the interviews will have the participants' consent to tell their personal stories and experiences regarding programs, curricula, and teaching methods. See Appendix A for the interview protocol. Interviews will be conducted in a single one-on-one session with each interviewee that will be approximately 45 minutes with key research questions to allow for parallel data among participants. The sample of interviews will be six individuals (three leaders and three instructors) to ensure a variety of different experiences (Lichtman, 2013).

Instrument Development

The development of the semi-structured interview guide captures key research questions regarding how CTE programs and curricula are meeting the needs of industries in not only today's world, but also tomorrow's world. Interview questions were designed around teaching methods, program/curriculum development, as well as professional background of college leaders and instructors, such as certifications and licenses. Another subset of the questions pertained to how CVTC is preparing young adults for the future of work from an automated perspective regarding skills, knowledge, and adaptability.

A pilot interview was performed on a machine tool faculty member who was not a part of the study or CVTC. Interviewee feedback regarding the clarity of questions and the relevancy of questions were taken into consideration to further hone the interview questions to ensure they will capture the key areas of the study and the purpose of the study. Moreover, the timing of the interview was performed to ensure the interview would not take more than an hour; the pilot interview was timed at 45 minutes.

Data Collection Procedures

The data collection process will be collecting the findings of the analysis after a capta reduction through the semi-structured interviews, which will reveal enduring themes that will be

presented in narrative form of the researcher retelling the participants' stories (Lichtman, 2013). The semi-structured interviews will be recorded and transcribed to ensure original data stays intact. See Appendix B for the interview recruitment email letter for administrators and instructors. See Appendix C for the consent form that would be signed by interview participants.

The data collection process for the collection and examination of course artifacts will allow for further insight on how programs and curriculums are designed and what feedback avenues are used to ensure they meet industry and academic expectations (Lichtman, 2013). The data collection process includes the examination of course artifacts. Examples will consist of a course syllabus and grading rubrics for student projects and lesson plans. These course preparation materials provide a roadmap to guide the student through lessons and help the instructor see how well the student understands the lesson through the successful completion of course projects by following the lesson scoring rubric. Guo et al. (2020) utilized rubrics for student work in their case study as the rubric allowed students to have a guideline of project/assignment expectations and learning outcomes.

The data collection process for documents will be first to receive permission from college leaders to access the documents. See Appendix D for the letter of introduction email sent to CVTC institutional review board. However, some documents that will be reviewed are public, such as the WTCS handbook. Areas that will be examined are learning outcome measurement systems (TSA), and a review of the WTCS handbook for processes related to designing and revising programs and curricula. In addition, the review of graduate follow-up surveys from employers regarding the Machine Tooling Technics program will ensure validation of program and curriculum effectiveness. The desired results from the process will be for the researcher to

see what teaching materials and methods work or are the most effective for ensuring students are prepared for the future of work through multiskilling.

Another element of the data collection will be 30-minute classroom observations from the classes of the three interviewed technical instructors. See Appendix E for the consent form that would be signed by classroom observation participants. The researcher will take on the role of the observer through noninteractive techniques (Wiersma & Jurs, 2009). Classroom observation will aid in evaluating how engaged students are in the learning, and if timely and effective feedback is given to the students. See Appendix F for the classroom observation field notes template used. Other observations will include teacher and student interactions, and method(s) of instruction. Casabianca et al. (2014) noted that classroom observations that pair teaching and interactions are vulnerable to trends in both behavior and quality of instruction. Classroom observations that examine multiple dimensions of teaching that follow established protocols have an increased use in not only research but also teacher evaluations (Casabianca et al., 2014).

The five key areas of observation were chosen to compliment the learning theory tenets that include experiential, constructivism, and cognitive. The observation for teacher/student interactions mirrors the constructivism learning theory where the teacher takes on the role of the guide and resource (Mahmud, 2013). The student engagement relative to the present content reflects the constructivism learning theory as the student needs to be a dynamic player due to the learnings are an active process and becomes tailored to the learner (Fernando & Marikar, 2017). The feedback from instructor also compliments the constructivism learning theory as the student looks to the wisdom of the instructor to better themselves in their learnings with the course material (Fernando & Marikar, 2017; Mahmud, 2013). The observation for student behavior was chosen due to the connection to the cognitive learning theory as the student has control of their

thinking through their own actions and volition (Ruiz-Martín & Bybee, 2022). Lastly, the chosen observation for teacher method of instruction reflects the experiential learning theory as the teacher may adopt different instructional strategies through their teachings to help the student understand the learning material (Scott, 2014).

Data Analysis

The process of inquiry for the current research will use semi-structured interviews and interview observations through the recording of the dialogues (Lichtman, 2013). Additional information will come from the analysis of documents and other artifacts, such as course artifacts. The process of the triangulation of data will be between the interviews, document review, course artifacts, and classroom observations. Lichtman (2013) expressed that communicating one's ideas through qualitative research methods involves attention; yet, one has the freedom of enhancing one's perspectives. When one is faced with new scenarios and experiences, the encounters allow for new experiences to be lived. Through the semi-structured interviews and the analysis of the transcripts, the learnings allow the researcher to live the experiences of the interviewees and give the participants an opportunity to retell their stories in their own words with the aid of enduring themes (Lichtman, 2013). The observation of the recorded interviews allows for a transcript of the narrative data, which eases the utilization of a reduction table (Lichtman, 2013). See Table 2 below for the design of the reduction table that will be used in the study.

Table 2*Data Reduction Table*

Raw capta or data	Reduction of raw capta	Themes based on original capta	Refined themes that are declared
Original transcript with extra verbiage lined out but still visible.	Elimination of extra verbiage to clarify structural meaning.	Captured meanings consist of phrases that present ideas.	The declaration of emerging themes while preserving the honesty from previous steps and written in the researcher's own words.

The reduction table process of capta or data analysis consists of four columns. The first column consists of the raw data that was transcribed verbatim. The second column consists of the elimination of extra verbiage, such as extraneous words that allows for clarity and structural meaning. In the third column, themes are captured based on original raw capta that presents ideas or concepts. The ideas or concepts either emerged directly from the text, while in other instances, they were rephrased or paraphrased to reflect the true meaning. In the fourth column, final themes or concepts were determined and refined that were written in the researcher's own words.

The key importance of rewriting another person's individual experiences is to bracket or mitigate the researcher's own views and values that invite trust and validity of the written narrative results (Creswell & Creswell, 2018; Lichtman, 2013). Administering the reduction process through a table allows the researcher to make discoveries and further their own understanding of what the interviewees shared through their experiences. The researcher finds their own pathways of understanding through the reduction process as they become the observer of the interviewees' stories (van Manen, 2011). Rewriting the interviewees' stories from the personal perspectives of CTE leaders and instructors through the recorded interviews and the administration of the reduction process that unearths common themes.

Limitations

The limitations of using the above research method approach are as follows:

- Interview participants openly and honestly answer questions
- Sample is limited to this population of students (convenient sample of students)
- Possible challenges regarding the class observations due to students and instructors knowing they are being observed thus altering their behaviors
- Some documents may not be current

Timeline

The timeline for the collection of data started at the beginning of the spring semester of 2022 in the first week of February. The data collection did not proceed without UW-Stout's Institutional Review Board (IRB) approval or approval from Chippewa Valley Technical College IRB. The plan was to be onsite at Chippewa Valley Technical College between three and four days which would capture research data for the semi-structured interviews, classroom observations, and document and course artifact examination.

Summary

To conclude, the proposal of incorporating the qualitative approach of a case study with the addition of a narrative research approach will allow the perspectives of CTE leaders and instructors that will permit for an in-depth analysis of data. In addition, the examination of documents and course artifacts regarding program plans and curriculum will reveal how and why they were designed and developed, and if they do indeed meet the expectations of the future of work and foster multiskilling characteristics. The added research element of classroom observation will allow the researcher to view first-hand how course content is conveyed to the students. The collection of data and the effective analysis will allow buy-in from the reader that

all corners of evaluation will be considered (Lichtman, 2013). Furthermore, the opportunity for the researcher to retell interview participants' experiences will allow for a deeper understanding of the study. The new understandings permit self-reflection from the researcher's point of view that furthers the advancement of additional layers of inquiry. These inquiries lead to knowledge that already exists but is waiting to be discovered (Lyon, 2017).

Chapter Three discussed the methodology used in the study. The areas included research methodology, setting of the study, subject selection and description, instrumentation and instrumentation development, data collection procedures, data analysis, limitations of the study, a timeline of the study regarding data collection, and a summary. Chapter Four will discuss the presentation of the findings with the areas of demographics, analysis overview, the research questions, and a summary.

Chapter IV: Presentation of Findings

The purpose of the research was to investigate how Wisconsin's postsecondary CTE curricula and programs were preparing students in the future of work through multiskilling to meet current, emerging, and future workforce needs. In addition, the study identified methods of instruction used to ensure students acquire the necessary skills to be successful in the ever-changing workplace. The research site was one technical college, CVTC in Eau Claire, Wisconsin. The case study and narrative research methodology were selected to gain a rich understanding of participants' perceptions regarding how the college is preparing young adults for the future of work. The gathered data was triangulated, which consisted of semi-structured interviews, classroom observation, review of documents, and course artifacts. The results of the study could lead to effective recommendations in sustainable practices in Wisconsin's postsecondary CTE curriculum and program design that educate far beyond the labor tasks. The content of this chapter includes demographics, item analysis, research questions, and a summary.

Demographic

The program of study was the Machine Tooling Technics due to the core of the study pertains to manufacturing. The Machine Tooling Technics program is a two-year technical diploma that consists of 62 credits (Chippewa Valley Technical College, 2022). Students enrolled in the program would learn operation, setup, and programming of computerized machine tools along with operating manual machines (Chippewa Valley Technical College, 2022).

The individuals that were invited to participate in the study were three CTE leaders that included the Director of Curriculum and Professional Development, the Dean, the Provost, and three instructors from the Machine Tooling Technics program. The purposeful sampling of the

individuals was due to their knowledge and rich resources that would be a valid source of information (Patten & Newhart, 2018). Further, the sampling would also be a sample of convenience due to studying in one geographic location with a focus on the Machine Tooling Technics program. From an analysis perspective, having six interviewees to interview captured a diverse population of individuals that were deemed to be most effective and manageable. Capturing the experiences of these key individuals would validate and create trust with the readers of the research due to the participants being the closest to the main area of study (Creswell & Creswell, 2018; Lichtman, 2013).

Analysis Overview

The case study approach explored a current issue or problem that is being faced in manufacturing industries as technology is moving faster than human skills (Pilz, 2012). Multiple sources of data were used that included semi-structured interviews, classroom observations, documents, and course artifact examination. The collection of qualitative data was bounded by one institutional location to allow the researcher to experience an outside-in perspective on how CVTC meets the demands of the future of work in manufacturing industries. The importance of administering a case study and narrative research approach that was conducted in real-time, real-life, and in an authentic setting, allows for relevant data that could offer valuable information. The valuable information regarding what and how young adults learn to keep moving forward in technology-driven manufacturing.

Data was gathered through semi-structured interviews that were conducted on the CVTC campus in Eau Claire, Wisconsin. The interviews took place in a conference room or personal office and was held at the interviewees' requested time that worked best for their schedules. Each interview was recorded for the transcription of data to uncover common themes. See Appendix G

that illustrates a sample of the interview table for the reduction process. The three instructors from the Machine Tooling Technics program that were interviewed also participated in the classroom observations. The classroom observations included teacher/student interactions, methods of instruction, student engagement, and instructor feedback. Document and course artifact review was the last area for the triangulation of data. These included the WTCS handbook for curriculum and programs, learning assessments for the Machine Tooling Technics program, recent employer surveys regarding graduate follow-ups for the Machine Tooling Technics program, and instructor lesson plans (syllabus/rubrics).

Research Questions

The following research questions were designed to understand postsecondary CTE manufacturing programs and their curricula through the lens of the current, near future, and the yet to be envisioned future as it relates to the knowledge, skills, and dispositions being taught:

- 1) How are postsecondary CTE instructors designing their curriculum and programs to move at the pace of technological change?
 - a. What is the process for program development and revision within the Wisconsin Technical College System?
 - b. How do technical college programs keep pace with technological change?
- 2) What methods of instruction do teachers employ to ensure students are able to work and adapt to unpredictable environments and other changes in the workplace?

