AI and CTE: A Literature Review of Current Professional Development Needs

Jeremy Jeffery, Ph.D.
Associate Professor
Commonwealth University of Pennsylvania
jjeffery@commonwealthu.edu

Abstract
Artificial intelligence, especially generative AI, is changing both education and the careers for which CTE prepares students, making professional development a challenge for CTE teachers. Now, teachers not only have to figure out how to use AI in the classroom but also need to prepare students for jobs where AI is part of daily work. Recent literature shows that CTE teachers need more than just basic training in AI tools, they also need skills in AI literacy, effective use in teaching, assessment, ethics, data privacy, fact-checking, and tailoring AI to their particular industry. Since many CTE teachers have industry experience rather than formal teaching training, professional development should tap into their existing skills while also giving them useful teaching strategies. The literature suggests a strong need for hands-on, ongoing training that's practical, encourages teamwork, and is customized to each career field, always keeping real industry needs in mind. Still, there is a shortage of studies focused specifically on the AI training needs of secondary CTE teachers, so more research is needed to understand where the biggest gaps are and what kinds of support work best.

Introduction

Artificial intelligence (AI) has increasingly moved from a specialized technology to a common part of education in the workplace. Generative AI applications can create text, images, code, simulations, learning resources, and even data analyses simply by responding to prompts written in everyday language (Santos et al., 2023). Additionally, AI technologies are changing occupational tasks in fields ranging from business and information technology to manufacturing, health care, agriculture, transportation, and skilled trades. As such, career and technical education occupy an especially important position in discussions about AI and education (Sun & Pratt, 2024).

Career and technical education (CTE) bridges the gap between classroom education and hands-on job skills. CTE teachers have a unique role, not only do they teach, but they also bring industry experience into the school. Their job requires them to stay current with new technologies, certifications, equipment, job standards, and what employers expect in the workplace (Stone & Lewis, 2012). With AI now reshaping many industries, these teachers must keep up with how artificial intelligence can be used in their own teaching and how it is changing the careers their students will pursue. Sun and Pratt (2024) observed that CTE has received substantially less attention in the AI-in-education literature than traditional K-12 and higher education settings. This shift matters because CTE's practical, hands-on nature and its ability to meet business and industry needs mean generic AI training may not meet CTE teachers' distinct needs. As AI tools become more common in the workplace, it is important to examine the specific skills and knowledge CTE educators need to help students succeed in these changing fields (Baidoo-Anu & Owusu Ansah, 2023; Sun & Pratt, 2024).

The purpose of this literature review is to synthesize recent literature concerning the professional development needs of CTE teachers as AI becomes increasingly incorporated into education and

the workplace. This review brings together recent research on what career and technical education (CTE) teachers need to keep abreast of the abundance of AI as AI becomes an integral part of both teaching and the workplace. The review further explores several key areas, including the basics of AI, how to use and assess AI tools in the classroom, ways to design lessons and assessments with AI in mind, ethical considerations, job-specific AI skills, the importance of strong human skills for students, and how professional development for teachers should be organized and delivered.

Conceptual Framework

The conceptual framework for understanding the professional development needs of career and technical education (CTE) teachers in an artificial intelligence (AI)-influenced learning setting is grounded in the relationship among teacher AI competency, pedagogical application, and occupational expertise. CTE teachers create a distinctive position because they must simultaneously prepare students to use emerging technologies and ensure that instruction continues aligned with changing workplace expectations. The literature suggests that effective AI competency exceeds familiarity with individual generative AI applications and includes a wider array of technical knowledge, ethical awareness, pedagogical judgment, and analytical assessment. UNESCO's *AI Competency Framework for Teachers* provides an appropriate foundation for conceptualizing these competencies through five interconnected dimensions: 1. a human-centered mindset, 2. ethics of AI, 3. AI foundations and applications, and 4. AI pedagogy, and AI for professional learning (Miao & Cukurova, 2024).

