

ORIGINAL RESEARCH

Integrating artificial intelligence into career and technical education: A scalable framework for innovation, curriculum design, and workforce alignment

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Abstract

This article examines the transformative role of artificial intelligence (AI) in shaping effective, student-centered curricula for career and technical education (CTE) programs within the California State University (CSU) system. It argues that AI has the potential to sustain and enhance CTE offerings, preventing program closures such as the dissolution of the Professional Studies Department at California State University, Long Beach (CSULB) in 2009. Drawing on secondary data, institutional documents, published research, and the author's case-informed experience, the article develops a conceptual framework for AI-enabled curriculum design that aligns educational programs with labor market demands, supports personalized learning experiences, and strengthens enrollment by addressing the diverse needs of adult learners, particularly in fully online formats. Rather than reporting new statistical findings, this article uses conceptual analysis and illustrative diagrams to organize existing knowledge and propose practical directions for AI integration in CSU-based CTE programs.

Keywords

artificial intelligence, curriculum design, career and technical education, adaptability, growth

INTRODUCTION

In 2009, California State University, Long Beach (CSULB) made the controversial decision to dissolve its Professional Studies Department, which had successfully served nearly 2000 adult learners each semester. This decision, driven by political factors and internal power struggles, reflected a broader institutional failure to adapt to changing educational landscapes and workforce demands. This case highlights the critical importance of agility in higher education, especially for programs catering to adult learners who require flexibility, relevance, and alignment with career goals. It serves as a cautionary tale, emphasizing the necessity for institu-


tions to prioritize innovation and responsiveness to shifting demographics and market trends.

At California State University, San Bernardino (CSUSB), career and technical education (CTE) programs take a fully online approach, reflecting a commitment to accessibility and flexibility for adult learners. These programs demonstrate how higher education can address the diverse needs of working professionals while adapting to the demands of a dynamic workforce. One transformative strategy for ensuring the continued relevance of such programs is integrating artificial intelligence (AI) into curriculum design (Xia *et al.*, 2022). AI has the potential to revolutionize

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higher education by enabling responsive, data-driven, and inclusive curricula that align with labor market trends and meet the unique needs of adult learners.

This research article explores how AI can be strategically integrated into CTE program development at CSUSB to enhance student engagement, improve learning outcomes, and prepare graduates for the modern workforce. Specifically, it addresses the following questions: (1) How can AI be leveraged to design a curriculum that aligns with labor market trends while accommodating diverse adult learners? (2) In what ways can AI-driven tools personalize learning experiences and improve student success in online programs? (3) How can AI identify and address barriers to inclusivity, ensuring equitable opportunities for all students? (4) What ethical considerations must be addressed when integrating AI into higher education, including data privacy, algorithmic bias, and equitable access to technology?

By addressing these questions, this study aims to provide a comprehensive framework for integrating AI into CTE programs to foster innovation while upholding academic integrity and equity.

The dissolution of CSULB's Professional Studies Department underscores the risks of failing to embrace technological advancements and respond to market demands. In contrast, CSUSB's proactive integration of AI into CTE programs represents a forward-looking approach to addressing these challenges. AI-driven tools, such as predictive analytics, personalized learning pathways, and adaptive assessment methods, can enhance student engagement, ensure curricular alignment with industry needs, and provide tailored educational experiences for adult learners with diverse backgrounds and goals.

AI also plays a critical role in promoting inclusivity in curriculum design (Bhimdiwala *et al.*, 2022). By analyzing student performance and demographic data, AI can identify barriers to success and suggest targeted interventions, ensuring that all students receive the support they need to excel. This is especially important in CTE programs, where students may face varying levels of prior knowledge or unique challenges. An inclusive, AI-supported approach not only improves individual outcomes but also ensures that these programs remain accessible to a wide range of learners.

In addition to curriculum design, AI can enhance marketing and enrollment strategies for CTE programs. By using predictive analytics and segmentation, institutions can more effectively identify and reach prospective students. Targeted, personalized outreach campaigns can boost

enrollment and attract adult learners seeking flexible, career-relevant education. These strategies support higher education's mission to expand access and adapt to the needs of a rapidly changing workforce.

However, the integration of AI in education must be thoughtful and ethical. Issues such as data privacy (Yang & Beil, 2024), algorithmic bias, and overreliance on technology must be carefully managed. Institutions must prioritize fairness, transparency, and student-centered practices to ensure that AI is used responsibly. This study examines these ethical challenges (Akgun & Greenhow, 2022) and proposes strategies for mitigating risks while maximizing the benefits of AI integration.

