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Bridging the Skills Gap: The Impact of High School CTE Programs on Local Industry Recruitment in Arizona

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ABSTRACT

Arizona's strategic sectors, particularly semiconductor manufacturing and healthcare, currently face an alarming skills gap as local talent availability fails to keep pace with rapid high-tech industrial expansion. This study explores the role of high school Career and Technical Education (CTE) programs in addressing this crisis through the Career and Technical Education Districts (CTED) model. Utilizing a qualitative descriptive case study approach, primary data were gathered through virtual interviews and in-depth document analysis of official reports from 2024–2025 to ensure research credibility despite remote implementation. The findings indicate that CTE concentrators achieve a graduation rate of 94.5%, with over 90% of graduates positively engaged in the economy. This high engagement is qualitatively driven by an industry-synchronized curriculum that mirrors actual workplace environments, fostering high student self-efficacy. Furthermore, the acquisition of industry-recognized credentials (IRC) emerged as a decisive factor that technically reduces recruitment costs and training time for local companies by providing instant proof of competence. The study concludes that while CTE programs serve as a strategic bridge, challenges regarding rural access and instructor shortages persist. To address the shortage of expert instructors, it is recommended that the state government simplify teaching certification pathways for industry practitioners through a specialized "adjunct instructor" scheme.

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INTRODUCTION

The global economy is currently undergoing a fundamental structural transformation Driven by the massive integration of digital technology and automation, global labor markets are undergoing a profound transformation. This phenomenon has drastically altered workforce requirements across various major industrial sectors worldwide, creating a pervasive "skills gap" where the supply of skilled labor cannot keep pace with technological advancement (Kim et al., 2021; Liu & Paramalingam, 2025). In Indonesia, this global challenge is mirrored in the struggle of the vocational education system to produce graduates who are immediately ready for the increasingly digitized manufacturing landscape (Mahmudah & Santosa, 2021). Such shifts pose significant challenges to traditional educational institutions, which are often perceived as slow in adjusting academic curricula to volatile market dynamics (Somantri & Pramudita, 2024).

In the state of Arizona, the accelerated growth of high-tech industries and advanced manufacturing has exposed a widening gap between graduate qualifications and employer needs. This imbalance is not merely a quantitative issue regarding the number of workers, but rather a crisis of skill quality encompassing both technical aspects and strategic leadership capacities (Carruthers et al., 2024). Rapid industrial expansion requires a steady pipeline of skilled technicians, reinforcing the urgency for adaptive education systems capable of responding to evolving labor demands (Dougherty, 2023). Consequently, more adaptive educational interventions are required to ensure the region's future economic sustainability.

The skills gap in Arizona has reached an alarming point, particularly within the semiconductor manufacturing, healthcare, and construction sectors. Rapid economic growth in the region has not been matched by the availability of local talent possessing industry-recognized technical certifications (Ecton & Dougherty, 2022). As a result, many large corporations are forced to recruit from out-of-state to fill specialist positions requiring high expertise, creating inefficiencies in local labor markets (Furey, 2025). These recruitment pressures are further exacerbated by the wave of mass retirements from the baby boomer generation, making the re-engineering of educational pathways through Career and Technical Education (CTE) a necessity.

Arizona's CTE programs have emerged as a strategic intervention to align educational output with industry needs through an experiential learning approach. The implementation of these programs is carried out through a highly organized structure known as Career and Technical Education Districts (CTEDs), which enable resource-sharing and cost efficiency among schools (Cashdollar, 2022). The CTED model provides students with access to state-of-the-art facilities, effectively addressing the budget constraints that typically hinder individual schools from purchasing expensive industrial-grade equipment (Soliz, 2023).

Through CTEDs such as West-MEC and EVIT, students receive intensive training in high-demand fields like cybersecurity and advanced manufacturing. The applied curriculum is developed alongside industry partners to ensure the relevance of every skill to current labor standards (Mariah et al., 2025). This collaborative approach demonstrates that education with direct relevance to the professional world is capable of increasing student engagement and success (Wahyudin et al., 2025). By centralizing resources, CTEDs ensure that even smaller or rural schools can offer their students a pathway to high-tech careers.