These dimensions are essential to CTE because educators must determine not only how AI can support teaching and learning as well as how AI is transforming occupational practices. Sun and Pratt (2024) emphasize that AI integration within CTE should be understood in relation to the field's applied instructional practices and strong connections with industry. Accordingly, the framework conceptualizes CTE teacher AI competency as developing through the interaction of foundational AI literacy, responsible and ethical use, instructional application, critical evaluation of AI-produced information, and knowledge of industry-specific applications. By implementing this method, the literature reviewed in this study, which identifies foundational AI literacy, prompting, instructional design, assessment, ethics and privacy, and occupationally relevant AI skills as important professional development needs for CTE educators (Sun & Pratt, 2024).

Artificial Intelligence and the influence on CTE education

CTE teachers have always helped students link what they learn in class to the skills they will need on the job. Now, with AI becoming a regular part of fields like data analysis, customer service, design, manufacturing, logistics, programming, marketing, health care, and financial services, keeping that connection up to date is more challenging (Organisation for Economic Co-operation and Development, 2025a). As AI keeps changing the way people work, schools need to think carefully about what students should know and be able to do to be ready for the jobs of tomorrow (Organisation for Economic Co-operation and Development [OECD], 2025a).

The implications spread beyond teaching students how to operate AI applications. CTE teachers must determine when AI enhances occupational performance, when human decision processes are still necessary, how AI-generated information should be evaluated, and how workers can cooperate effectively with intelligent systems. The *Center for Public Education* (2025) states that

CTE programs should simultaneously develop AI-related capabilities and durable skills such as communication, critical thinking, problem solving, and adaptability.

Recent CTE literature similarly stresses the revolutionary implications of AI. Crevar et al. (2026) describe AI as capable of enhancing instruction, improving efficiency, supporting personalized learning, and providing data that teachers can use for focused interventions. However, the authors also emphasize challenges involving algorithm bias, privacy, moral decision-making, and preserving the human dimensions of education. Altogether, these changes will affect how AI is integrated into the classroom to prepare for skills to meet the 21st century.

Foundational AI Literacy

Before CTE teachers could effectively use AI in their classrooms, they need a solid grounding in the basics of artificial intelligence. Without this foundation, educators struggle to make thoughtful choices about how, when, and why to incorporate AI tools into instruction. Professional development should therefore emphasize building core AI literacy before moving on to more advanced or applied topics (Holmes et al., 2021).

UNESCO's *AI Competency Framework for Teachers* provides a pertinent framework for conceptualizing this need. Miao and Cukurova (2024) identify 15 competencies organized into five dimensions: a human-centered mindset, ethics of AI, AI foundations and applications, AI pedagogy, and AI for professional learning. The framework further organizes teacher development into three levels: Acquire, Deepen, and Create, showing that AI competency.

For CTE educators, foundational literacy should include an understanding of what generative AI can and cannot do, how machine-learning systems depend on data, why generative models may produce inaccurate information, and how algorithmic systems can reproduce biases found in their training data or design (Miao & Cukurova, 2024; Pan et al., 2021). Teachers should also understand the differences between predictive AI, generative AI, automation, and other technologies encountered in contemporary workplaces.

AI Output and Evaluation

Knowing how to work effectively with generative AI is now a key skill for teachers. They need hands-on practice creating prompts that give explicit context, outline the goals, set any limits, and guide the AI toward better outputs over time. This skill is especially important in career and technical education, where the accuracy and usefulness of AI's answers commonly rely on using the right industry terms and grasping the specific work environment (Kovanović et al., 2023).

CTE teachers can use carefully crafted prompts to create case studies, workplace scenarios, tailored explanations, project ideas, formative assessments, technical problem-solving tasks, or simulations. Still, generating content is just one part of using AI well; teachers also need to be able to critically evaluate the accuracy and usefulness of what AI produces (Zawacki-Richter et al., 2022).

Generative AI tools can produce information that sounds credible but may be wrong or misleading. In CTE classes, using inaccurate instructions can lead to financial losses, technical mistakes, legal problems, or safety risks (Luckin et al., 2016). Because of this, teachers need

training that encourages them to double-check AI-generated material and use their own judgment, rather than accepting it at face value.