In summary, the closure of CSULB's Professional Studies Department serves as a reminder of the consequences of failing to adapt to the evolving needs of adult learners and workforce trends. CSUSB's use of AI in its CTE programs demonstrates a proactive strategy to address these challenges, creating responsive, data-driven curricula that meet the demands of the modern job market. Through ethical and inclusive practices, CSUSB can establish itself as a leader in CTE education within the CSU system and beyond, providing a model for other institutions to follow. This study highlights the transformative potential of AI in ensuring the relevance, accessibility, and effectiveness of higher education for the future.

Methodological approach

This article employs a conceptual and secondary data-based design. Rather than reporting primary empirical findings, it synthesizes (1) published research on AI in education, adult learning, and CTE; (2) publicly available CSU system documents and policy announcements; and (3) the author's institutional experience with the closure of the Professional Studies Department at CSULB and the development of fully online CTE programs at CSUSB. These sources are treated as secondary data that inform a case-informed conceptual framework for AI-enabled CTE in the CSU context. Any numerical illustrations or projections in the text are presented as hypothetical, explanatory scenarios rather than as the outcomes of a formal statistical study.

Theoretical framework

This research is grounded in several key theoretical perspectives that explore the intersection of adult education, technology, and curriculum design. The concept of andragogy (Knowles *et al.*, 2020; Purwati *et al.*, 2021) serves as a foundational framework, emphasizing the unique needs of adult learners, who often juggle multiple roles in their personal and professional lives. As adult learners seek education that is relevant, flexible, and directly aligned with

their career goals, this theoretical lens advocates for learning experiences that are self-directed, problem-based, and tailored to real-world applications—qualities that AI can help facilitate in modern curricula.

In addition, the technology acceptance model (Davis, 1989) informs the exploration of how AI tools and applications can be integrated into higher education. This model posits that perceived ease of use and perceived usefulness are critical factors in the adoption of new technologies. In the context of CTE, AI's role in personalized learning, predictive analytics, and adaptive assessments can enhance student engagement and success, provided it is perceived as valuable and accessible to learners.

Furthermore, constructivist learning theory (Piaget, 2005; Vygotsky, 1978) underpins the idea that learning is an active process in which learners build upon prior knowledge. AI's potential to provide adaptive learning experiences that personalize content and assessments aligns with this view by supporting students in constructing knowledge at their own pace and level of understanding. This framework supports the integration of AI to address the varying needs of adult learners in CTE programs, ensuring that the content is relevant, personalized, and impactful.

Finally, the principles of universal design for learning (UDL; CAST, 2018) are relevant for ensuring inclusivity in AI-driven curriculum design. UDL emphasizes the importance of providing multiple means of engagement, representation, and expression to accommodate diverse learners. AI tools can analyze student data to identify barriers and provide tailored interventions, ensuring that all students, regardless of their background or experience, have equitable opportunities for success.

Taken together, these theoretical perspectives frame AI not as a neutral technical add-on but as a set of tools that must be aligned with adult learners' autonomy (andragogy), technology adoption dynamics (technology acceptance model), active knowledge construction (constructivism), and inclusive design (UDL). The following sections draw explicitly on this framework by linking specific AI-enabled practices in CTE—such as adaptive assessments, predictive enrollment models, and AI-supported advising—to the corresponding theoretical principles.

Together, these theoretical perspectives provide a comprehensive lens through which to explore the integration of AI into CTE program development at CSUSB. By aligning the curriculum with these principles, this study seeks to promote a more responsive, inclusive, and effective educational experience for adult learners while addressing the

evolving demands of the workforce.

AI IN CURRICULUM DESIGN: OPPORTUNITIES AND APPLICATIONS

Data-driven curriculum alignment

AI is transforming how higher education aligns its curricula with labor market demands. By analyzing labor market trends, AI systems can identify high-demand skills and competencies with precision and efficiency. Machine learning algorithms can process vast datasets from industry reports, job postings, and government statistics to uncover patterns and predict emerging skill requirements. This capability allows CTE programs to stay ahead of industry changes, ensuring their offerings remain relevant and attractive to prospective students (Wang & Torrisi-Steele, 2024).

One of the key benefits of using AI for curriculum alignment is its ability to highlight skills that are growing in demand but are underrepresented in existing programs. For instance, if data indicate a surge in demand for expertise in sustainable energy technology, AI can recommend incorporating modules or certifications related to this field into the curriculum. By proactively adapting to such trends, institutions not only enhance their appeal to students but also play a crucial role in addressing workforce shortages in critical areas.