Interview Question 1: Tell Me a Little Bit About Yourself, Such as Your Role and Responsibilities at the College.

Common Themes. The following enduring themes that emerged from question 1 are as follows and is in no order of importance:

- Alumni of CVTC machining program gained industry experience then came back to teach
- Long-term employee of CVTC and worked up to leadership roles

Alumni of CVTC Machining Program Gained Industry Experience Then Came Back to Teach. Technical instructors were previous students of the machining program and gained industry experience before they returned to the college to teach. When an instructor gains practical, student experience in the program that they teach in, then uses that experience in their career, allows for a better understanding of expectations needed to be successful in job roles. Interview participant two noted, *“I am an instructor and within the program, I’ve been here for 25 years. I have taught basically all classes from entry-level manual machining classes up through our most elaborate Cad/Cam classes.”* Interview participant two further expressed that, *“In 1988 I graduated from this program, which I now teach in, [and] I worked in industry for about a year.”* Interview participant four had a similar experience with their career pathway as they stated, *“I came through the machine tool program here at CVTC in 1990 through 1992 and then went out and worked for five years and came back. The education that I had after that was my certification courses in order to teach.”*

Interview participant three also shared the pathway of starting the journey with CVTC’s machining program as they expressed, *“I’ve been here at Chippewa Valley Technical College [starting as a] student here in 1990 going through the machine tool program [and] graduated in 92. I worked in industry as a machinist, and I came back as an employee and machine tool instructor in 1997.”* This shows students that they have future career paths beyond being a machinist as the student could create base foundational knowledge that could lead to a teaching career.

A Long-Term Employee of CVTC and Worked Up to Leadership Roles. The commitment of a long-term employee allows the person to have many different experiences within the college. The experience of learning through the different roles creates a deep understanding and connection to the college that becomes expressed through their teachings and behaviors. Interview participant one noted, *“I’m the [a leadership role] at the college. My background is I graduated from a two-year Technical College and then worked in industry, and I went back [to] gain more education [then] became a CTE teacher at the secondary level for a while and then entered this role in 2013.”* Interview participant five was also a long-term employee of CVTC that worked up to a leadership role within the college. Interview participant five noted, *“My title is [a leadership role at the college]. I oversee all academic programming across the college and all faculty, Deans, and academic staff as well [and I] have the opportunity to oversee and influence the budget for each of the programs.”* The experience of having a similar pathway within the college that allows one to share knowledge creates an environment of unity and having an awareness of the struggles and challenges one may face in higher leadership roles.

Interview Question 2: How Long Have You Been in Your Current Position?

Common Themes. The following enduring themes that emerged from question 2 are as follows and is in no order of importance:

- Employed at CVTC at a minimum of six years
- Longest at CVTC was 25 years

Employed at CVTC at a Minimum of Six Years. When instructors have been at an institution for a number of years, it allows them to grow into their role. Interview participant six stated, *“I’ve been here since July of 2016 and have been in working in the Wisconsin Technical*

College system for almost 30 years.” Interview participant five noted, *“I have been in this position about four months, and I have been at CVTC for nine years.”* When key technical college employees have been in the technical college arena, it allows them to understand the needs of the communities and industries they serve. This understanding helps the college stay relevant with its courses and programs.

Longest at CVTC Was 25 Years. When one has a long career in the same institution, it allows the individual to grow within the institution and have awareness of changes needed to keep programs and curriculum current. This fosters not only commitment but shared values on what is expected of students when they graduate from their programs. Interview participant four noted, *“I’ve been here roughly 25 years. [...] seeing a lot of changes throughout the years in terms of general responsibilities, I guess just to maintain my courses, come up with new curriculum, new projects depending upon how I see industry-changing [...] the types of machines that have been replaced and the software that we use.”* Interview four participant continues, *“Those three [course maintenance, new curriculum, and machine replacement/software] tend to drive the changing of our curriculum.”* Interview participant two has also been at CVTC for at least 25 years as they expressed, *“I’ve been here for 25 years; I have taught basically all classes from entry-level manual machining classes up through our most elaborate Cad/Cam classes.”* When instructors have a long history of teaching through the different stages of innovation, it allows them to adapt to the changes needed for students to keep up to date with current technologies.

Interview Question 3: Could You Tell Me About Your Academic History?

Common Themes. The following enduring themes that emerged from question 3 are as follows and is in no order of importance:

- Embraces the importance of higher education
- Began educational journey with a technical degree

Embraces the Importance of Higher Education. Earning high-level degrees enhances one's educational foundation that allows one to become more effective in their teachings. Interview participant one noted, *“My K12 education is on the Southeast side of the state, started at a two-year technical college. [I] worked for a while and then ended up at UW-Stout and became a technology educator, earned my masters from UW-Stout and my doctorate from UW-Stout.”* Interview participant five stated, *“I earned my bachelor's degree from UW-Eau Claire in Business Education in CTE, I did or my Doctorate from UW-Stout as well.”* Participant five further expressed, *“I taught middle school for one year, Business Education, and then high school for 14 years; during that time, I earned a master's degree in Education with an emphasis on Business and Education Partnerships.”* Having educators with high-level degrees allows for them to have a broad understanding of education that gives them an opportunity to mentor other educators on best practices and understand the importance of staying current on trends and teaching practices/methods.

Began Educational Journey with a Technical Degree. When educators have a strong foundational base of technical degrees, it allows them to teach more effectively on the core basics of manufacturing careers and other technical disciplines. Technical degrees teach more application than theory that helps students get through school quickly and start their desired careers resulting in school-to-work readiness. Interview participant two noted, *“I graduated from this program, which I now teach in.”* Interview participant one expressed, *“My background is, I graduated from a two-year technical college and then worked in industry, and I went back [to] gain more education [then] became a CTE teacher at the secondary level [...].”* Technical

degrees are a springboard to either enriching careers in technology or strong foundations to build higher levels of education on.

Interview Question 4: What Licenses or Certifications Have You Earned?

Common Themes. The following enduring themes that emerged from question 4 are as follows and is in no order of importance:

- Industry recognized certifications
- Teaching certificates
- CTE coordinator licenses

Industry-Recognized Certifications. When leaders and instructors of CTE have industry-recognized certifications, it creates validation of the awareness and credentials for teaching in a technical arena. Interview participant one expressed, “*NIMS certification [certifies individual skills against the national standards] that I earned as part of the initial implementation of NIMS into our machine tool program, [...] different industry type certifications that I have picked up with training as I've been [in] education and leader in CTE.*” Interview participant four noted, “[...] and NIMS certification, which is a National Institute of Machining Standards.” When technical instructors earn industry-recognized certifications, it validates their skills and knowledge in what industries view as the most important areas to be successful in manufacturing job roles.

Teaching Certificates. When leaders and instructors acquire teaching certificates, it shows validation that they are competent in effective teaching techniques. Interview participant one noted, “*I've also earned K12 teaching license for Tech Ed. 220.*” Interview participant four noted, “[...] teaching certifications through CTE.” The importance of keeping up with the latest

in teaching best practices through certificates allows instructors to be the most effective in techniques that lead to student success.

CTE Coordinator License. When CTE leaders and instructors earn licenses in CTE, it permits a deep understanding of technical education and how to best teach students on current technologies that help them be successful in the job roles. Interview participant one stated, “*I had CTE coordinator certification.*” Interview participant five noted, “*I went to UW-Stout and earned my CTE Coordinator licensure certification.*” The more licenses CTE leaders and instructors acquire, the more they are valued regarding the needed skills and knowledge to effectively teach students in technical fields.

Interview Question 5: How Are Postsecondary CTE Instructors Designing Their Courses and Programs to Move at the Pace of Technological Change?

Common Themes. The following enduring themes that emerged from question five are as follows and is in no order of importance:

- Keeps an eye on industries
- Seeks advisement from the advisory committee
- Utilizes competency-based curriculum

Keeps an Eye on Industries. When manufacturing programs are in tune with what is going on around local industries, it allows the college to keep up with new technologies and trends. Interview participant four noted, “*The way we process parts [is] to meet what is happening in industry [...].*” Interview participant three stated, “*We design our curriculum around what's happening in our region of technology.*” The importance of preparing students for work and ensuring their education is relevant to what is going on within manufacturing industries helps them from an employability standpoint. Interview participant five expressed, “[...] we are

also on a 5-year rotation at a minimum for curriculum refresh to make sure that we stay updated and don't fall stagnant." Interview participant five continued, "That's the maximum amount of time, but in some areas where the technology changes so very fast that the curriculum gets updated to keep pace with what industry is telling us [what] we need to prepare for." When colleges can adjust their curriculum at the pace of technology through industry needs, it creates fewer challenges for industries to meet market demands when they hire CVTC graduates.

Seeks Advisement from the Advisory Committee. When college leaders and instructors have the knowledge and support from their advisory committees, it allows for effective communication and the ability to navigate challenges that the college may face. Interview participant one noted, "Our input is from our advisory committee; we take our lead on what's happening in industry from our advisory committee, we align with the mission of our college to deliver innovative and applied education to meet their workforce needs in the region." Interview participant three noted, "We have an advisory committee that we meet with twice a year, and they advise us on new technologies, different software and processes that they're doing to keep us up [to date] and we will adjust our curriculum accordingly so that our students can get jobs."

Interview participant six noted, "Our advisory committees play a key role in advising us on the changes within the industry, [...] and a lot of times those changes are connected to technology." Interview participant six continued, "We have an annual process where programs are reviewing and looking at their programs to see if programs need to be adjusted through our program modification process; part of that is also having those discussions with the advisory committee every year about any potential changes in regards to the actual curriculum and technology [...]." The partnerships between industry, advisory committees, and college faculty

solidify those needs are met and that everyone is in alignment with what adjustments are needed for programs and curriculums to keep pace with the changes in manufacturing technologies.

Utilizes Competency-Based Curriculum. Competency-based curriculum plays an important role in education as it maps out predetermined competencies that students need to achieve through learning outcomes and performance. Interview participant five stated, “[...] *focusing on the competencies and ensuring that there is applied learning [...].*” When students can perform and demonstrate the lessons that they have learned, it validates the success of learning outcomes. In most cases, the students will come into the program with no prior experience, so they are learning completely new tasks, so having a guide through competencies allows the instructor to better assess the new learnings.

Interview participant two proclaimed, “*The level of indepthness of our high school programs is less than ever; therefore, they [new students] have little to no machining experience.*” Participant two further explains, “*They [new students] will have some welding, very little fabricating, [and] almost no machining...what happens is when we get students into our program, they do not understand the fundamentals [...].*” Interview participant six noted, “*The core of our CTE courses and programs in the Wisconsin Technical College system were competency-based; being competency-based is something that isn't universal across higher ed, so being competency-based, the courses are being developed in relationship [...] with business and industry [...].*” The need for adaptability through competency-based curriculum becomes crucial when technologies continue to develop at a rapid pace.

Interview Question 6: How Does the Machine Tooling Technics Program Keep Pace with Technological Change?

Common Themes. The following enduring themes that emerged from question 6 are as follows and is in no order of importance:

- Keeps current with industry trends and utilizes DACUM
- Expose students to current technology with the awareness that technology is ever-changing

Keeps Current with Industry Trends and Utilizes DACUM Process. The need to keep current with industry trends allows the college to stay relevant with what they are teaching the workers of tomorrow. Interview participant three noted, “[...] *other things that we will attend is the International Manufacturing Technology Show.*” Interview participant three continues, “*We’ll bring the students down to that just to see what’s the new technology is out there and manufacturing.*” Interview participant two expressed, “*We are here to support the industries that are out there and in order for technical college to be proactive, it actually means that we have to be extremely reactive, so if there is a process or a company or a demand for a skill of our graduates, we need to react at lightspeed.*”

Interview participant six notes, “*We brought in the industry, and we held a DACUM for that program [Machine Tooling Technics].*” Interview participant six continues, “*Part of that DACUM was going back and re-validating with the industry and the employers what the key program outcomes were for that program and identifying them and mapping the courses and the competencies in the courses to those key outcomes [...] really focusing in with the industry folks on the key concepts [...].*” Interview participant five noted, “*The course competencies are reviewed through an advisory committee to make sure that they’re teaching what is relevant and*

they would go through that five-year curriculum review cycle.” This shows that the college is focused on their main customer, local industries. Staying current on area industries and their technological changes through validation of trends and practices ensures when students graduate from the program, they have high levels of work readiness through multiskilling.