AI-Supported Pedagogy and Instruction

Research shows that professional development should help teachers go beyond simply experimenting with AI tools and instead focus on using them with clear purpose in their instruction. Just knowing how to type a prompt into an AI program does not mean it will actually improve learning. Teachers need time and support to figure out when AI genuinely supports a lesson and when it might distract from or even hinder student understanding (Trust et al., 2022).

The OECD (2025b) argues that effective digital education requires adaptation of pedagogy rather than simply reproducing existing instructional practices with digital technologies. Professional learning should therefore help teachers connect technical resources to sound instructional decisions.

It can be noted that teachers need more than just basic exposure to AI tools; they need support in figuring out how to use AI intentionally in their teaching. Just because someone knows how to enter a prompt does not mean technology will help students learn. Professional development should give teachers time to explore when AI can genuinely support a lesson and when it might actually interfere with student understanding (Pan et al., 2021).

An emerging example is the *Center on Education and Training for Employment* at The Ohio State University, which has developed professional development specifically for career-technical educators. The workshops have allowed CTE teachers to identify gaps in their own AI knowledge, experiment with generative AI as an instructional advisor, look at student assessment data, and understand the importance of AI-supported instructional plans connected to industry-specific competencies (Center on Education and Training for Employment [CETE], 2026).

Assessment, Integrity, and Authentic Learning

Generative AI is arguably requiring teachers to rethink how they assess student learning. When students can use advanced AI tools to produce written work in seconds, take-home assignments are no longer a reliable way to measure what students know and understand. This shift means teachers urgently need professional development to design assessments that better represent authentic student learning (Baidoo-Anu & Owusu Ansah, 2023).

Professional development should help CTE teachers shift their assessments toward real-world tasks and hands-on demonstrations. This change makes sense for CTE, since many programs already rely on labs, projects, simulations, work experiences, and technical skill checks to measure student learning. Giving students opportunities to show what they can actually do—rather than just what they can write—offers a better picture of their readiness for the workforce (Wang et al., 2022).

Rather than attempting to eliminate AI from every assignment, educators may need to distinguish between tasks in which AI use is prohibited, tasks in which AI is permitted as a support, and tasks specifically designed to assess students' ability to use AI responsibly. Students might critique an AI-generated troubleshooting procedure, compare an AI recommendation relative to

industry benchmarks, improve an AI-generated business plan, or document how human decisions changed an AI-produced solution.

Ethics, Privacy, Bias, and Responsible AI

Understanding and using AI responsibly is central to being an effective teacher today. UNESCO highlights ethics as just as important as technical skills and instructional techniques when it comes to working with AI in the classroom (Miao & Cukurova, 2024). For CTE teachers, this means professional development should cover issues like privacy, intellectual property, bias, transparency, accessibility, misinformation, and making sure people, and not just machines, remain accountable.

Data privacy is especially important in today's classrooms. Teachers and students sometimes enter personal details, student records, or even confidential employer information into public AI tools without realizing the risks. Professional development should clearly explain school or district policies and help educators recognize what information should never be shared with outside AI platforms (Willis et al., 2023).

Bias is a serious concern in AI. These systems can reflect and even bolster stereotypes and inequalities that exist in the data they are trained in how they are built. CTE teachers should understand that algorithmic discrimination can influence decisions in areas like hiring, job evaluations, finance, health care, criminal justice, and marketing, all of which can have real impacts on people and communities (Mehrabi et al., 2021).

AI Competencies for Business and Industry

Perhaps the most important distinction between general teacher AI professional development and CTE-specific professional development is the need for occupational relevance. AI is not affecting every industry in identical ways. A business teacher, automotive instructor, health-science educator, welding instructor, agriculture teacher, and cybersecurity teacher may all need AI competency, but the applications relevant to their programs will differ considerably.

Sun and Pratt (2024) stress the importance of contextualizing AI adoption within CTE's distinctive pedagogical practices and industry relationships. Professional development should therefore include career-cluster-specific learning opportunities rather than relying exclusively on generalized workshops.