In addition to identifying emerging skills, AI enables dynamic curriculum updates. Traditional curriculum development often lags behind industry needs due to lengthy review and approval processes. AI-powered analytics can shorten this timeline by providing real-time insights into labor market fluctuations. As a result, CTE programs can make timely adjustments, such as introducing new courses or revising existing ones, to better align with the latest workforce demands. This adaptability is particularly critical in fast-evolving industries, such as technology, healthcare, and renewable energy.

AI also facilitates the integration of interdisciplinary skills into CTE programs. Today's job market increasingly values soft skills, such as critical thinking, communication, and adaptability, alongside technical expertise. AI can analyze employer preferences and suggest ways to embed these competencies into technical curricula, creating well-rounded graduates. For instance, a program focused on information technology might incorporate modules on teamwork and project management, ensuring that students are prepared for the collaborative nature of modern workplaces.

Moreover, AI supports personalized learning pathways that

align with industry needs. By analyzing individual learner data, AI can recommend courses or certifications that match a student's career goals while meeting labor market requirements. This level of customization not only enhances student engagement and success but also improves the employability of graduates, benefiting both learners and the broader economy. Personalized pathways also empower students to specialize in niche areas, giving them a competitive edge in the job market.

Ultimately, the integration of AI into curriculum design (Lin, 2024) ensures that CTE programs are not only reactive but also proactive in addressing workforce demands, while remaining consistent with andragogical and constructivist commitments to relevant, problem-centered, and experience-based learning for adults. By leveraging AI-driven insights, institutions can position themselves as leaders in higher education, producing graduates who are highly skilled and adaptable to the changing landscape of work. This data-driven approach underscores the importance of innovation in meeting the dual objectives of student success and economic development.

Personalized learning pathways

Generative AI tools, such as ChatGPT, are revolutionizing how personalized learning pathways are designed and implemented in higher education. These tools can create tailored course materials that address the unique needs of diverse learners, ranging from those requiring foundational support to advanced learners seeking enrichment. By generating customized assignments, study guides, and feedback, AI empowers faculty to provide individualized instruction at scale. This adaptability is particularly valuable in CTE programs, where students often have varying levels of prior experience and distinct career goals.

AI-powered learning analytics further enhance the personalization of education by identifying students' strengths and areas for improvement. These analytics enable faculty to design instructional strategies that cater to individual learning trajectories. For instance, a student excelling in practical applications but struggling with theoretical concepts could be offered additional resources, such as interactive simulations or simplified readings. By addressing specific gaps, AI fosters a more equitable learning environment, ensuring that all students have the opportunity to succeed.

Adaptive learning platforms represent a significant innovation in delivering personalized learning experiences. These platforms use AI to dynamically adjust the complexity and pacing of course content based on real-time student performance. For example, a student demonstrating

mastery of introductory concepts in a programming course might be presented with advanced coding challenges, while another student who is struggling might receive additional tutorials and practice exercises. This level of customization keeps learners engaged and motivated, preventing both boredom and frustration (Wang *et al.*, 2022).

Generative AI also supports faculty in creating alternative instructional pathways that align with diverse learning preferences. Visual learners, for instance, might benefit from AI-generated diagrams and infographics, while auditory learners could access AI-narrated podcasts or lectures. Similarly, AI can design interactive quizzes and gamified content for students who thrive in hands-on, experiential learning environments. By leveraging these tools, educators can simultaneously cater to multiple learning styles (Ezzaim *et al.*, 2025), thereby improving overall outcomes and satisfaction.

Another advantage of personalized learning pathways is their alignment with career objectives. AI can analyze students' interests, strengths, and career aspirations to recommend elective courses, certifications, or internships that align with their professional goals. For instance, a CTE student pursuing a career in renewable energy might receive personalized recommendations for courses in sustainable design or advanced solar technology. This targeted guidance not only enhances the educational experience but also improves employability by ensuring that students graduate with skills that are directly relevant to their chosen fields.

From an andragogical and UDL perspective, these AI-mediated pathways are valuable precisely because they allow adult learners to exercise greater control over pace, modality, and focus while providing multiple means of engagement, representation, and expression.

Ultimately, personalized learning pathways powered by generative AI ensure that no two educational journeys are the same. By combining data-driven insights with flexible instructional design, AI allows educators to tailor instruction to students' current competencies and needs and guide them toward their full potential. This approach not only supports academic success but also prepares students to excel in dynamic and competitive job markets, fulfilling the dual mission of education to serve both individual learners and society at large.