Expose Students to Current Technology with the Awareness That Technology is Ever-Changing. Exposing students to what is going on in the world of manufacturing allows them to understand their expectations of them when they graduate. However, it is equally important for instructors to be aware of the newest trends so they can bring that information back to the classroom. Interview participant three expressed, “[...] *we will attend conferences, it's called an 'H tech' and that's 'HAAS' teacher's educational conference.*” Participant three further noted, “[...] *there's a regional conference that we attend and a national conference that we attend. Both [are] annual events and we share best practices with other colleges, universities, and actually high schools within the region and within the National Conference [...].*” When colleges see what other colleges are doing regarding keeping up with industry, it allows for a wider view and a shared community of information that instructors bring back to their classrooms.

Interview participant four noted regarding teaching students the latest technologies, “*As the technology changes, we just change with it [...] we don't necessarily train the students to be at the highest level of what industry does, they just can't comprehend after two years [...] highest end stuff is multi-axis, we give them exposure to it, we program some stuff, we run it, but then we don't challenge them by having them do that exact same thing on their own.*” Interview participant four further expressed, “*We are limited on the machine tools that we have and they're probably not going to find themselves in that position in industry for at least five years...by then, the amount of technology that has changed, they would probably be retrained in that particular*

area.” Teaching students the fundamental of machining allows for a strong foundation of knowledge that the student can build upon as technology changes thus creating adaptability to the changing environment of manufacturing.

Interview Question 7: What is the Process for Program Development and Revision within the Wisconsin Technical College System?

Common Themes. The following enduring themes that emerged from question seven are as follows and is in no order of importance:

- Program maintenance through curriculum review and program scorecards
- Utilizes employer feedback through conversation and research local needs

Program Maintenance Through Curriculum Review and Program Scorecards.

Ensuring that the curriculum stays current through routine maintenance allows for needed adjustments or alterations to keep up with industry needs. Interview participant one noted of the maintenance process as, *“You can maintain your program if there are more than 20% modifications, there has to be a request form sent to the state with your advisory [committee] validating that process saying that we approve the changes that you're recommending to the program.”* Interview participant one continues, *“Then there's a curriculum, edit, and review, and then there's a contracting process where our curriculum department will review what was changed or modified; the Dean will review what was changed and modified, and then the curriculum will be implemented.”*

Interview participant two noted, *“[...] we review what we do twice a year and we take input as to what areas we should be looking at or what are those emerging technologies that are really going to be here.”* Interview participant three expressed, *“Every five years we revisit our*

curriculum, do updates, will not go as far as a DACUM but we will definitely revisit anything [and] look at trends.”

Interview participant five stated, “[...] we have a five-year curriculum refresh cycle that's followed with a course champion [...].” Interview participant six noted, “[...], we have an annual process where we have a program improvement process. Each year[our] program gets a scorecard; that scorecard includes many different elements...it has demographic data about their students, it has student success data, it has course completion data, and it has data on retention, and it has data on [the] number of jobs available in the area.” Interview participant six continues, “It has their graduate follow-up data that's kind of an annual pulse for programs to take a look at like how we are doing.” Interview participant six further notes, “It's an opportunity for them to have discussions about specific areas, looking at that program scorecard and having a program improvement plan which is where annually they have goals connected to their program and things they want to accomplish depending upon those goals and the things they want to do, it informs if they are in a situation, or they may want to consider making a program modification or a program change.” When scorecards are reviewed, it allows for better decision-making regarding how to make the programs more effective. When proper processes and procedures are practiced by everyone who is involved with program development and revision, it creates transparency and consistency resulting in effective programs.

Utilizes Employer Feedback Through Conversation and Research Local Needs.

Tapping into the resource of the employer becomes a powerful tool in ensuring that programs align with industry needs. Interview participant two stated, “I guess to a certain extent we work very closely with our employers, so we talk to them.” Interview participant five noted, “We have to a program concept put together where we can show that there will be jobs for our graduates.”

Interview participant six stated, *“There’s several steps in development, [...] it revolves [...] the college needing to demonstrate that there’s a need in their local district; CVTC covers 11 counties, we need to demonstrate with employment data and jobs data that there is a need for those employees in our district trained specifically at the level of education that we provide.”*

Interview participant six continues, *“We have to also look at the other educational entities within the area [...] they are also potentially producing graduates in those areas.”* When the Wisconsin Technical College System and industries work together through conversations and having awareness of what is going on within the community and other colleges, it creates alignment and relevancy of the college’s curriculums and programs. Strong lines of communication become a necessity for student, industry, and community success.

Interview Question 8: What Methods of Instruction do Teachers Employ to Ensure Students are able to Work and Adapt to Ever-Changing Environments in the Workplace?

Common Themes. The following enduring themes that emerged from question 8 are as follows and is in no order of importance:

- Utilizing a mixed-method approach to learning
- Self-directed learning where the instructor plays a support role
- Focus on active learning

Utilizing a Mixed-Method Approach to Learning. When instructors employ a mixed-method approach to learning it allows for all types of learners to be successful in their courses by using a variety of learning approaches. Furthermore, utilizing a mixed-method approach allows for flexibility to the students where they can go at their own pace. Interview participant one noted, *“We’ve offered more flexibility with student learning through Canvas, our learning management system.”* Interview participant one continued, *“We have more of a flipped-*

classroom approach where students can review lectures before going into the lab, we have a lab open for a week where students could come in and either get caught up or get ahead for their coursework [...].” Interview participant three noted, *“We do have blended classes where we have all support information online and ready, available with certain videos and processes.”* Interview participant three further noted, *“The face-to-face hands-on is truly what makes our program as strong as it is, and our students still learn even if you're setting up, and theoretically you can do a lot of things on a computer, but until you set that machine up, [and] run parts, you know, depending on this, setup dictates everything.”*

Interview participant five expressed, *“We have a variety of different course deliveries, but our methodology is that of competency-based and applied learning to ensure that students can do not just know about what to do, but we verify that they are able to perform, and we can check that they're ready for workplace in terms of how that delivery occurs.”* Interview participant five continues, *“We have face-to-face, we have online courses, we have hybrid courses and of course in machining, we've got a lot of lab time because the most critical thing is for students to be in working on machines and honing their skills.”* Blending learning techniques allows students to learn lessons on various levels that help hone skills and knowledge needed to meet learning outcomes.

Self-Directed Learning Where the Instructor Plays a Support Role. When students take charge of their own learnings, it creates a sense of accountability and ownership in their education. Interview participant one noted, *“The students still have ability to manage their schedule, we do have scheduled times when courses are being offered, we do have somewhat of an open lab format for some of the courses, [while] others are scheduled.”* Interview participant one continues, *“There are periods of time where they're teaching lessons or lectures to the*

students, but there may be a group that's in the lab, and then there's another group that's being taught.” Interview participant one further continues, “[...] they're constantly working the lab and teaching students, or there are pieces where there's theory where that's a specific class in a classroom setting that students are taught the theory and then carry out the practical application in the lab.” Interview participant three expressed, “[...] we have 16 hours a week in our main lab that we meet face to face with the students, and there's a full four-hour online portion that they do to prepare it [lab lesson].

Interview participant four noted, *“We guide them [the students] in their initial courses and show them problems that can happen and how to solve them to try prepare them to do this on their own and then incrementally as we get near the end of the course, we may just present them with a problem and try to have them problem solve it out to be able to do that problem solving on their own to make them self-sufficient [...] how to teach themselves.”* When instructors take a step back from actively teaching the student and allowing the student to navigate problems on their own, this allows the student to have a deeper understanding of the lesson content. Also, it allows the student to hone their problem-solving skills through problem-based learning that fosters multiskilling.

Focus on Active Learning. Active learning allows the student to become directly involved with the learning process that encourages the demonstration of learned activities. Interview participant one stated, *“[...] there's theory where that's a specific class in a classroom setting [where] students are taught the theory and then carry out the practical application in the lab.”* Interview participant two noted, *“We're hands-on; we are an industry model, so we are not associate degree, we are vocational diploma [...] we believe that the doers need to do to learn.”* Interview participant two further explained, *“[...] in our program, you need to have turned the*

cranks. Theoretically based education that's done in the classroom at the associate degree level is not what works for us or employees, so we are a hands-on based doing a doer type of educational program.” Interview participant three expressed, *“We focus on the hands-on learning.”*

Interview participant four noted, *“We're limited with the amount of machines that we have to do a particular project, so I'll put them [students] in groups and then assign them in the group of two or three.”*

Interview participant four continues, *“You do that and then they got to work together and explain what the person did to get to that point or whatever the case may be from that standpoint, so they're learning what the other person did this through show or tell.”* Interview participant five stated, *“[...] our methodology is that of competency-based and applied learning to ensure that students can do not just know about what to do [...].”* Interview participant six noted, *“[...] we really focus on active learning and different strategies for active learning [...].”* Active learning through hands-on experience allows students to demonstrate their learnings and connect to what the machines are performing and why certain applications work better than others.

Interview Question 9: What Knowledge with Technical Skills are Expected for Graduates to Work and to Know to be Successful in Forward-Thinking Industries from an Automated Perspective?

Common Themes. The following enduring themes that emerged from question nine are as follows and is in no order of importance:

- Learning how to learn and apply to new learning experiences
- Soft skills are at the core of graduate success

- Learning outcomes through TSA help validate graduate skills and knowledge

Learning How to Learn and Apply to New Learning Experiences. Learning how to learn allows students to use their foundational knowledge to build new knowledge through their previous learning experiences. Committing to becoming a lifelong learner creates the desire to take previous experiences and knowledge to apply them to new situations. Interview participant one noted, *“The other thing really has to be lifelong learning, so the ability to teach or train themselves if there's a new technology or find the resources.”* Interview participant one continues, *“They [students] need to demonstrate the ability to communicate problems and issues and advocate for themselves and then to identify appropriate applications of technology where the technology would fit, how it's used, how it impacts our work, and maybe why the businesses are using the technology in place.”* When students become independent through their own resourcefulness, it allows them to achieve greater knowledge and abilities that will carry them through challenging and new situations through multiskilling techniques. Interview participant three expressed, *“Our curriculum is set up as competency-based, so they [students] learn very base level competencies coming into the program and it keeps building and the building blocks will get them to the advanced programming.”* When students can demonstrate their learnings and understand how the different pieces of knowledge fit together, it makes it easier to advance to higher-level tasks.

Soft Skills Are at the Core of Graduate Success. Multiskilling through soft skills or employability skills are important to have as they create an added layer to technical skills that allow for adaptability in the work world. Interview participant one noted, *“They [students] need to be problem-solvers; they need to demonstrate the ability to communicate problems and issues [...]”* Interview participant three expressed, *“We focus on critical thinking with the students.”*

When students are armed with the multiskilling of soft skills, it helps them become better communicators, problem-solvers, and leaders as they can navigate around potential challenges they may face in the workplace. Interview participant five stated, *“Every advisory committee, no matter what advisory committee, is asking for employability and soft skills which are not the technical skills, but they are what they ask our students to ensure or us to ensure that our students have.”* Interview participant five continues, *“We've adapted four core abilities that we have that are cross-cutting across every single program and that would include communicating effectively, modeling integrity, valuing diversity, [and] teamwork.”*

Interview participant six also noted the four core abilities as they stated, *“We have four core abilities at the college, [...], those were created with our industry input, and they will go through a 10-year review next year and so they'll be revalidated or changed or update[d].”* Interview participant six continues, *“All programs use these four [core abilities] that communicates effectively, models integrity, thinks critically, and values diversity.”* When the college focuses on these soft skills for all its programs, it creates unity and alignment while creating successful graduates that champion these core abilities. The core abilities will carry the student far beyond their job roles and help them be successful in their lives outside of work.

Learning Outcomes Through TSA Help Validate Graduate Skills and Knowledge. The TSA is the assessment of learning outcomes for students that has industry, advisory committee, and the Wisconsin Technical College System validation to ensure students are learning the needed skills and abilities to be successful in their job roles. Interview participant five noted, *“Technical skills are determined by the input from the Program Advisory Committee and the Wisconsin Technical College System has what's called a technical skills attainment.”* Interview participant five continues, *“At the end of any machining program across the state, there is an*

agreed-upon rubric that all faculty use to determine if a student has met the proficiency expectation for that particular technical skill [...].”