Theoretically, the effectiveness of these CTE programs can be analyzed through the lens of Human Capital Theory, which posits that education is an investment in human capital. This perspective emphasizes that enhancing individual skills is directly proportional to productivity and economic growth (Stevens et al., 2015). In Arizona, investment in secondary-level vocational education is considered a strategic investment to maintain the region's attractiveness to global investors. Without this strengthening of human capital, the growth of high-tech industries will be hindered by the limitations of local talent.

Furthermore, Social Cognitive Career Theory (SCCT) provides a critical foundation for understanding how hands-on experience can enhance student self-efficacy. This theory explains that an individual's career interests are influenced by their self-beliefs regarding their abilities and expected outcomes (Bettencourt et al., 2021). Empirical evidence shows that exposure to real-world work environments significantly improves students' confidence and career readiness, contributing to higher completion rates in CTE programs.

The Link and Match theory also serves as a primary pillar in ensuring that the competencies produced by educational institutions are synchronized with labor market qualifications. This concept demands strong integration between school curricula and the actual needs within the industrial world (Estriyanto, 2021; Yoto et al., 2024). In Arizona, this synergy is achieved through formal curriculum advisory boards where industry practitioners actively design and review learning modules at CTEDs. This alignment aims to create a seamless transition path from the classroom to the professional workforce and minimize the mismatch between education and employment outcomes.

The development of the semiconductor industry in Arizona, supported by the CHIPS Act, has become a major catalyst for strengthening vocational programs. Giant corporations such as Intel and TSMC require thousands of operational technicians who precisely understand advanced fabrication processes (Conrad, 2025). Secondary CTE curricula specifically address technical competencies like cleanroom protocols, mechatronics, and precision quality control to meet these standards (Wosczyna-Birch & Robicheau, 2024). A focus on industry-recognized certifications (IRCs) ensures that graduates possess instant credibility and a "fast track" into high-tech recruiters' pipelines (Harris et al., 2025).

The labor market in Arizona is currently experiencing significant pressure due to uneven economic growth across various sectors. As the state shifts its focus toward high-tech industries, employers face major challenges in finding leadership and technical talent (Kwok, 2022). Labor shortages in healthcare positions and specialized executive functions are particularly acute in the region (Michaeli et al., 2024). Rapid economic growth and the adoption of artificial intelligence demand leaders who are operationally proficient and strategic. Without systematic educational intervention, this skills gap will continue to hinder regional productivity.

At the regional level, the growth of the advanced manufacturing industry in Pinal County is projected to increase significantly over the next decade, driven by the emergence of the electric vehicle industry. However, these opportunities are not always evenly distributed due to limited access to vocational education in some remote areas (Kim et al., 2021). This disparity potentially limits social mobility in rural populations, making equitable access to CTE a critical agenda for policymakers (Alam, 2022). Expanding access to CTE programs to every corner of the state is necessary to ensure inclusive economic growth.

The integration of Artificial Intelligence (AI) literacy has now become a new foundational standard for entry-level jobs in the manufacturing sector. CTE programs in Arizona are beginning to adopt curricula that include the use of AI tools within engineering and information technology pathways (Chee et al., 2024; Stolpe & Hallström, 2024). Employers highly value CTE experience, viewing it as an early talent pipeline aligned with real business needs (Gauthier, 2021). By aligning program offerings with national reindustrialization strategies, Arizona is positioning itself as a hub of economic resilience.

Data shows that there are over 127,000 secondary CTE participants in Arizona engaged in various fields of competence. Students participating in these programs have graduation rates that significantly exceed the average for general track students, reflecting the effectiveness of applied learning approaches (Dougherty, 2023; Ecton & Dougherty, 2022). This reflects the success of a practical approach in giving meaning to academic learning, which often feels abstract. Investing in local talent through CTE is considered a crucial step to ensure readiness to lead the future economy (Stevens et al., 2015).

The primary challenge faced by CTE programs is the high investment cost for laboratory equipment and the recruitment of expert instructors. Many industry practitioners are reluctant to transition into teaching due to the significant compensation gap between industry and academia (Soliz, 2023). Without a solution to this gap, the quality of instruction in CTEDs risks lagging behind rapid industrial technological advancements. The state government needs to provide specific incentives to attract the best industry talent to teach in vocational schools.