Prior research on AI-powered adaptive learning systems in higher and adult education has consistently reported improvements in course completion and student satisfaction, particularly in online and hybrid formats (Chiu & Chai, 2020; Zhai *et al.*, 2021). These findings support the

conceptual claim advanced in this paper: When thoughtfully implemented, AI-enabled personalization can enhance persistence, perceived relevance, and learning outcomes for diverse CTE learners.

Efficient program development

AI tools are revolutionizing the process of curriculum development by streamlining time-consuming and repetitive tasks. For example, AI-powered platforms can automate syllabus creation by generating course outlines based on predefined learning objectives and accreditation requirements. Similarly, resource curation becomes more efficient as AI tools quickly sift through vast databases of academic materials, identifying the most relevant articles, case studies, and multimedia resources for inclusion in a course. By offloading these tasks to AI, faculty members gain valuable time to focus on pedagogical innovation and strategies to enhance student engagement.

One of the most impactful applications of AI in program development is the design of assessments. AI tools can generate customized quizzes, tests, and assignments that align with course objectives and target specific competencies. For instance, AI can create a variety of question types, such as multiple-choice, essay, or scenario-based tasks, tailored to different levels of Bloom's Taxonomy. This automation not only saves time but also ensures assessments are diverse and comprehensive, effectively measuring student learning outcomes.

AI also facilitates iterative curriculum refinement by analyzing student performance data to identify areas in which a program may need improvement. For example, if data reveal that students consistently struggle with a particular module, AI can suggest revising the content or incorporating supplementary materials. Similarly, AI can highlight which teaching methods yield the best results, guiding faculty in adopting evidence-based practices. This feedback loop ensures that programs remain dynamic and responsive to student needs and learning outcomes.

Another advantage of AI in program development is its ability to simulate real-world scenarios and challenges within curricula. In fields such as CTE, AI-powered simulations can provide students with hands-on experience in a controlled, virtual environment. For example, a program in healthcare technology could include AI-driven simulations of diagnostic procedures or patient interactions. These immersive experiences not only enhance learning but also prepare students for practical, on-the-job challenges (Dimitriadou & Lanitis, 2023), making them more competitive in the workforce.

Finally, AI supports the scalability of program development (Wang, 2018), enabling institutions to expand their offerings without compromising quality. By automating core aspects of curriculum design and assessment, universities can quickly develop new programs in response to emerging industry needs or student interests. This scalability is particularly valuable in online education, where the demand for flexible, high-quality programs continues to grow. By leveraging AI, institutions can ensure that their programs remain relevant, efficient, and capable of meeting the diverse needs of learners and employers.

SAFEGUARDING THE FUTURE OF CTE AT CSUSB

The challenge

CTE programs at CSUSB face a distinct set of challenges in an increasingly competitive and dynamic educational landscape. One of the primary hurdles is maintaining enrollment in fully online programs, which require innovative strategies to attract and retain adult learners (Edwards-Fapohunda & Adediji, 2024). Unlike traditional students, adult learners often juggle multiple responsibilities, including work and family obligations, making their educational needs more complex. Addressing these needs effectively is critical to ensuring the continued success and growth of CTE programs at CSUSB.

Program distinctiveness is another significant challenge. In a crowded market of online education providers, standing out requires a compelling value proposition. CSUSB's CTE programs aim to balance academic rigor with practical applications, but this unique scholar-practitioner approach must be effectively communicated to prospective students. Without clear differentiation, the programs risk being overshadowed by competitors, particularly those with larger marketing budgets or established reputations in online education.

The shift to fully online delivery amplifies these challenges, demanding innovative approaches to both curriculum design and student engagement. Online courses must compete not only on content quality but also on user experience, accessibility, and technological integration. Ensuring that online learners feel connected to the institution and supported throughout their educational journey is paramount, especially in programs such as CTE, where hands-on skills and real-world applications are central to the learning experience.

The solution

Integrating AI offers scalable and innovative solutions to address these challenges. AI has the potential to transform

how CTE programs at CSUSB operate from enrollment management (Akgun & Greenhow, 2022) to marketing and student support. By leveraging AI-driven tools and analytics, the university can enhance its ability to attract, engage, and retain adult learners while reinforcing the distinctiveness of its CTE offerings.