Interview participant six stated, *“We have for each program what's called technical skills attainment, TSA for each program [that has] identified the key program outcomes; the key program outcomes would list and have the program outcomes, their industry-validated rights or advisory committee and our employers validate those program outcomes.”* Interview participant 6 further explained the checks and balances of validation, *“[...] are we practicing those, and are reassessing them because with those program outcomes?”* *“We want to ensure that if our industry has said these are the key things that graduates need to be able to do when they graduate, we want to make sure that they're covered [...].”* Interview participant 6 continues, *“[...] we have a summative assessment in identified in each program where they then have to report how students are doing at meeting those program outcomes; each program has specific system [...] [and] organized by specific programs.”* When colleges have a checks and balances validation of student learning outcomes, it ensures their graduates are prepared for their jobs. Creating a shared skills assessment between the college, industry, and advisory committees allows for alignment and understanding that students are learning the needed skills to be successful after they graduate.

Interview Question 10: How Do You Know That Your Practices Are Successful in Meeting the Needs of Employers?

Common Themes. The following enduring themes that emerged from question 10 are as follows and is in no order of importance:

- Advisory committee feedback
- Employer communications through feedback

- Industry support and value for CVTC graduates

Advisory Committee Feedback. The close relationship that the advisory committee has with local industries helps with a shared understanding of what industry wants from graduates. Interview participant one expressed, *“The feedback we get during our advisories on what we discuss and how we discuss things and it's more of an open discussion and if we need to make corrections or changes, we act upon it [...].”* Interview participant four noted, *“[...] on our advisory council, everyone is pleased with the product we're turning out.”* Interview participant five stated, *“[...] our advisory committee meets twice a year, and they can let us know too if we have any adjustments to make.”* By creating strong lines of communication between industry, advisory committees, and college instructors, effective decisions can be made to meet everyone’s needs that allow for graduates to be successful and the college to be a strong source for competent employees.

Employer Communications Through Feedback. Employer feedback becomes a powerful tool when assessing how graduates are perceived in industry after they exit the school doors. Interview participant two noted how the college knows they are meeting industry needs when they stated, *“‘cause [sic] they'd let us know if it wasn't.”* Interview participant three expressed, *“We have a very good relationship with our local industry, and they strive for the students to graduate before they will hire them full time [...].”* Interview participant four stated, *“Direct feedback from the employers; employer surveys, we go out and talked to them [industry][and] several of them are on our advisory council.”*

Interview participant five noted, *“We also send out, approximately every six months, employer feedback surveys, so we ask our employers how we're doing and if our graduates are meeting their needs.”* Interview participant six expressed, *“It's our direct relationships with*

employers; our team is also involved in supporting those [...] having that kind of direct one on one relationship, it's pretty easy for employers to tell us what their needs are, and if we're not meeting those needs.” Interview participant six further states, *“We also have our college graduate follow up study, which is a formal process that all of the WTCS colleges have to engage in and, so that's where we formally seek information from employers [...] to give the college the programs feedback.”* Keeping close relationships with industries and having different types of feedback avenues allows the college to adjust to industry needs.

Industry Support and Value for CVTC Graduates. When the college has industry support for CVTC graduates, it creates a strong pipeline of competent workers for the community. The industries support the successful completion of the machining program before they hire students full-time, or they will support their education goals if they are still in the program through flexible work schedules. Interview participant three noted, *“[...] they [industry] strive for the students to graduate before they will hire them full time or adjust their [work schedule] if they're working full time; the pay will reflect on their completion of our program.”* Interview participant five stated, *“We have program scorecards where we keep track of our student graduation information, and we also track students being hired after they graduate.”*

Interview participant four expressed, *“We have a local company whose headquarters is out of Texas and they're trying to hire people down there and can't and they know the success that they've had up here with their company and getting graduates from CVTC.”* Interview participant four continues, *“There was a teleconference teams meeting [...] with the technical college down there in Texas and some folks from our college because they were wanting to find out what we do, why we were so successful at what we do.”* Interview participant six stated, *“We*

have at CVTC, one of the highest graduate placement rates of any of the 16 technical colleges in their field.” CVTC has become a desired source of new employees for area industries, and they have become a model for best practices where other colleges seek their input.

Classroom Observation

The classroom observations consisted of three classes that were taught by the three technical instructors who participated in the semi-structured interviews. Each observation was 30 minutes, and no interventions were performed by the researcher as to not interrupt normal class activities. There was no personal information collected on individual students who were being observed. All three classroom environments were within the internal walls of the building inside the Machine Tooling Technics learning area, so there were no windows, but rooms were adequately lit and had comfortable temperatures. All three classroom observations will be explained separately below. The key areas of observation consisted of teacher/student interaction, student engagement relative to the presented content, instructor feedback, student behavior, and teacher method(s) of instruction.

Classroom Observation 1

The first class that was observed was a mathematics course with the lesson topic of area. The date of the observation was January 31, 2022, at 11:00 am. There were eight students in the class that day. The room consisted of rows of desks with the instructor at the front of the classroom. The learning materials that were used were the instructor’s computer and an overhead projector.

- **Teacher/Student Interactions:** The teacher/student interactions were positive. The students were given a worksheet of math problems that consisted of perimeters. The instructor expressed that he would be available if anyone had questions regarding the

lesson content. The instructor walked around the room after the lesson was presented to ensure all students understood the learnings.

- **Student Engagement Relative to the Presented Content:** The student engagement relative to the presented content showed that most students were engaged. It was observed that some students were on their cellphones during the time that students were to work on their worksheets, or when the instructor was setting up the different lessons.
- **Feedback from Instructor:** The feedback students received from the instructor was very helpful and hands-on. The instructor explained individual questions to students before the class began. The instructor helped students with what the next homework assignment would be so they would be prepared for the next class.
- **Student Behavior:** The students appeared to be very comfortable with the instructor as it was a casual atmosphere where students were not afraid to ask their questions. The students collaborated on math problems as they came to the aid of other students who were having challenges with the lesson/assignment. The students were active participants as they asked questions and solved math problems as the lesson was performed by the instructor.
- **Teacher Method(s) of Instruction:** The method of instruction was problem-based learning partnered up with a lecture from the instructor. The class was interactive that allowed for independent thinking. The instructor used an overhead projector to teach the lessons. The instructor showed the separate steps needed to solve a variety of shape areas, such as a square, parallelogram, and a trapezoid. The instructor

encouraged students to work through the problems as they presented the lessons on the overhead projector.

Classroom Observation 2

The second class that was observed was a blended class that incorporated a programming class and machining techniques lab that required programming on a computer. The presented lesson for the programming class pertained to programming lathe operations. The date of the observation was February 1, 2022, at 10:30 am. There were two students in the class that day for the programming lecture and four students for the lab course. The reasoning for the blended courses is that there are 16-week semesters and instruction is delivered in eight-week blocks, so the switching between the two courses is necessary to keep students on schedule. Instruction was given to each group to keep them working while the instructor addresses the other students. The concern arose regarding if students in the lab experienced difficulty concentrating; the instructor responded that it helped students' problem-solve and use the instructor as a resource. The class environment involved computers at each students' desk.

- **Teacher/Student Interactions:** The teacher/student interactions were positive as when students had questions, the instructor was available to advise the student. This allowed the student to come up with their own solutions to the issues they faced with their projects. One observed interaction demonstrated that the instructor guided the project process for the student while the student navigated their own solutions to complete their project.
- **Student Engagement Relative to the Presented Content:** The students that were involved in the lab were engaged with their projects. There was no observation of cellphone use or other nonproductive behavior. The programming lecture showed that

- both students were actively engaged with the learning content. It was observed that lab students could walk in and out of the classroom.
- **Feedback from Instructor:** Observed one student that had a question regarding the programming course as the instructor explained what was wrong and talked through the right solution with the student. Observed one student in the lab asking the instructor a question and the instructor gave immediate feedback that allowed the student to explore alternative solutions to their problem.
 - **Student Behavior:** The lab students worked independently on their projects on their computers. Observed that one student had a question about their project to another student who quickly helped them. All students appeared to have respect towards one another and towards the instructor.
 - **Teacher Method(s) of Instruction:** The lab course was a self-directed learning environment and problem based. The programming lecture course appeared to be fast paced. The students appeared to be keeping up as they did not ask questions regarding the programming applications. The instructor used a whiteboard to show programming students what actions were being performed with each program command.

Classroom Observation 3

The third class that was observed was a computer drafting course with the lesson topic of drafting a male/female knuckle using computer-aided design. The date of the observation was February 1, 2022, at 12:00 pm. There were five students in the class that day. The class environment involved computers at each students' desk.

- **Teacher/Student Interactions:** The instructor encouraged active/problem-based learning as they would ask students how to remedy potential drafting issues. It was observed that one student entered the classroom that was not a part of the class and requested help from the instructor. The instructor willingly helped the student with their question regarding their project out on the production floor.
- **Student Engagement Relative to the Presented Content:** The students appeared to be engaged with the presented content. It was observed that there were not any students on their cellphones. The students were quiet and listened to the instructor present the lesson.
- **Feedback from Instructor:** The instructor took a guiding role in the lessons so it would encourage students to come up with their own solutions to their projects. When concepts were unclear, the instructor explained the concepts in a way that the student could relate to the content.
- **Student Behavior:** The student's behavior was very respectful towards the instructor. The students remained quietly listening unless they had a question regarding the lesson content or were prompted to verbally explain a concept.
- **Teacher Method(s) of Instruction:** The teacher method of instruction problem-based learning paired up with a lecture of the lesson. The instructor used an overhead projector that showed the instructor's computer screen so they could demonstrate and explain the lessons to the students on how to perform certain applications to their drafting projects. The instructor encouraged students to express their ideas and opinions regarding how to effectively perform drafting tasks.

Documents and Course Artifact Examination

The documents that were examined in the case study included the WTCS handbook for curriculum and programs, the TSA for the Machine Tooling Technics program, and the employer survey for the Machine Tooling Technics program. The examination of course artifacts regarding instructor lesson plans included a course syllabus and grading rubric for student projects. Below describes the results and findings for the documents and course artifacts.

Wisconsin Technical College System (WTCS) Handbook for Curriculum and Programs

The WTCS is guided by the Educational Services Manual (ESM) for policies, processes, and procedures pertaining to educational services (WTCS, 2021a). The ESM allows for consistent quality within the WTCS. Each college in the WTCS has the ability to develop, modify, execute, or discontinue programs (WTCS, 2021a). Technical diplomas align with the community needs of business and industry. The diplomas are designed to ensure graduates are school-to-work-ready. The WTCS office approves new programs to ensure quality and expectations are met by employers and students (WTCS, 2021a).

The WTCS process and procedures for new program development encompass local business/industry needs by analyzing how the program would support local employment demands (WTCS, 2021a). A comprehensive detailed analysis of the local labor market is submitted to the WTCS (WTCS, 2021a). Sources of data for the analysis include databases, such as Economic Modeling Specialist International or the Bureau of Labor Statistics (WTCS, 2021a). Qualitative data used includes employer surveys, focus groups, advisory groups, and employer interviews in order to further understand labor needs (WTCS, 2021a). If an employer or college provides evidence of current and future needs, a program could be approved (WTCS, 2021a).

To modify an existing program to align more closely with business/industry needs a college must submit evidence of regional employment trends or a mandate by an accredited authority (WTCS, 2021a). All major changes to a curriculum are reviewed by the WTCS education director. When further analysis is needed for changes, the education director will review the program advisory committee meeting minutes and contact the college if further discussion is needed before any modifications are approved (WTCS, 2021a).

Examples of changes that require an in-depth review are training for a different occupation other than the approved program, modifications that do not meet WTCS business rules, or modifications that lead to the curriculum being differentiated than similar programs that are offered at other WTCS colleges (WTCS, 2021a). Disproval of modifications from the WTCS may be a result of the lack of alignment with business/industry, the program advisory committee does not support the changes or is believed to not be in the best benefits of students (WTCS, 2021a). Modifications could be initiated every three years or as needed per requests from college presidents, deans, advisory committees, or instructors (WTCS, 2021a).