Based on this background, this study aims to evaluate the effectiveness of Arizona's CTE programs in bridging the industrial skills gap. The primary focus is on how the CTED model produces competitive graduates in strategic sectors like semiconductors. By utilizing Human Capital and Link and Match frameworks, this research provides applicable policy recommendations for stakeholders. Finally, this study dissects opportunities for integrating digital technology like AI into future curricula to ensure graduates remain competitive globally (Rupnik & Avsec, 2025; Walter, 2024).

METHOD

This study utilizes a qualitative method with a descriptive case study approach to explore the implementation of Career and Technical Education (CTE) in Arizona from 2024 to 2025. This design was specifically chosen to document the unique operational dynamics of the Career and Technical Education Districts (CTED) model, particularly West-MEC, which was selected due to its prominent success and diverse programming in high-growth sectors (Carruthers et al., 2024; Haviland & Robbins, 2021). The primary focus of the research is to evaluate how curriculum structures and industry-linked policies influence the effectiveness of talent recruitment without resorting to rigid generalizations. This strategy is essential for analyzing educational programs that are highly dependent on specific socio-economic contexts and industry alignment (Düzgünçınar, 2025).

The participants in this study were selected using purposive sampling to ensure that data originated from authoritative sources directly involved in the "link and match" cycle (Ahmad & Wilkins, 2024; Campbell et al., 2020). A total of 12 key informants participated in this research, categorized in the following table to ensure transparency:

Table 1: List of Informants

Informant ID	Position / Sector
Informant 1-3	Administrators from Arizona CTEDs (West-MEC, EVIT)
Informant 4-6	Management Representatives, Semiconductor Industry (Intel, TSMC)
Informant 7-9	Management Representatives, Healthcare Sector
Informant 10-11	Vocational Instructors in Engineering & Health Sciences
Informant 12	Stakeholder, Arizona Department of Education (ADE)

Data collection was conducted through method triangulation, including interviews, systematic documentation, and participant observation. This triangulation approach strengthens the validity of qualitative findings by combining multiple data sources (Fatimah & Chamidi, 2025; Kebede et al., 2024). Interviews were conducted online via Zoom and Microsoft Teams to maintain transparency in remote data collection procedures. Regarding participant observation, field data was gathered through virtual facility tours and high-resolution video recordings of learning activities in Arizona's laboratory facilities. Documentation studies complemented these findings by analyzing CTED annual reports (FY 2024–2025), regional economic impact reports, and data from the ADE CTE portals.

The data analysis follows the interactive model of Miles, Huberman, and Saldaña, encompassing data condensation, data display, and conclusion drawing (Miles & Huberman, 1994, 2013). The coding process was conducted manually using thematic categorization tables to identify central patterns such as the "skills gap" and "IRC attainment". This analytical framework allows for systematic interpretation of complex qualitative data (Huberman & Miles, 2002).

To ensure the credibility of the findings, the researcher implemented member checking by returning narrative summaries to key informants for verification (Birt et al., 2016; Candela, 2019). Furthermore, peer debriefing with vocational education experts was conducted to minimize subjective bias in interpreting the international data (Lloyd et al., 2024).

In accordance with international publication standards, this research strictly adhered to research ethics considerations. All participants provided informed consent, and the study ensured the confidentiality of sensitive industry data, particularly regarding proprietary semiconductor fabrication standards. Strict documentation of the audit trail was maintained to allow for study replication in different geographical contexts, ensuring that the resulting conclusions possess high scientific integrity.

RESULTS AND DISCUSSION

Student Participation and Success Profile of CTE in Arizona

Research findings demonstrate a substantial increase in student participation in Career and Technical Education (CTE) programs across Arizona over the past five years. This trend aligns with broader national patterns showing increased engagement in vocational pathways as viable alternatives to traditional academic routes (Aliaga, 2023; Soliz, 2023). Based on Career and Technical Education District (CTED) annual reports for the 2024–2025 period, enrollment levels reached 35,990 students in West-MEC, 32,634 students in East Valley Institute of Technology (EVIT), and 21,909 students in Pima County JTED. This upward trajectory reflects a structural shift in students' educational preferences toward skill-

oriented pathways, driven by expanded funding access and policy support at earlier grade levels (Bonilla & Thim, 2025).