Predictive enrollment models

AI-powered predictive analytics can play a critical role in addressing enrollment challenges (Wang, 2025a). By analyzing historical enrollment data, demographic trends, and external factors, such as economic conditions, AI can forecast potential drops in enrollment and identify underlying causes. These insights enable proactive interventions, such as targeted outreach to at-risk students or the development of new course offerings to meet emerging demands. Predictive models can also help allocate resources more effectively, ensuring that faculty and support staff are prepared to meet the needs of incoming cohorts.

Marketing optimization

AI-driven marketing tools provide a powerful way to enhance the visibility and appeal of CSUSB's CTE programs. These tools can analyze data on prospective students, such as their online behavior, preferences, and demographics, to create personalized marketing campaigns. For example, AI can segment audiences based on career aspirations or educational backgrounds, tailoring messages to highlight how the scholar-practitioner model aligns with their goals. Personalized outreach not only increases the likelihood of attracting students but also builds a stronger connection between the institution and its prospective learners.

Enhancing program distinctiveness

AI can also help articulate and amplify the unique value of CSUSB's CTE programs. For instance, natural language processing tools can analyze competitor messaging and identify gaps or opportunities for differentiation. This information can be used to refine the program's branding and communication strategy, ensuring that prospective students understand the practical and scholarly advantages of enrolling at CSUSB. In addition, AI-generated testimonials or success stories from alumni can be used in marketing materials to build credibility and emotional resonance.

Supporting adult learners

The integration of AI into student support services addresses the unique challenges faced by adult learners (Lewis & Bryan, 2021). AI chatbots and virtual assistants can provide 24/7 support, answering questions about enrollment, financial aid, or course requirements in real

time. These tools can also send reminders about deadlines or recommend resources tailored to individual students, helping them stay on track despite their busy schedules. By offering personalized and accessible support, CSUSB can create a more welcoming and responsive online learning environment.

Improving online engagement

AI-powered tools can enhance the online learning experience by making it more interactive and engaging. For example, AI can personalize course content based on a student's learning preferences or performance, ensuring that materials are both challenging and relevant. In addition, AI-driven platforms can facilitate virtual simulations or group projects by replicating the collaborative and hands-on aspects of traditional CTE programs in an online setting. These innovations not only improve learning outcomes but also foster a sense of community among online learners.

The future of CTE at CSUSB

Integrating AI into CTE programs represents more than just a technological upgrade (Wang, 2025b); it is a strategic approach to reimagining the future of education at CSUSB. By addressing enrollment challenges, optimizing marketing efforts, and enhancing student support, AI provides the tools needed to thrive in an increasingly competitive market. Most importantly, it enables CSUSB to fulfill its mission of delivering high-quality, accessible education that meets the evolving needs of adult learners and the workforce.

AVOIDING THE CSULB SCENARIO

The closure of CSULB's Professional Studies department in 2009 serves as a stark reminder of the consequences institutions face when they fail to adapt to evolving student demographics and market demands. Despite serving nearly 2000 adult learners each semester and offering valuable programs, the department faced challenges in maintaining relevance in an era where flexibility and responsiveness to student needs were paramount. However, the decision to close the department was influenced by internal political power struggles, which further hindered efforts to innovate and align the department's offerings with the needs of working professionals and emerging industries. This institutional failure highlights the critical importance of proactive innovation in higher education.

The comparison developed in this section draws on the author's experience in CSULB's Professional Studies Unit and on publicly available accounts of the department's closure. It is presented as a case-informed narrative to motivate the conceptual framework rather than as a comprehensive empirical case study.

In contrast, CSUSB has taken a forward-thinking approach by positioning its fully online CTE programs as a response to these challenges. Recognizing the diverse needs of adult learners, CSUSB's online format offers unparalleled flexibility, catering to working professionals who balance career advancement with family and other responsibilities. This approach underscores CSUSB's commitment to accessibility, lifelong learning (Lyndgaard *et al.*, 2024), and responsiveness to the evolving demands of the workforce.

Another critical factor that distinguishes CSUSB's CTE programs is its scholar-practitioner faculty model. Unlike county offices of education, which often emphasize practical training without a robust academic foundation, CSUSB integrates both theory and practice. Faculty members bring a wealth of experience from their respective industries alongside advanced academic credentials. This dual expertise ensures that students receive education grounded in real-world application while benefiting from the critical analysis and research-driven insights characteristic of university-level instruction.