Changes to the National Career Clusters Framework highlight how important it is for students to understand AI. Advance CTE (2026) describes AI literacy as a useful skill in many careers and shows that AI use can vary widely from one industry to another. To keep programs relevant, educators should work closely with industry partners, advisory boards, employers, professional groups, credentialing bodies, and workforce agencies to learn which AI tools and practices are used on the job.

Transferrable Skills in an AI-Enhanced Workplace

As AI continues to increase its usage and its role in the workplace, some human abilities are becoming more valuable, not less. Skills such as clear communication, creative problem-solving, critical thinking, and adaptability continue to be harder for machines to replicate and set people

apart in the job market. According to the Center for Public Education (2025), these durable skills are a key part of career and technical education, especially while technology keeps changing how we work. Employers are looking for graduates who can not only use new tools but also work well with others, cope with unexpected challenges, and think on their feet. For CTE programs, this means putting just as much emphasis on teaching these basic skills as on technical know-how, so students are ready to succeed in an economy defined by AI.

CTE teachers need professional development that shows them how to use AI in the classroom without taking away chances for students to think for themselves. When AI handles every draft, calculation, or troubleshooting step, students miss out on building the real-world skills needed to judge when AI gets things wrong. Ongoing training should help teachers create lessons where AI supports but does not replace student thinking. Students should be encouraged to question AI's suggestions, justify their choices, weigh different options, and use their subject knowledge to make final decisions (Pan et al., 2021; Trust et al., 2022).

Structuring Ongoing Professional Development

The literature suggests that the format of AI professional development may be nearly as important as its content. One-time workshops are unlikely to be sufficient given the speed with which AI technologies and workplace practices are changing.

The OECD (2025b) describes teacher professional learning as ongoing, not a one-time event. Ongoing learning is regarded as essential for teachers to keep up with digital education. UNESCO also encourages this kind of steady growth, outlining stages from basic understanding to deeper knowledge and creative application, showing that real development takes time and repeated effort (Miao & Cukurova, 2024).

For CTE educators, effective AI professional development should be hands-on, contextualized within career fields, result in usable instructional products, provide time for collaboration and reflection, and be revisited regularly as AI technologies and industry expectations evolve.

Barriers to Professional Development and AI Adoption

Even well-designed professional development will not guarantee successful AI adoption if organizations ignore systemic barriers. Sun and Pratt (2024) identify infrastructure, equitable access to resources, and organizational culture as important considerations affecting AI permeation within CTE.

Opportunities to use AI in the classroom vary by school. While some teachers have access to paid platforms, up-to-date computer labs, and administrative support, others find that AI websites are blocked or that school policies are unclear about what is allowed. Time is another real challenge for CTE teachers, who are already overextended by the need to stay current in their field, maintain certifications, oversee labs and equipment, lead student organizations, connect with advisory committees, and manage work-based learning partnerships (Baidoo-Anu & Owusu Ansah, 2023; World Economic Forum, 2023; Trust et al., 2022).

Policy uncertainty can discourage experimentation. Teachers need clear guidance regarding acceptable student AI use, privacy, copyright, assessment, and approved platforms. Professional

development should therefore be accompanied by coherent institutional policies rather than placing responsibility entirely on individual teachers.

Implications for CTE Leaders and School Districts

The literature suggests that AI training should not be treated solely as an information-technology initiative. Because AI affects curriculum, instruction, assessment, ethics, and workforce preparation, professional development requires collaboration among CTE administrators, instructional leaders, technology personnel, industry advisory committees, and classroom teachers.

Before introducing any AI training, school districts should speak with teachers and find out what support they need. Not everyone has the same experience with these tools. It makes sense to start with the mechanics of AI: what AI is, how to write prompts, privacy issues, and how to recognize bias. Once teachers are comfortable with the foundation, the next level may examine the impact on lesson planning, assessment, adapting instruction for different learners, and using AI for job-specific tasks. To strengthen ongoing support, training could include cooperating with industry partners, updating courses, using AI to analyze data, or leading efforts to bring new technology into the school (Trust et al., 2022).