Table 2: Student Participation and Success Data at Major CTEDs in Arizona (FY 2024-2025)

CTED Name	Student Enrollment	Completion Rate	Industry Credentials Earned
West-MEC	35,990	63.38%	>9,000
East Valley IT	32,634	61.44%	149 (In-demand)
Pima County JTED	21,909	60.46%	Varied

Source: *Processed from Arizona Department of Education (2025) and West-MEC Economic Impact Report (2024).*

The success of these programs is further evidenced by outcome indicators. The graduation rate of CTE concentrators reached 94.5%, significantly higher than the 77.3% rate among non-CTE students. This finding is consistent with prior empirical studies demonstrating that participation in CTE significantly increases high school completion rates and reduces dropout risks (Gottfried & Plasman, 2017; Tague, 2023). The effectiveness of these programs can be attributed to the implementation of an "industry-synchronized curriculum," which enhances student engagement by linking academic content with tangible career outcomes (Dougherty, 2023).

Furthermore, the acquisition of Industry-Recognized Credentials (IRCs) plays a crucial role in strengthening graduate employability. These certifications function as validated indicators of technical competence and are strongly associated with improved graduation outcomes and labor market entry (Glennie et al., 2024; Stevens et al., 2015). As a result, IRC attainment serves not only as a credentialing mechanism but also as a bridge facilitating smoother transitions from school to work.

Program Impact on Strategic Industrial Sectors: Semiconductors and Healthcare

The semiconductor industry represents a primary beneficiary of Arizona's CTE ecosystem. This aligns with broader evidence suggesting that vocational education systems play a critical role in supporting high-demand industrial sectors through targeted skill development (Silliman & Virtanen, 2019). Major corporations rely on a consistent pipeline of technically proficient graduates capable of operating within complex manufacturing environments. CTE curricula particularly in mechatronics and advanced manufacturing are designed to replicate real-world industrial settings, thereby ensuring technical readiness and reducing training costs for employers.

Similarly, in the healthcare sector, CTE programs provide early exposure to professional environments through clinical training and certification pathways. Research indicates that such early engagement significantly enhances students' readiness for employment and improves long-term career outcomes (Ecton & Dougherty, 2022; Shoemaker, 2025). This experiential learning model strengthens professional identity formation and contributes to higher workforce participation rates among graduates.

Effectiveness of Link and Match Effectiveness and Economic Impact

The effectiveness of Arizona's workforce alignment strategy can be understood through the *link and match* framework, which emphasizes the synchronization between educational outputs and labor market demands. Empirical

evidence suggests that such alignment significantly improves employment outcomes and reduces inefficiencies in workforce development systems (Dougherty et al., 2019; Kim et al., 2021). By involving industry stakeholders in curriculum design, CTEDs ensure that competencies taught in schools remain relevant and responsive to evolving industrial needs.

From an economic perspective, CTE programs generate substantial regional value. Studies indicate that vocational education contributes positively to local economic development by increasing workforce productivity and reducing unemployment (Dougherty, 2016; Stevens et al., 2015). Furthermore, high rates of post-graduation employment among CTE participants reflect strong returns on public investment and validate the long-term sustainability of such programs.

Discussion: Theoretical Perspectives and Implementation Challenges

From a theoretical standpoint, the effectiveness of Career and Technical Education (CTE) programs can be profoundly explained through human capital theory, which posits that strategic investments in education directly enhance individual productivity and long-term economic outcomes (Dougherty, 2016). This theory suggests that specialized technical training serves as a critical economic asset, elevating a student's value within a competitive labor market. The high graduation and employment rates observed in Arizona provide robust empirical support for this assumption, indicating that vocational pathways effectively build market-relevant skills that meet modern industrial demands. Furthermore, these outcomes suggest that when curriculum design aligns with employer needs, the transition from the classroom to the workforce becomes a seamless driver of regional economic growth.

However, despite these systemic successes, significant challenges remain regarding the democratic distribution of these benefits. One significant issue is the persistent inequality in access and outcomes across different student groups, which threatens the idealized meritocracy of vocational education. Research highlights that while CTE programs improve overall outcomes on a macro level, their benefits are not always evenly distributed, with distinct disparities observed across various socioeconomic and demographic groups (Furey, 2025; Howard et al., 2022). This reality raises urgent concerns about equity and the potential reproduction of social stratification within vocational systems. If certain populations are funneled into lower-wage technical tracks while others access high-growth sectors, the system may inadvertently reinforce the very social hierarchies it seeks to bridge.