TSA for Machine Tooling Technics Program (Assessment of Learning Outcomes)

To ensure students are meeting competence expectations, the WTCS and the Technical Skills Attainment (TSA) processes ensure students have the ability to demonstrate industry-validated technical skills upon completion of their programs (WTCS, 2021a). The TSA is managed and supported by the System's Office for all programs. The WTCS evaluates program outcomes and relevant criteria to ensure that graduate skills and knowledge meet employer needs (WTCS, 2021a). A standard scoring guide is used that validates that graduates are prepared for the workplace through the demonstration of occupational competence (WTCS, 2021a). There are two phases: planning and implementation.

The assessment of learning or TSA included six main areas for the Machine Tooling Technics program. The six areas were 1) apply basic safety practices in the machine shop, 2) apply precision measuring methods to part inspection, 3) interpret industrial/engineering drawings, 4) perform advanced CNC machining operations, 5) perform basic machine tool equipment set-up and operation, and 6) perform programming, set-up, and operation of CNC machine tools (L. Michels, personal communication, January 24, 2022). The 20 students that were assessed met all the requirements of the TSA (L. Michels, personal communication, January 24, 2022).

The TSA for the category of the application of basic safety practices in the machine shop included the following key areas of assessment:

- Demonstrate proper lock-out tag-out procedures
- Demonstrate safety procedures
- Maintain clean and organized work environment
- Operate machine with all required guards in place
- Wear appropriate clothing and personal protective equipment (PPE) (L. Michels, personal communication, January 24, 2022)

The TSA category of the application of precision measuring methods to part inspection included the key areas of the following assessments:

- Convert English/metric measurements
- Demonstrate care of precision measuring equipment according to established procedures
- Perform precision measurement according to established procedures
- Select correct measuring tool for job requirements

- Use standard industry measurement terminology (L. Michels, personal communication, January 24, 2022)

The TSA category of the interpretation of industrial/engineering drawings included the following key areas of assessment:

- Calculate tolerances according to established specifications
- Determine location of part features according to established specifications
- Distinguish between structural shapes
- Drawings follow view projection standards
- Interpret Geometric Dimensioning and Tolerancing
- Interpret a Bill of Materials
- Interpret lines, symbols, conventions, and notations
- Interpret orthographic projections (L. Michels, personal communication, January 24, 2022)

The TSA category of the performance of advanced CNC machining operations included the following key areas of assessment:

- Apply self-directed problem-solving strategies
- Control multi-axis CNC machines
- Operate CAD/CAM systems
- Perform advanced programming of CNC machines
- Perform one or more alternative CNC machining processes as defined by local industry needs
- Use computer-aided metrology (CMM)

- Utilize CNC process control, multi-part, and statistical process control (SPC) (L. Michels, personal communication, January 24, 2022)

The TSA category of the performance of basic machine tool equipment set-up and operation included the following key areas of assessment:

- Complete an inspection document to verify print specifications
- Complete project within specified timeframe
- Monitor machine tool operation according to established procedures and guidelines
- Operate machine tools according to established procedures
- Select and load tools according to the requirements of the job
- Select and set up work-holding devices for specified operation according to established procedures
- Verify machine set-up
- Verify proper application of speeds and feeds (L. Michels, personal communication, January 24, 2022)

The TSA category of the performance of programming, set-up, and operation of CNC machine tools included the following key areas of assessment:

- Adjust speeds and feeds to optimize machining conditions
- Execute program
- Load the correct program into the machine
- Select, load, enter and verify work and tool offsets
- Verify the accuracy of the CNC program
- Write basic programs for specified CNC machine tools according to EIA-ISO standards (L. Michels, personal communication, January 24, 2022)

When students meet these key areas of assessments, it provides documentation and verification of learned knowledge and skills that allow students to be workplace ready. Each area of the TSA categories requires multiskilling in both technical skills and non-technical (or soft) skills. The multiskilling for the technical areas requires students to understand how to operate machines and adjust machines for different applications and follow set process/procedures. The multiskilling for the non-technical skills area requires students to problem-solve through different scenarios, make decisions on the correct methods to perform tasks, and navigate around potential issues that may arise while working on projects.

Employer Surveys Regarding Graduate Follow-Up for Machine Tooling Technics Program

The employer survey results reflect the 2018 year as the next employer survey will be administered in the summer of 2022. Below in Table 3 are the latest employer survey results from employers of CVTC Machine Tool Technics graduates. There were 13 surveys sent out resulting in 7 responses (L. Michels, personal communication, January 24, 2022). See Appendix H for the employer survey used.

Table 3

2018 Employer Survey Results for the Machine Tooling Technics Program

Response rate	Mastery of knowledge	Technical skills	Communication	Relevancy of skill	Hire again
53%	86%	86%	71%	85%	100%
Mastery of STEM	Preparedness	Satisfaction with education	Importance of CVTC	Recommended graduate	
100%	100%	100%	100%	100%	

Note. Adapted from “2018 Employer Survey Results for the Machine Tooling Technics Program,” for Chippewa Valley Technical College, 2018, L. Michels, personal communication, January 24, 2022.

According to the survey results, there was a 53% response rate from employers who hired CVTC Machine Tooling Technics graduates (L. Michels, personal communication, January 24, 2022). The mastery of knowledge and technical skills was 86% (L. Michels, personal communication, January 24, 2022). In the area of communication, the result was 71% (L. Michels, personal communication, January 24, 2022). In relevancy of skill, the result was 85% (L. Michels, personal communication, January 24, 2022). The survey areas of mastery of STEM, preparedness, satisfaction with education, the importance of CVTC resulted in 100% (L. Michels, personal communication, January 24, 2022). The graduate recommendation and if the employer would hire again, resulted in 100% (L. Michels, personal communication, January 24, 2022). The results show that the CVTC Machine Tooling Technics program is meeting employer needs.

Instructor Lesson Plans

Instructor lesson plans that were examined included the course syllabus and grading rubric for student projects. Other learning material items used for teaching students included study guides, sample programs, videos for select applications, and PowerPoint presentations that students can access through the learning management system of Canvas (D. Thompson, personal communication, February 2, 2022). The course syllabus that was examined was for a multi-axis machining class. The course was three credits and contained 16 weeks of instruction to complete the course. The course is taught in a lab/lecture format. The syllabus focused on the core abilities of communication, models integrity, critical thinking, and values diversity (W. Reese, personal

communication, February 1, 2022). The course description expressed that it would provide students with a base knowledge of utilizing computer-aided design for multi-axis machining (W. Reese, personal communication, February 1, 2022). The purpose of the course is for students to be able to use software to create drawings and models that would generate toolpaths for the multi-axis machines (W. Reese, personal communication, February 1, 2022).

The learning outcomes would include the student being able to program a part, set up the machine, and run the part complete to rubric and blueprint (W. Reese, personal communication, February 1, 2022). The feedback from the instructor would be in the form of a progress report at the end of every four weeks, so the student would know how they are meeting expectations (W. Reese, personal communication, February 1, 2022). The weekly schedule printed in the rubric included different learning tasks that the student was expected to learn that led to a scoring guide using a points system for the different course projects (W. Reese, personal communication, February 1, 2022). A grading scale was also included within the syllabus so the students would know what score they needed to achieve a certain grade (W. Reese, personal communication, February 1, 2022). The scoring rubric helped the student understand the expectations of the course learning outcomes along with a process sheet that walked the student through the different step operations of the project. The scoring rubrics included a breakdown of scores from 0 to 4. See Table 4 below for a breakdown of the different levels of scoring.

Table 4*Basic Grading Rubric for the Machine Tooling Technics Program*

0 Project	2 Project	3 Project	4 Project
<ul style="list-style-type: none"> • Does not meet learning objectives • Does not meet blueprint requirements • Is scrap and not useable • Does not meet all process requirements • Not submitted before the end of the course • Includes an incomplete inspection sheet 	<ul style="list-style-type: none"> • Does meet learning objectives • Does not meet all blueprint requirements • Does not meet all process requirements • Completed before end of course • Submitted in a timely manner • Includes a completed inspection sheet 	<ul style="list-style-type: none"> • Is reworked or repaired to meet blueprint tolerances • Correctly completed to process requirements • Meets blueprint tolerances • Is free of burrs & bluing • Submitted in a timely manner • Includes a completed inspection sheet 	<ul style="list-style-type: none"> • Correctly completed to process requirements • Meets blueprint tolerances • Is free of burrs & bluing • Submitted in a timely manner • Includes a completed inspection sheet

Note. Adapted from “Basic Grading Rubric for the Machine Tooling Technics Program” for Chippewa Valley Technical College, 2022, W. Reese, personal communication, February 1, 2022.

Each scoring area of the rubric allows the student to understand the criteria for each grading score. The grading criteria allows the student to compare their completed project with the rubric to see if they met the grading expectations set by the instructor. The scoring rubric also

includes a topic area, description of what is scored in each section, and the scoring levels that the student could achieve for each of the criteria.

Summary

Chapter Four discussed the presentation of the findings with the areas of demographics, analysis overview, research questions that drove the semi-structured interviews, classroom observations, documents, and course artifact examinations. Semi-structured interview participants shared their knowledge and experiences when it came to how CVTC is preparing the manufacturing workers of tomorrow to meet the needs of industry through multiskilling. Questions related to instructor and leader backgrounds regarding their positions at the college, academic history, and what license and certifications they have earned. Other interview questions pertained to program and course design, how the Machine Tooling Technics program is keeping pace with technological advances, the processes for WTCS, method of instruction, what is expected of graduates, and how CVTC knows they are meeting the needs of employers through their practices.

Classroom observations were also performed for the researcher to quietly observe the classroom environment that included teacher/student interaction, student engagement relative to the presented content, instructor feedback, student behavior, and teacher method of instruction. Document review included the WTCS handbook, the TSA for the Machine Tooling Technics program, and employer surveys. Course artifacts were also examined that included a course syllabus and a scoring rubric. Chapter Five will include a discussion, conclusion, and recommendations based on the data results of the case study and narrative research.

Chapter V: Discussion, Conclusion, and Recommendations

The case study and narrative research examined how Wisconsin's postsecondary CTE curricula and programs were preparing students in the future of work through multiskilling to meet present and future workforce needs. In addition, the study identified methods of instruction used to ensure students acquired the necessary skills to be successful in the ever-changing workplace. The contents of this chapter include a discussion of the research findings along with connections to the literature, conclusions of the study, then ending with effective recommendations. The recommendations addressed would allow for sustainable practices in Wisconsin's postsecondary CTE curriculum and program design that educate far beyond the labor tasks and prepare young adults to be successful in their job roles.

The following research questions have been designed to understand postsecondary CTE manufacturing programs and their curricula through the lens of the current, near future, and the yet to be envisioned future as it relates to the knowledge, skills, and dispositions being taught:

- 1) How are postsecondary CTE instructors designing their curriculum and programs to move at the pace of technological change?
 - a. What is the process for program development and revision within the Wisconsin Technical College System?
 - b. How do technical college programs keep pace with technological change?
- 2) What methods of instruction do teachers employ to ensure students are able to work and adapt to unpredictable environments and other changes in the workplace?

Discussion

The case study and narrative research included semi-structured interviews with three CTE leaders and three CTE instructors from the Machine Tooling Technics program at CVTC in

Eau Claire, Wisconsin. Data sources included classroom observations, document review that included the WTCS handbook for curriculum and programs, the TSA for assessment of learning outcomes, employer follow-up surveys, and instructor lesson plans that consisted of a course syllabus and scoring rubric. The study strived to understand how CTE is preparing young adults for the future of work in manufacturing industries through the lens of one technical college. As a group, there was alignment regarding what skills and knowledge were crucial for student success. There was shared understanding that students needed a combination of technical skills and soft skills that would result in multiskilling characteristics to be workplace ready.

How do Technical College Programs Keep Pace with Technological Change?

The common themes for the semi-structured interview questions are discussed in the same order the interviews were conducted. The first question in the interviews was an icebreaker that asked interview participants to tell the researcher a little about themselves. All participants proudly expressed their backgrounds and their roles and responsibilities at the college. The common themes were that some of the participants were alumni of CVTC's machining program, went into industry for a couple of years to gain experience, then came back to teach at the college. Instructors with a strong background in industry are greatly valued in CTE classrooms (Stephens, 2015). Some participants were long-term employees who worked themselves up to leadership roles. The majority of the participants furthered their education to either a master's level or doctoral level.