What further sets CSUSB apart is its use of AI to enhance program competitiveness. By leveraging AI tools, the university ensures that its CTE programs remain innovative and responsive to market demands. AI-powered tools, such as predictive analytics for enrollment trends and adaptive learning platforms, enable CSUSB to offer a cutting-edge educational experience. These technologies not only attract students but also improve retention and learning outcomes, solidifying the university's position as a leader in the rapidly evolving CTE domain.

Ultimately, CSUSB's fully online CTE programs exemplify a model of modern higher education that prioritizes adaptability, quality, and innovation. By learning from the challenges faced by institutions such as CSULB, CSUSB has crafted a value proposition that addresses the needs of adult learners while maintaining academic excellence. The integration of flexibility, scholar-practitioner leadership, and AI-driven enhancements ensures that CSUSB's CTE programs remain competitive and relevant in an ever-changing educational landscape.

STRATEGIC MARKETING OF AI-ENHANCED CTE PROGRAMS

The nine-unit CTE credential programs at CSUSB serve as key feeders into the university's bachelor's and master's degree programs, offering foundational, industry-relevant knowledge aligned with California Commission on Teacher Credentialing (CTC) standards. These programs provide students with the credentials needed to teach in specialized

fields, creating a strong pipeline for further academic and career advancement. CSUSB's emphasis on CTC alignment gives its programs a competitive edge, ensuring that graduates are well prepared for teaching roles in high-demand industries. In addition, the university's faculty, with a unique combination of academic expertise and practical experience, adds value to the program's reputation. AI-driven outreach initiatives, such as targeted marketing campaigns and virtual events, can further enhance engagement by reaching potential students—especially working professionals—through personalized communication, showcasing the program's benefits and the faculty's expertise. One of the defining strengths of the CTE programs at CSUSB is its faculty, which comprises both scholars and practitioners in their respective fields. This scholar-practitioner model ensures that students receive a balanced education, blending theoretical knowledge with practical, real-world experience. Faculty members not only hold advanced academic degrees but also have substantial experience working in industry or teaching in professional environments, which makes them uniquely equipped to prepare students for the challenges and opportunities they will encounter in their careers. Highlighting the expertise of these instructors is a powerful way to showcase the value and credibility of CTE programs, positioning the university as a leader in high-quality, industry-relevant education.

By positioning faculty expertise as a key selling point, CSUSB can differentiate its CTE programs from competitors that may rely on instructors with more limited practical experience. The emphasis on faculty members who are actively engaged in their fields, whether through consulting, research, or ongoing industry involvement, enhances the credibility of the curriculum and ensures that students benefit from the latest trends and practices in their areas of study. This dynamic approach to instruction not only enriches the student learning experience but also prepares graduates to enter the workforce with cutting-edge knowledge and skills that are in high demand. Showcasing this dual expertise in marketing materials, presentations, and outreach campaigns underscores the unique value proposition of CSUSB's CTE programs.

Moreover, faculty involvement in industry projects, community engagement, and professional development initiatives strengthens the university's reputation within both academic and professional networks. It provides students with opportunities for mentorship, networking, and career advancement, which are often unavailable in programs led by instructors who are disconnected from current industry practices. Faculty expertise thus becomes a critical factor in ensuring the long-term success of CSUSB's CTE programs. By continuously highlighting the scholarly and professional

accomplishments of its faculty, CSUSB can reinforce the competitive edge of its programs and attract students who are seeking transformative educational experiences that blend academic excellence with real-world applicability.

While specific enrollment effects depend on local conditions and are beyond the scope of this conceptual analysis, institutions that clearly differentiate their CTE programs and use data-informed outreach often report measurable gains in adult-learner enrollment. In the CSUSB CTE context, the framework outlined in this article is intended to guide such efforts rather than to predict a particular percentage increase.

Finally, using AI to monitor and adjust outreach campaigns in real time can optimize marketing efforts, ensuring that messages resonate with prospective students and drive enrollment. AI can track which types of content or events generate the most interest and conversions, allowing CSUSB to continually refine its approach. By strategically using AI to enhance its outreach, the university can effectively target a wider audience and attract a diverse pool of students who will benefit from the nine-unit CTE programs and go on to pursue further degrees in the CTE field. This combination of program quality, faculty expertise, and innovative outreach strategies will ensure that CSUSB's CTE programs continue to grow and remain competitive in the evolving higher education landscape.

ADDITIONAL DISCUSSION: CSU'S AI INVESTMENT AND GLOBAL BEST PRACTICES

Building on the conceptual framework developed above, this section situates CSUSB's CTE programs within the CSU system's AI initiative and selected international examples to clarify how AI-enabled CTE can be scaled and aligned with broader economic and policy priorities.