Additionally, the meaningful inclusion of students with diverse learning needs remains a critical issue for policymakers and educators alike. While CTE has shown demonstrably positive impacts for students with disabilities, providing them with practical avenues for independence ensuring truly inclusive program design requires continuous policy attention and pedagogical adaptation (Dougherty et al., 2018; Theobald et al., 2019). This necessitates not only physical accessibility but also the implementation of universal design for learning to accommodate various cognitive styles. Without such intentional and sustained efforts, the vocational system risks reinforcing existing educational inequalities rather than mitigating them, potentially leaving vulnerable populations behind in an increasingly complex economy.

Another structural challenge relates to the profound post-pandemic shifts that have redefined global education systems. Emerging evidence suggests that participation patterns and gender-based disparities in CTE programs continue to evolve in the post-pandemic context, reflecting new social pressures and changing

labor market priorities (Ecton & Dougherty, 2022; Howard et al., 2022). These shifting dynamics require adaptive and equity-oriented policy responses to ensure long-term inclusivity and the sustainability of the workforce pipeline. Addressing these modern hurdles involves a proactive reassessment of how digital divides and remote learning modules have impacted vocational training, ensuring that the recovery process benefits all students regardless of their background.

CONCLUSION AND RECOMMENDATION

Based on the results of the analysis, this study concludes that Career and Technical Education (CTE) programs at the secondary level in Arizona are crucial instruments in bridging the skills gap while strengthening the local industrial recruitment system. The implementation of the CTED district model has been empirically proven to be a unique managerial innovation, enabling resource efficiency that allows schools to meet expensive and sophisticated semiconductor industry standards. The integration of industry-synchronized curricula and the acquisition of Industry-Recognized Credentials (IRC) have significantly increased student graduation rates to 94.5%, with over 90% of graduates positively engaged in the economy through job placement or further education. Qualitatively, this success has shifted the perception of the Arizona community toward vocational education from a "second-class choice" to a primary pathway toward prestigious careers.

When examined through the frameworks of Human Capital Theory and Social Cognitive Career Theory (SCCT), CTE in Arizona does not merely function as a mechanism for technical skill transfer; it also serves as a driver of student self-efficacy, making graduates more proactive in seeking opportunities in demanding sectors such as advanced manufacturing and healthcare. Strengthening this self-efficacy is the most valuable long-term impact, ensuring graduates remain resilient in the face of future technological disruptions. Nevertheless, the long-term effectiveness of these programs still faces significant structural challenges, particularly regarding geographic access disparities in rural areas and the limited number of expert instructors due to significant compensation gaps.

Recommendation. To optimize the impact of these programs, it is recommended that Arizona policymakers implement outcomes-based funding models that provide incentives to school districts based on tangible achievements, such as the number of high-value credentials earned and successful student job placements in priority sectors. These incentives must be allocated proportionally to address the rural access equity issue, ensuring that schools in remote areas receive extra support so their credential standards remain equivalent to metropolitan areas. Additionally, periodic audits of IRC relevance are necessary to ensure the curriculum stays aligned with the rapid technological changes in the semiconductor and healthcare sectors.

Structurally, the government should simplify teacher certification bureaucracy for industry practitioners through "teaching fellowships" or "adjunct instructor" schemes, allowing their expertise to be transferred to students without rigid administrative hurdles. The industrial private sector must also be encouraged to participate in curriculum advisory boards to ensure a real-time flow of labor market data. Finally, investment in digital infrastructure to support virtual laboratories and Artificial Intelligence (AI) literacy should be a top priority to ensure Arizona graduates are not only ready for current roles but also possess the adaptability required for future industrial automation.

Research Limitations. This study is limited as its primary analytical focus is on the semiconductor and healthcare sectors; therefore, dynamics in other industrial sectors may show different patterns. Additionally, as a descriptive case study utilizing remote data collection, further longitudinal research is required to measure the long-term impact of AI technology integration on the social mobility of students in rural Arizona. Sustained Return on Investment (ROI) evaluations will ensure that every public investment in CTE provides an equitable economic impact for all levels of society.

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