How do Technical College Programs Keep Pace with Technological Change?

The findings of common themes for the second interview question pertained to how long they have been in their current position included a shared commitment to CVTC where the span of time as an employee was between 6 and 25 years. This commitment showed that CVTC

employees feel satisfaction and passion about their jobs and the college. Studies show that student learning achievement reflects the field expertise of instructors and their passion for teaching (Jeswani & Jaiswal, 2014). When instructors and leaders feel true pride for the college, it shows through their personal commitments for teaching and leading others. Jeswani and Jaiswal (2014) expressed that lower-student performance and commitment was a result of non-committed faculty who have higher levels of turnover or put less effort into their teachings.

How do Technical College Programs Keep Pace with Technological Change?

The findings of common themes for the third interview question regarded participants' academic history showed a shared importance in their education. Four participants embraced higher education as they earned their master's degrees and doctoral degrees. There was a common starting point of some participants' educational journey beginning with a technical degree. The Wisconsin State Legislature (2015) noted that to ensure quality education for Wisconsin's technical colleges, the FQAS, a Wisconsin Statute, would ensure that technical instructors meet academic, occupational, and teaching requirements.

How do Technical College Programs Keep Pace with Technological Change?

The fourth interview question asked participants what license or certifications they have earned. The overall findings showed that all participants earned the proper license and certificates that made them effective in their job roles. Certifications included industry-recognized, such as the NIMS (National Institute of Machining Standards) certification, teaching certificates, and CTE coordinator licenses that validate the recipients' skills and knowledge in the technical arena. The Wisconsin State Legislature (2015) expressed that instructors are required to have credentials, such as transcripts from an accredited post-secondary institution,

copies of professional licenses required by the state, and verifications for both appropriate teaching experience and occupational experience.

How are Postsecondary CTE Instructors Designing Their Curriculum and Programs to Move at the Pace of Technological Change?

The fifth interview question was about how postsecondary CTE instructors were designing their courses and programs to move at the pace of technological change. The shared themes included keeping an eye on what industries are doing, seeking advisement from the advisory committee, and utilizing a competency-based curriculum. Across the majority of the interviews, there was a shared consensus of the importance of keeping an eye on what industries are doing and their needs. Baumann et al. (2014) noted to meet the growing needs of industry, joint efforts between manufacturers, government, and education stakeholders demand an effective strategic alliance to develop successful competency-based, industry-driven education. It appeared to be a natural connection between the college and industry where the curriculum is designed around current industry needs and trends. The primary avenue of communication between industry and the college was through the advisory committee.

How do Technical College Programs Keep Pace with Technological Change?

Common themes for interview question six that pertained to how the Machine Tooling Technics program (as a separate entity from the college) kept pace with technological change noted the awareness of industry trends and the utilization of the Developing a Curriculum process or DACUM. When the DACUM process was used for curriculum development, it taps into set tasks, knowledge, skills, and traits that are necessary for specific jobs (DACUM International Training Center, 2021). An additional theme emerged regarding exposing students to the latest technologies with the understanding that the technology will be constantly changing.

Grenčíková et al. (2020) expressed that education today needs to change its character as the modern workforce needs to have the ability to deal with the rapid changes of technology through adaptability.

What is the Process for Program Development and Revision within the Wisconsin Technical College System?

Common themes for interview question seven regarded the process for program development and revision within the WTCS were maintenance through program review; another theme included employer feedback. The need for program maintenance through curriculum review ensured that needed adjustments and alterations were applied when necessary to keep up with the pace of technology. The WTCS has goals of alignment with both the needs of the students and community employers through collaboration, so graduates are school-to-work ready (WTCS, 2021b). In addition, the WTCS engages policymakers, educators, employers, workforce development partners, and community organizations to ensure sustained economic stability and continued growth (WTCS, 2021b).

What Methods of Instruction do Teachers Employ to Ensure Students are able to Work and Adapt to Unpredictable Environments and other Changes in the Workplace?

Common themes for interview question eight regarded what methods of instruction teachers employ that ensures students are adaptable to the ever-changing landscape of manufacturing environments included the utilization of a mixed-method approach to learning. Other themes included self-directed learning and a focus on active learning. The theme regarding the utilization of a mixed-method approach to learning addressed a variety of learning strategies. Strategies included flexibility of courses through the college learning management system (LMS) of Canvas that allows students to use study guides, PowerPoints, and videos so they can

prepare themselves for labs and lectured classes. This allowed students to learn at their own pace. DiBenedetto & Myers (2016) expressed that when teachers instruct learning skills, such as positive and creative thinking, clarity in communication, curiosity, self-direction through motivation, and engagement in life-long learning, the teachings instill the attributes of the skills needed in future work and the characteristics of multiskilling. When students transfer these learnings to the work environment, they would have the capability of adapting to their work environment as they would be prepared with job-specific technical skills (DiBenedetto & Myers, 2016).

Self-directed learning would allow students to be accountable for their learnings and have a deeper understanding and connection to lesson content. The focus on active learning would allow the student to have direct involvement in the learning content where they could carry theory into application. Ozar (2015) expressed that the learning techniques of experiential or hands-on learning would provide the elements for students to have a stronger identification of their role and the teacher's role as the teacher becomes the facilitator of experience.

What Methods of Instruction do Teachers Employ to Ensure Students are able to Work and Adapt to Unpredictable Environments and other Changes in the Workplace?

Common themes for interview question nine regarded what knowledge with technical skills were expected for graduates to work and to know to be successful in forward-thinking industries from an automated perspective. The themes included learning how to learn and to apply those new learnings to new experiences. Other themes that emerged were that the core of graduate success were soft skills and learning outcomes through TSA (technical skills attainment) that helped validate graduate skills and knowledge. Learning how to learn was not only important in manufacturing professions but also in all professions and life itself. Having the

ability to recall knowledge and knowing how to apply it to new situations are tenants to being a lifelong learner and multiskilled. Interview participants noted how important it was for students to be able to be effective communicators, problem-solvers, and being resourceful.

It is imperative for students to be flexible and resourceful as it ensures students would be the future innovators that would keep industries on the cutting-edge of modernization (Alismail & McGuire, 2015). It was also stated that being the curriculum was competency-based, it allowed students to build upon existing knowledge to apply those new learnings to higher-level course projects, such as advanced programming. When mutual industry standards are agreed upon by all stakeholders through competency-based education models, the program could adjust and adapt to current and yet to be envisioned needs (Baumann et al., 2014). When students can demonstrate their learnings and understand how the different pieces of knowledge fit together, it makes it easier to advance to higher-level tasks.

How do Technical College Programs Keep Pace with Technological Change?

Themes for interview question ten regarded how CVTC knows that their practices are successful in meeting the needs of employers included feedback from the advisory committee. Other themes included feedback from employers and industry support for CVTC graduates. Interview participants noted that feedback from the advisory committee created a direct communication of what industry wants from graduates regarding knowledge and skills. The open discussions create a trusting environment where industries can address concerns or spotlight best practices from the college. Having periodic pulse checks with industry would ensure that the college was keeping up with technological demands and new ideas. The connection of WTCS and industry showed that there is a shared partnership between the processes for developing programs and curriculums that had local needs at the forefront of priorities (WTCS, 2021b). The

connection showed through as WTCS would perform local needs assessments and consultations to ensure Wisconsin's manufacturing workforce development would be armed for success (WTCS, 2021b).

There was evidence of college-wide planning and coordination that utilized industry and the advisory committee to ensure the college was teaching young adults what they needed to learn regarding knowledge and skills. The periodic validations of curriculum and program relevancy were prevalent through the interviews as the college wanted to ensure they were keeping up with technology in the ever-changing landscape of manufacturing.

What Methods of Instruction do Teachers Employ to Ensure Students are able to Work and Adapt to Unpredictable Environments and Other Changes in the Workplace?

The findings regarding the three classroom observations concluded that the teacher/student interactions were very positive as the students appeared to be very comfortable in asking the instructor questions and using them as a valuable resource for their learnings. Lussier and Achua (2016) noted that the learner-centered teaching model showed that the teacher takes on a guardian leadership role as they become the main supporter of the students' needs, tools, and resources for teachings. Added enhancements to students in learner-centered classrooms are the ability to work as a group, become responsible and accountable, and practice their leadership skills (Dole et al., 2015). Stoller (2015) proclaimed that student growth stemmed from an experimental inquiry that would encourage students to voice their own opinions and experiment freely.

Feedback from the instructor appeared to be very positive as all the instructors were prompt with their feedback and allowed the student to self-navigate solutions to their problems. Dole et al. (2015) noted that in learner-centered classrooms, trust was established through

teacher confidence, independent instruction that allowed students to teach themselves, strategies in problem-solving, and learning to ask relevant questions to identify and solve problems. The classroom student behaviors showed they were independent when not in a lecture setting and appeared to have a mutual respect not only to the instructor but also towards one another.

The classroom observation regarding the teacher's method of instruction showed a variety of techniques. These techniques included self-directed learning in a lab environment, and problem-based learning through discussion and analysis within lecture-based instruction. This instruction regarded technical teachings in math, programming, and drafting. Alismail and McGuire (2015) expressed that problem-based learning strategies supported student capabilities in critical thinking, allowed for self-directed learning, promoted cooperation within their student group, and enhanced social interaction. The instructors used learning materials, such as overhead projectors and whiteboards to illustrate to students how to perform certain machining or mathematical applications. Studies showed that deep cognitive understanding comes from visualization and that teachers and curriculum designers could create engaging materials and learning environments for students (Evagorou et al., 2015). During the lectures, the instructors encouraged students to problem-solve through challenging issues to complete projects. Learner-centered classrooms connect to the constructivism learning theory as lessons are related to students' previous experience, the teacher takes on a guide role, and teacher demonstrates expertise of learning material (Mahmud, 2013; Fernando & Marikar, 2017).

The findings for the documents and course artifacts will be discussed next. The documents included the Wisconsin Technical College System (WTCS) handbook for curriculum and programs, the TSA for the Machine Tooling Technics program, and the employer survey for

the Machine Tooling Technics program. The examination of course artifacts regarding instructor lesson plans included a course syllabus and grading rubric for student projects.

What is the Process for Program Development and Revision within the Wisconsin Technical College System?

The findings for the WTCS's handbook for curriculum and programs were that it guided the college in making effective decisions regarding any changes or alterations in programs or curriculum. The guidance from the Educational Services Manual helped the college navigate through proper policies, processes, and procedures when changes were needed through the validation of consistent quality (WTCS, 2021a). The role of the WTCS office was to ensure alterations to programs or the implementation of new programs align with the expectations of employers (WTCS, 2021a). In the interviews when the research question asked interview participants regarding the process for program development and revision within the WTCS system, there was a shared understanding of what elements were needed to make changes or updates. Further, there was also a shared understanding regarding what communication avenues were needed to make those changes.

How are Postsecondary CTE Instructors Designing Their Curriculum and Programs to Move at the Pace of Technological Change?

The findings for the TSA for the Machine Tooling Technics program showed the different categories that focused on the industry standards for assessments. The different areas of assessment included safety practices, application of measuring tools, the interpretation of blueprints, and CNC operations that included set up and programming. The TSA categories were further defined that allowed for students to demonstrate the learning outcomes and helped instructors validate success of those learning outcomes. The TSAs reflect Bloom's Taxonomy as

the TSAs were used as an evaluation tool and teaching process (Chandio et al, 2016). The TSAs also reflected competency-based education that uses the DACUM process to capture the main duties of occupations through set tasks, knowledge, and skills (DACUM International Training Center, 2021).

How do Technical College Programs Keep Pace with Technological Change?

The findings for the employer survey results for the Machine Tooling Technics program were that employers had a positive outlook towards CVTC graduates. According to the results of the survey, employers felt that graduates had a high level of mastery of the learned knowledge that they gathered throughout their program. The technical skills were rated very high along with relevancy of skill and mastery of STEM. Communication was high but could use a little improvement as the graduates were scored at 71%. Employers gave graduates 100% in the areas of preparedness, satisfaction with educational outcomes, the importance of the college to industries, and if they would recommend CVTC graduates to other companies. The employers also resulted a 100% regarding if they would hire CVTC graduates in the future.