In February 2025, the CSU system announced a \$16.9 million systemwide initiative to provide ChatGPT Edu access across its 23 campuses (DiPierro, 2025). This initiative, aimed at building faculty capacity and supporting AI-based innovations in pedagogy, represents a transformative opportunity for CTE programs. By empowering faculty with AI tools and professional development, CSU is positioning itself as a national leader in higher education innovation.

For CTE specifically, this funding offers unprecedented potential. AI-driven tools can help institutions create more agile, data-informed curricula that respond to labor market changes in real time. Faculty in CTE fields—often

balancing applied industry knowledge with pedagogical expertise—can benefit greatly from AI-enabled analytics, personalized content delivery, and predictive student support systems. With targeted investment from the CSU system, these programs can more effectively prepare students for success in the workforce while enhancing retention and equity.

Beyond the CSU system, California and the United States at large must take cues from China's strategic leadership in CTE, particularly in advanced manufacturing. China's CTE system is widely regarded as the largest in the world and substantially larger in scale than that of the United States. This vast ecosystem, supported by substantial government policy and industry integration, offers a scalable model for aligning technical education with economic competitiveness.

To remain globally competitive, CSU's CTE programs must move beyond fragmented credentialing and embrace a holistic, workforce-aligned approach modeled after China's integration of CTE with national priorities, such as smart manufacturing, AI, and green technology. Doing so would not only elevate CSU's institutional relevance but also ensure that its graduates remain at the forefront of innovation.

The CSU system's AI investment should be strategically deployed to support this ambition—encouraging partnerships with industry, streamlining pathways from training to employment, and creating curricula that incorporate global best practices. This alignment will allow CSU to emerge as a beacon of next-generation CTE innovation in the United States.

ETHICAL CONSIDERATIONS IN AI INTEGRATION

Although AI offers immense potential to enhance educational practices, its integration into higher education, particularly in CTE programs, must be approached with a strong focus on ethical considerations. One of the primary ethical concerns is bias in algorithms (Laupichler *et al.*, 2022). AI systems are only as effective as the data on which they are trained, and if the data sources used to train these algorithms are incomplete or unrepresentative, there is a risk of perpetuating biases. For instance, if AI models rely on historical data that reflect societal biases or exclude certain groups, the outcomes they produce can marginalize underrepresented or disadvantaged student populations. To ensure fairness and inclusivity, it is crucial to employ diverse and representative data sources when developing AI algorithms, actively working to eliminate biases that could dispropor-

tionately affect specific groups. By carefully curating data and constantly auditing AI systems for bias, institutions can mitigate these risks and promote equity (Ainscow, 2020) within AI-driven educational models.

Data privacy is another major concern when integrating AI into educational settings. AI tools often require access to vast amounts of personal data to analyze and tailor learning experiences. However, these data must be handled with the utmost care to safeguard student privacy. In higher education, students' academic and personal information is sensitive, and breaches of these data can have severe consequences. To address this, institutions must implement robust cybersecurity measures to protect student data. These measures can include encrypted communication, secure cloud storage solutions, and regular audits of data protection protocols. In addition, ensuring transparency with students about how their data are being used and giving them control over their information can build trust and reinforce ethical standards in AI applications. By prioritizing data privacy, educational institutions can create a safe environment for students while reaping the benefits of AI-enhanced learning tools.

Finally, equity in access is a critical issue when implementing AI technologies in education. The digital divide remains a significant barrier for many students, particularly those from low-income backgrounds or rural areas. If AI tools are not accessible to all students, the benefits of AI-driven innovations could exacerbate existing inequities in education. Institutions need to bridge these digital divides by ensuring that students have equal access to the necessary technology, such as high-speed internet, devices, and AI-supported platforms. This can be achieved through initiatives such as providing students with loaner devices, offering subsidized internet services, or developing AI solutions that are compatible with a wider range of technological infrastructures. By addressing the digital divide and ensuring that AI tools are accessible to all, institutions can ensure that every student benefits from the transformative potential of AI, thus promoting fairness and equity in educational outcomes (Office of Educational Technology, 2023).

In the CSUSB CTE context, these ethical principles translate into several concrete design guidelines. First, predictive models used for enrollment management or student risk identification should be regularly audited for disparate impacts, and their role in high-stakes decision-making—such as program dismissal or access to limited seats—should be tightly constrained. Second, any AI-supported advising or tutoring tools deployed in CTE courses should be opt-in, transparent about their limitations, and complemented by human advising so that adult learners

remain informed decision-makers rather than passive data points. Third, CSUSB could establish a faculty–student advisory group for AI in CTE to review new use cases, recommend safeguards, and communicate expectations about responsible AI use to both instructors and students. Together, these measures move the ethical discussion from general principles to institution-specific implementation strategies.

Reflections

Taken together, the preceding sections develop a conceptual framework for integrating AI into CSU-based CTE programs grounded in adult learning theory, technology acceptance, constructivism, and UDL. Rather than treating AI as an isolated technical upgrade, this article positions it as a set of sociotechnical practices that can either reinforce or disrupt existing inequities, depending on how it is implemented. For CSUSB, the framework highlights the importance of aligning AI-enabled curriculum design with the specific needs of working adult learners in fully online CTE programs, the regulatory requirements of the CTC, and the labor market dynamics of Inland Southern California and beyond.

For institutional decision-makers, several implications follow. First, AI investments should be tied explicitly to program-level outcomes—such as improved progression, reduced time-to-credential, or stronger alignment with regional workforce needs—rather than to generic innovation rhetoric. Second, faculty capacity building is critical: CTE scholar-practitioners need structured support and professional development to integrate AI tools into course and program design in ways that remain consistent with andragogy and UDL. Third, system-level initiatives, such as the CSU AI investment, should include dedicated resources for high-impact CTE fields that serve large numbers of adult and non-traditional learners so that these programs do not fall behind more visible disciplines.

This analysis has several limitations. It focuses on a single-state system and draws primarily on secondary data, institutional documents, and the author's professional experience rather than on new empirical data collection. Future research could build on this framework by conducting multi-campus studies of AI-enabled CTE implementation, evaluating specific AI tools in online CTE courses, and examining student and faculty perceptions of AI-supported advising and instruction. Despite these limitations, this article offers a structured, theory-informed foundation for ongoing experimentation and evaluation in AI-enhanced CTE at CSUSB and across the CSU system.

CONCLUSION

The dissolution of CSULB's Professional Studies

Department in 2009 serves as a stark reminder of the challenges institutions face when they fail to adapt to shifting educational landscapes and market demands. This decision, driven by the university's inability to keep pace with evolving student demographics and workforce needs, underscores the critical importance of staying ahead of trends in higher education, particularly when serving adult learners and addressing industry requirements (Zhai *et al.*, 2021). CSULB's institutional failure to innovate and respond to changes in the job market resulted in the loss of valuable programs for working professionals seeking flexibility, credentials, and career advancement. This cautionary tale highlights the necessity for institutions such as CSUSB to proactively embrace new technologies and strategies to prevent similar setbacks and ensure long-term success.

In contrast, CSUSB's fully online CTE programs, enhanced by AI-driven curriculum design, embody a forward-thinking approach to education. These programs cater to the increasing demand for flexible, accessible learning opportunities for working professionals, particularly those pursuing career advancement or transitioning into teaching roles. AI plays a key role in maintaining the relevance and responsiveness of CSUSB's CTE programs by providing data-driven insights into industry trends, identifying emerging skills, and enabling personalized learning pathways for students. This ensures that the curriculum remains dynamic, up-to-date, and aligned with real-time labor market demands. As a result, CSUSB is not only enhancing student engagement and enrollment but also positioning its CTE programs as vital contributors to workforce readiness and professional development.

Furthermore, CSUSB's emphasis on the scholar-practitioner model—in which faculty bring both academic expertise and industry experience—strengthens the quality of its CTE programs. This model allows students to learn from instructors who possess real-world knowledge, thereby bridging the gap between theory and practice. By aligning this model with AI-driven curriculum innovation, CSUSB ensures that its programs are both academically rigorous and highly relevant to the evolving needs of the workforce. AI enables faculty to personalize course content and adapt teaching methods to suit diverse learning styles, ensuring an education tailored to the professional goals of adult learners (Storey & Wagner, 2024; Wang, 2025c). This blend of AI and scholarly expertise positions CSUSB as a leader in the CTE space within the CSU system and beyond. By prioritizing these innovative strategies, CSUSB has established itself as an institution that leads the way in the future of CTE education, ensuring that its programs remain responsive to both educational and workforce needs.

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The author declares no conflicts of interest.

Generative AI use declaration

During the preparation of this work, the author used ChatGPT (OpenAI) to assist with language polishing and drafting support; after using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

Data availability statement

All data supporting the findings of this study are included in this paper, and no additional data are available.

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