The results of the survey concluded that area industries thought very highly of CVTC graduates and felt they were meeting the needs of the industry. This showed that CVTC was in alignment with industry needs and up to date with its curriculum and programs that met technology demands and would continue to be on the cusp of cutting-edge modernization. Jankowski et al. (2018) noted that employer survey feedback helps colleges regarding what courses to add, change requirements, and student projects that would help develop and hone needed skills for the workplace along with employer satisfaction.

What Methods of Instruction do Teachers Employ to Ensure Students are able to Work and Adapt to Unpredictable Environments and other Changes in the Workplace?

The findings for the instructor lessons plans pertained to the course syllabus and scoring rubric showed how clear expectations were of the student and the completion of their projects. Other learning materials used by the instructors included study guides for lessons, sample programs that demonstrate to students what a CNC program should look like, videos for different applications to give students a visual learning experience, and PowerPoint presentations. Studies show that engaging materials and environments generate social and epistemic content that steers the student towards reasoning, experimental procedures, or a way to communicate that permits the reflection of learned content (Evagorou et al. 2015). All these teaching materials are on CVTC's learning management system of Canvas. The collection of learning aids along with a course syllabus and scoring rubric gave clarity to the student regarding learning outcomes and set expectations that would guide the student to success.

The course syllabus illustrated an outline of what the course would be teaching week to week. This gave the student awareness and preparedness of what topics would be taught in a particular week. This allowed the student to take a proactive approach to their learnings. Dole et al. (2015) noted that in learner-centered classrooms, trust was established through teacher confidence, application of independent instruction permits students to teach themselves, and strategies in problem-solving are practiced [...] that help shape student learning. The course syllabus partnered up with the scoring rubric showed the student what elements they would need to achieve to earn a certain score. This allowed the student to drive their own success in meeting set criteria created by the instructor.

The learner-centered teaching model showed that the teacher takes on a steward leadership role as they become the main resource of the students' needs, tools, and resources for their learning projects (Lussier & Achua, 2016). In addition, the instructor gave the student feedback in the form of a progress report at the end of every four weeks that allowed the student to correct themselves if they were falling short in certain areas of learning outcomes. This also invited a conversation between the instructor and the student that permitted the instructor to be a mentor and resource for their students. In learner-centered teaching models, it gave control to the student who drives the learning; giving the student the opportunity to self-evaluate their progress [...] (Dole et al., 2015). The way the curriculum was set up for the Machine Tooling Technics program showed a great interest in student success that resulted in school-to-work ready graduates.

Conclusion

The case study and narrative research consisted of document review, course artifact examination, classroom observations, feedback surveys, and semi-structured interviews. The result of all these components allowed the researcher to have a deeper understanding of how CTE programs, curriculum, teaching techniques, and processes and procedures were preparing young adults for the future of work in manufacturing industries. The triangulation of data results showed a common alignment regarding what and how to teach young adults that fostered multiskilling and preparation for the industry needs of today and for the jobs of tomorrow.

Technical and non-technical multiskilling through postsecondary CTE is becoming more important as technologies in manufacturing are ever evolving. The rapid advancement of technologies puts pressure on industries to move towards automation to fill labor gaps as human skills are struggling to keep up. It becomes crucial that CTE teaches young adults multiskilling

and keeps adaptable to the changes in industries through effective teaching methods, curricula, and program design. Wisconsin's manufacturing plays a pivotal role in the U.S. economy. With the increase in skills demand, more employers are looking for workers that are adaptable, problem-solvers, innovative, and are able to meet the needs of industry. Bushmaker and Franz (2017) expressed that Wisconsin manufacturers are having challenges in finding talented workers, which has escalated from 29% in 2011 to 80% as of 2017.

The need for CTE to prepare the workers of tomorrow through effective educational strategies would keep manufacturing industries on the cutting-edge of modernization. An and Reigeluth (2011) proclaimed that the traditional factory model of education may not be compatible with the growing demands of the new age of technology. CVTC demonstrated their program and curriculum effectiveness through a cornucopia of different strategies. The following four study findings of importance illustrates how CVTC would be at the forefront of the future of work:

- 1) The importance of advisory committees and industry feedback in guiding overall curriculum and expectations of graduates demonstrated a shared vision that was driven by industry needs. This partnership allowed the Machine Tooling Technics program to be cutting-edge and adaptable to industry changes.
- 2) The importance of using multiple educational philosophies, learning theories, and instructional strategies allow students to hone their skills through a variety of facets of learning. These skills included technical and non-technical multiskilling through competency-based education, applied learning techniques, and problem-based learning that fostered multiskilling characteristics. The hands-on approach to learning allows the students to have a direct connection to their learnings that would aid them

- in their future work endeavors that permits adaptability to navigate unforeseen challenges in manufacturing.
- 3) The importance in alignment of leadership expectations, faculty goals, curriculum processes, and assessment processes, equals program quality and competent graduates. The shared consensus reflects a unified approach to instruction that meets the needs of all stakeholders. This approach would help support area industries and communities to thrive in the current competitive world of manufacturing.
 - 4) The importance of leader and instructor industry background, certification, and education demonstrates the quest for giving students the best quality education. This quality shows through industry expertise, best practices in teaching techniques, and the ability to lead others to successful learning experiences. Further, the modeling of these academic qualities demonstrates to students that learning does not stop after the two-year diploma is earned, but to continue to improve oneself through education and self-development through life-long learning practices.

The results from this study would be useful information for other technical colleges to adopt the best practices from Chippewa Valley Technical College. Moreover, the results of the study could lead to recommendations in instrumental practices in Wisconsin's postsecondary CTE curriculum and program design. The improved teaching practices would allow young adults to be prepared to enter the modern work world of Industry 4.0 and beyond. As the study findings concluded, it was crucial for all stakeholders to become one when it came to ensuring the workers of tomorrow were prepared for any challenges, they may face in the manufacturing workplace. It takes the partnership of industries, colleges, and the local community to propel young adults into the future of work and to thrive in unpredictable environments. The overall

concluding take-a-way from this research was that it takes a collaborative effort from key stakeholders to ensure CTE curriculum and teaching strategies keep relevant to current industry needs. It takes more than one perspective regarding what and how to teach the workers of tomorrow to ensure the success of Wisconsin's manufacturing into Industry 4.0 and beyond.

The connections of the literature review studies to the current research study were shown in different areas of examination that allowed for a collaboration of ideas, theories, and methodologies. The Guo et al. (2020) study that applied project-based learning focused on student outcomes regarding perceptions of benefits and experience used similar methods that were used in this study. Methods of the study included interviews, observations, and rubrics to reflect student project success. The study noted that project-based learning encouraged students to construct new knowledge and create new ideas that champion competency of learned lessons (Guo et al., 2020). This becomes a direct reflection of what CVTC strives to teach their students regarding becoming a life-long learner and how to use foundational knowledge to construct new knowledge that could be applied to new situations.

Evagorou et al., (2015) performed a study of the role of visual representations in scientific practices that aided students from conceptual understanding and knowledge production to experiencing the inter-workings of science. This study connected to the hands-on approach or active learning that was heralded through the interviews as teaching methods allowed the students to transfer raw information into meaningful information through perception (Çeliköz et al., 2019). One of the case studies utilized Faraday's visual method that allowed students to observe magnetic forces and how those forces connected to the natural world (Evagorou et al. 2015). The visual images permitted students to associate what they were seeing and connecting

them to the natural world around them then led them to practical application. This would create a direct transfer of knowledge into practical applications through active learning.

The Baumann case study connected to the current study by developing a competency-based curriculum to capture industry set competencies through the DACUM process. The core of the study utilized the practical knowledge of industry standards that would create an effective competency-based curriculum that would meet industry needs (Baumann et al., 2014). The Baumann case study also created a guide that would standardize reporting and evaluation that would validate that the students met pre-set standards (Baumann et al., 2014). The expectations of students resulted in learning outcomes and objectives along with program development initiatives. The study mirrored the current studies importance regarding how industry plays an essential role in the future of work and the importance of industry and education partnerships.

Recommendations

CVTC requires an extensive partnership between industry, advisory committees, and instructors for program and curriculum success. The Machine Tooling Technics program practices showed an experimental or hands-on learning approach along with teaching students to become problem-solvers, effective communicators, and adapters to unforeseeable workplace conditions. These are key areas of multiskilling. Local industries are benefiting from the high-quality product that CVTC produces that result in a pipeline of competent workers that are ready to meet the needs of area industries and beyond. By keeping the collaborative spirit among all key stakeholders, industry and CVTC would be able to not only support the local communities they serve but allow them to thrive. After conducting the case study and narrative research and analyzing data results, the following three recommendations are offered for CVTC:

- Incorporate more project-based learning that allows students to work together to solve problems, share ideas, and collaborate to reach shared goals.
- Coach students to different career pathways that cultivate a wider scope of employment options after they earn practical industrial experience. This could be done by sitting down with the student and having a conversation with them and explain different career pathways.
- Incorporate an alumni survey six months after graduation to understand areas that the graduate feels need to be addressed within programs and curricula that would have further aided their success in their job roles.

Recommendations for further research include a study of current students regarding their learning experiences with CVTC in machine tool and what other subjects or topics they would like to learn more about. Another recommendation would be to explore through a comparative study regarding the benefits and shortfalls of different learning delivery models. This could be done by conducting a study that administers two groups: one could be taught using teacher-centered teaching methods while the other could be taught using student-centered teaching methods. This study would compare different models for effectiveness and could become a very useful tool in the creation of new curriculums and decision-making for future program plan strategies. Another recommendation for further research would be to replicate the current study at another WTCS college or nation-wide to see if similar data results emerge that reflect alignment and consensus throughout the WTCS and other technical college systems.

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Appendix A

Semi-Structured Interview Protocol

Introductory statement:

The purpose of this research is to investigate how Wisconsin's postsecondary CTE curricula and programs are preparing students in the future of work through multiskilling to meet current, emerging, and future workforce needs. In addition, this study will seek to identify methods of instruction used to ensure students acquire the necessary skills to be successful in the ever-changing workplace. The interview should be approximately 45 minutes of your time.

This interview is strictly voluntary and if at any point during the interview you feel uncomfortable, we can stop and the information you supplied will not be used in the research study.

In addition, confidentiality and the safety of research participants are the top priority, so your identity will not be revealed in any way.

The information participants will give will be in aggregate form and each participant will be assigned a participant number.

The data from the research will be housed in a secure folder in my personal computer's drive that is protected and will be destroyed after three years per federal regulation.

This interview will be recorded and transcribed for the purpose of moving it into themes on the topic of How CTE Curriculum/Program Design is Preparing Young Adults through Multiskilling to Meet Industry 4.0 Needs and Beyond.

Do you have any questions with these statements or any questions in general?

First of all, thank you so much for taking the time for doing this interview with me. Do you consent to take part in the recorded interview?

Wait for verbal and signed consent before continuing

Please sign the paper copy consent form.

Before we begin, please tell me a little bit about yourself, such as your role and responsibilities at the college.

How long have you been in your current position?

Could you tell me about your academic history?

What licenses or certifications have you earned?

How are postsecondary CTE instructors designing their courses and programs to move at the pace of technological change?

How does the Machine Tooling Technics program keep pace with technological change?

What is the process for program development and revision within the Wisconsin Technical College System?

What methods of instruction do teachers employ to ensure students are able to work and adapt to ever-changing environments in the workplace?

What knowledge with technical skills are expected for graduates to work and to know to be successful in forward-thinking industries from an automated perspective?

How do you know that your practices are successful in meeting the needs of employers?

Closing statement:

This concludes the interview at this point. Is there anything you would like to add that we did not discuss?

Thank you for agreeing to participate in this study and spending time with me today. I know you have a demanding role here at the college and I appreciate your time as your insights and experience are important and valuable to this study.

If you are interested, I can share the results of the study after it is completed.

Appendix B

Interview Recruitment Email Letter for Administrators and Instructors

Dear Administrators and Instructors:

I am a doctoral student at the University of Wisconsin-Stout, and I am working on my dissertation. I have received permission from Chippewa Valley Technical College's (CVTC) Institutional Review Board (IRB) and approval from the UW-Stout's IRB to conduct my research at CVTC. I am asking that you consider participating in the research study. Your participation is strictly voluntary, and if you decide to participate, you may withdraw at any time.

The title of my dissertation is "*Preparing Young Adults Through Multiskilling to Meet Industry 4.0 Needs and Beyond.*" The purpose of the research is to investigate how Wisconsin's postsecondary CTE curricula and programs are preparing students in the future of work through multiskilling to meet current, emerging, and future workforce needs. In addition, this study will seek to identify methods of instruction used to ensure students acquire the necessary skills to be successful in the ever-changing workplace. The results of the study could lead to effective recommendations in sustainable practices in Wisconsin's postsecondary CTE course curriculum and program design that educate far beyond the labor tasks. Sustainable teaching practices would allow young adults to be prepared to enter the modern work world of Industry 4.0 and beyond. Qualitative data will be gathered during this case study through field notes from classroom observations, curriculum/policy document review, artifacts, and semi-structured interviews.

Individual interviews will be conducted at a mutually agreed upon time and location within CVTC's campus and will take approximately 45 minutes of your time. I would like to interview three college administrators/leaders and three technical instructors within the Machine Tooling Technics program. In the interviews, I will collect basic information, such as the individual's background and questions regarding your personal experiences with student readiness for the future of work. IRB guidelines regarding human subjects will be honored including assigning participant numbers to ensure confidentiality. Instructors that participate in the interview will be invited to participate in the classroom observation.

Your participation is meaningful to the success of this research study. However, participation is strictly voluntary. The data collected will be used solely for the researcher's doctoral dissertation and possibly for future journal publications.

If you are interested in volunteering to participate in this study or have any questions, please email at ericksonh0617@my.uwstout.edu. I would appreciate a response by Thursday, January 27th that allows the study to stay on schedule.

Thank you in advance for your time and consideration.

Respectfully,

Heidi A. Erickson, Doctoral Candidate
University of Wisconsin-Stout

Appendix C

Consent Form Signed by Interview Participants

UW-Stout Signed Consent Statement for Research Involving Human Subjects

Consent to Participate In UW-Stout Approved Research

Project Title: *“Preparing Young Adults Through Multiskilling to Meet Industry 4.0 Needs and Beyond”*

Description: As a participant of this study, you will be participating in a recorded semi-structured interview. The results from this research could lead to effective recommendations in sustainable practices in Wisconsin’s postsecondary CTE course curriculum and program design that educate far beyond the labor tasks. Sustainable teaching practices would allow young adults to be prepared to enter the modern work world of Industry 4.0 and beyond.

Risks: The risks in this project are very minimal.

Benefits: The main benefit that will come from this research is understanding the process and procedures of program and curriculum development within the technical college. Another benefit would be to have an understanding of how and what instructors are teaching young adults to ensure they are meeting the present and future needs of manufacturing industries.

Confidentiality: You will be assigned a participant number and all data results will be presented in aggregate form. The informed consent form will not be kept with any other documents completed with this project.

Future Use: Data results and recommendations may be published in academic, peer-reviewed journals.

Time Commitment: The length of the interview will be approximately 45 minutes of your time. There is no payment of compensation related to this project.

Right to Withdraw: Your participation in this study is entirely voluntary. You may choose not to participate without any adverse consequences to you. You have the right to stop the interview at any time. However, should you choose to participate and later wish to withdraw from the study, there is no way to identify your anonymous document after it has been turned in to the investigator. If you are participating in an anonymous online survey, once you submit your response, the data cannot be linked to you and cannot be withdrawn.

IRB Approval: This study has been reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study, please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

Investigator:

Heidi Erickson
715-463-5571
Ericksonh0617@my.uwstout.edu

Advisor:

Dr. Julie Furst-Bowe
715-225-9683
Furst-bowej@uwstout.edu

IRB Administrator

Mike Mensink
Office of Research and Sponsored
Programs
101 Vocational Rehabilitation Bldg.
UW-Stout
Menomonie, WI 54751
715.232.5260
mensinkm@uwstout.edu

Statement of Consent:

By signing this consent form you agree to participate in the dissertation titled, *"Preparing Young Adults Through Multiskilling to Meet Industry 4.0 Needs and Beyond"*

 Name

 Date

 Name of parent or guardian
(if minors are involved)

 Date

Appendix D

Letter of Introduction Email to Chippewa Valley Technical College IRB

Dear [REDACTED]:

My name is Heidi Erickson, and I am a doctoral student at the University of Wisconsin-Stout, in Menominee, Wisconsin. I am writing to ask for your assistance in my current research.

My research area is in Career and Technical College program/curriculum design and how CTE is preparing young adults for the future of work in manufacturing. My plan is to study how CTE leaders and instructors design, teach and assess vital skills in multiskilling to prepare the workers of tomorrow. Qualitative data will be gathered during this case study through field notes from classroom observations, curriculum/policy document review, artifacts, and semi-structured interviews.

The interviews will capture background information on participants along with questions regarding participants' personal experiences with student readiness skills and knowledge for the future of work. The interview population would include three college leaders and three technical instructors from the Machine Tooling Technics program. UW-Stout's Institutional Review Board (IRB) guidelines for research with human subjects will be honored including the use of participant numbers to ensure confidentiality. Participation in this research study is strictly voluntary.

If you agree to participate in this research study, I will need your approval to begin reviewing curriculum/program documents and policies, recruiting interview participants, studying college artifacts, performing classroom observations, and conducting interviews. I would be more than happy to explain this process in more detail if needed at your earliest convenience.

If you are interested in participating in this research study, please contact me by email at ericksonh0617@my.uwstout.edu by the date of Monday, December 27, 2021.

Respectfully,

Heidi A. Erickson, Doctoral Candidate
University of Wisconsin-Stout

Appendix E

Consent Form Signed by Classroom Observation Participants

Informed Consent for Research Participation

Study Title:	Preparing Young Adults Through Multiskilling to Meet Industry 4.0 Needs and Beyond
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Researcher Names	Department	Contact Information
Heidi Erickson	Graduate	ericksonh0617@my.uwstout.edu 715-463-5571

Faculty Advisor	Department	Contact Information
Dr. Julie Furst-Bowe	Graduate	Furst-bowej@uwstout.edu 715-225-9683

Overview of the Research Study

Participation invitation:	You are invited to participate in the research study described below. Your participation is entirely voluntary, and you may stop your participation or withdraw from the study at any time and for any reason. If you choose to not participate or to stop your participation, there will be no negative consequences to you. Your decision to participate or not in this study will not change your relationship with the researchers or the University of Wisconsin-Stout.
Who can participate in this study:	3 Machine Tooling Technics instructors from Chippewa Valley Technical College who participated in the semi-structured interviews.
Study description:	The purpose of the research is to investigate how Wisconsin's postsecondary CTE curricula and programs are preparing students in the future of work through multiskilling to meet current, emerging, and future workforce needs. In addition, this study will seek to identify methods of instruction used to ensure students acquire the necessary skills to be successful in the ever-changing workplace.
What you will be asked to do:	You will participate in a classroom observation that will be conducted demonstrating your regular classroom activities. No researcher interventions will be administered.

Time commitment:	Observation will be 30 minutes and will not interrupt normal class activities.
Participation risks:	The researcher(s) do not believe this study will cause you any discomfort or other risk beyond what you would normally experience in your daily life.
What will be done to minimize your participation risks:	No personal information will be collected on individual students that are being observed.
Participation benefits:	There will be no participation payment but will share the results of the completed study with the participants.

Confidentiality and Data Protection

Who will have access to your data:	Only the researcher, Heidi Erickson.
Data protection and future use:	All research data will be kept on a secure drive on the researcher's personal computer. When research is complete, all stored information/data will be erased after three years per federal regulation. All participants will be assigned a participant number to ensure anonymity. Future use would be for academic publication to further advance research in technical education.

Protection of Human Research Subjects

If you have questions about this study, please contact:	<i>Heidi Erickson, Researcher</i> ericksonh0617@my.uwstout.edu 715-463-5571
If you have concerns about this study or your rights as a participant, please contact:	Institutional Review Board Chair University of Wisconsin-Stout Robert S. Swanson Learning Center #107 715-232-4042 irb@uwstout.edu
Your right to withdraw:	Your participation in this study is entirely voluntary. You may choose not to participate or to stop the study or survey without any adverse consequences to you. However, should you choose to participate and later wish to withdraw from the study, there may be no way to identify your data after it has been submitted. If you are participating in an anonymous survey, once you submit your responses, the data cannot be linked to you and cannot be withdrawn.
UW-Stout IRB approval statement:	This study has been reviewed and approved by the University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations for human subjects

	research as required by federal law and UW-Stout policies.
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Consent Statement

I agree to participate in this study and understand that I may stop my participation or withdraw my consent at any time during active participation.

Printed name of participant

Signature of participant

Date

Appendix F

Classroom Observation Field Notes

Course Title:

Number of Students:

Date of Observation:

Time of Observation:

Key Areas of Observation:

- Teacher/student interactions
- Student engagement relative to the presented content
- Feedback from instructor
- Student behavior
- Teacher method of instruction (student-centered or teacher-centered)

Appendix G

Interview Table for Reduction Process

Column 1	Column 2	Column 3	Column 4 Themes
<p><i>Please note: Due to space constraints, the whole narrative is not present in this appendix table.</i></p> <p>Interviewer What methods of instruction do teachers employ to ensure students are able to work and adapt to ever changing environments in the workplace?</p> <p>Participant 4 So, The evolution of most of my courses. We guide them. Quite a bit in their initial courses and. Show them. Problems that can happen and how to solve them to try prepare them. To do this on their own and then incrementally as we get near the end of the course, we may just present them with a problem. And try to have them problem solve it out.</p>	<p>Methods of instruction do teachers employ</p> <p>[...] my courses we guide them [...] in their initial courses and show them problems that can happen and how to solve them to try prepare them. To do this on their own and then incrementally as we get near the end of the course, we may just present them with a problem and try to have them problem solve it out. [...] groups and then assign them in the group of two or three. You do that and [...] then, but they got to work together and explain what the person did to get to that point or whatever the case [...]</p>	<p>Methods of instruction do teachers employ</p> <ul style="list-style-type: none"> • Simulation of potential problems • Demonstrate problem-solving abilities • Teaching students how to teach themselves • Demonstrating skills through show and tell • Group work when machines are limited and having them explain the process they used <p>Quote: “We guide them [the students] in their initial courses and show them problems that can happen and how to solve them to try prepare them to do this on their own [...].”</p>	<p>Themes</p> <ul style="list-style-type: none"> • Demonstrate problem-solving abilities through simulated activities • Teach students how to be self-sufficient • Show and tell activities to demonstrate learnings • Group projects to allow collaboration <p>Quote: “We guide them [the students] in their initial courses and show them problems that can happen and how to solve them to try prepare them to do this on their own [...].”</p>

Appendix H

Chippewa Valley Technical College Employer Survey



Employer Survey

Our records indicate that «ER_NAME» has hired a graduate from CVTC's «PGM_NAME» program. In this survey, you will evaluate the preparedness of our «PGM_NAME» graduates for entry-level positions in your organization. Your company/supervisor ID number is «PASSWORD».

The Employer Survey is designed to evaluate your satisfaction with the training that our graduates received as pertaining to their preparedness to fulfill the duties of working for your organization. Your participation in this survey will help us improve our ability to equip our graduates with the relevant skills that meet the labor needs of business community.

How well does CVTC's «PGM_NAME» Program prepare their graduates, compared to your expectations of an entry-level employee?

For each row below, darken in **ONE** response. If a certain attribute does not apply to fields in which you have hired CVTC graduates, please darken in 0 (Does Not Apply).

ATTRIBUTES:	Exceeds Expectations	Meets Expectation	Nearly Meets Expectations	Does Not Meet Expectations	Does not Apply
	4	3	2	1	0
1. Mastery of knowledge in the field	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Ability to perform technical skills of the profession	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Ability to communicate effectively with co-workers and/or customers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Relevancy of graduates' skill and/or knowledge base in relationship to real world applications within the industry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Mastery of science, technology, engineering or math skills needed in the field	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Overall preparedness for employment at your company	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. How satisfied are you with the graduates' technical college education?
 Very Satisfied Satisfied Unsatisfied Very Unsatisfied
8. Would you recommend graduates of this program to another employer?
 Yes No Maybe
9. Would you hire a CVTC graduate again?
 Yes No Maybe
10. How important is your local technical college(s) to the overall success of your business?
 Very Important Important Somewhat Important Not Important

Name of person completing survey: _____