Professional development should also be connected to measurable effects. Evaluation should go beyond participant satisfaction and assess whether teachers show increased AI competency, adjust instructional practices, improve curriculum alignment, and better prepare students for AI-influenced workplaces.

Areas to consider for future research

Although research concerning AI in education is expanding rapidly, a substantial gap remains regarding the professional development needs of secondary CTE teachers specifically. Sun and Pratt (2024) note that CTE has frequently been overlooked in AI-in-education research.

Future research could examine national and state-level needs assessments measuring CTE teachers' current AI knowledge, confidence, use, and perceived professional development needs. Research should also compare needs across career clusters because the AI competencies required in health science may differ considerably from those required in business, manufacturing, information technology, agriculture, or transportation.

Researchers could also investigate whether professional development needs differ according to years of teaching experience, occupational experience, certification pathway, school setting, and prior technology experience. Future studies could consider specific professional development models, such as workshops, coaching, professional learning communities, industry externships, and even online modules.

Finally, research should examine whether teacher AI professional development affects student outcomes, including AI literacy, technical skill attainment, career readiness, critical thinking, industry credential performance, and students' ability to evaluate AI-generated information.

Conclusion

Artificial intelligence presents both a technological change and a workforce development challenge for career and technical education. CTE teachers occupy a distinctive position because they must use emerging technologies effectively as educators while also preparing students to enter industries being transformed by those technologies.

The literature indicates that professional development must go beyond introducing teachers to popular AI applications. CTE educators require foundational AI literacy, effective prompting skills, pedagogical strategies, assessment redesign, ethics and privacy awareness, critical evaluation skills, and knowledge of industry-specific AI applications. They must also understand how to develop durable human skills that continue to be essential when workers collaborate with increasingly capable AI systems.

Effective professional development should be continuous, practical, collaborative, differentiated, and closely connected to industry. The relative paucity of empirical research focused specifically on CTE teachers is still a major limitation. Large-scale needs assessments, career cluster comparisons, and evaluations of CTE-specific professional development programs would substantially strengthen the need for this type of professional development.

References

Advance CTE. (2026). *Responsive by design: Integrating artificial intelligence across the National Career Clusters Framework*. Advance CTE.

Baidoo-Anu, D., & Owusu Ansah, L. (2023). Education in the era of generative artificial intelligence: Challenges and opportunities. *Education and Information Technologies, 28*, 7245–7261. https://doi.org/10.1007/s10639-023-11956-6

Center for Public Education. (2025). *Durable skills: Enhance career and technical education in the age of artificial intelligence*. National School Boards Association. https://www.nsba.org/center-public-education/durable-skills-ai

Center on Education and Training for Employment. (2026). *Career-tech teacher professional development workshop on the use of AI tools*. The Ohio State University. https://cete.osu.edu/career-tech-teacher-professional-development-workshop/

Crevar, A. R., Dubey, P. K., & Rischard, M. (2026). Artificial intelligence and the transformation of career technical education. In V. Wang (Ed.), *AI applications and pedagogical innovation* (pp. 49–76). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3373-5092-9.ch002

Holmes, W., Bialik, M., & Fadel, C. (2021). *Artificial intelligence in education: Promises and implications for teaching and learning*. Center for Curriculum Redesign. https://curriculumredesign.org/wp-content/uploads/AI-in-Education-Promises-and-Implications-for-Teaching-and-Learning-Holmes-Bialik-Fadel.pdf

Kovanović, V., Joksimović, S., Gašević, D., & Siemens, G. (2023). Prompt engineering for educators: How to communicate with generative AI tools. *Computers & Education: Artificial Intelligence, 4*, 100132. https://doi.org/10.1016/j.caeai.2023.100132

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence unleashed: An argument for AI in education*. Pearson.

Miao, F., & Cukurova, M. (2024). *AI competency framework for teachers*. UNESCO. https://doi.org/10.54675/ZJTE2084

Organisation for Economic Co-operation and Development. (2025a). *What should teachers teach and students learn in a future of powerful AI*? OECD Education Spotlights, No. 20. OECD Publishing. https://doi.org/10.1787/ca56c7d6-en

Organisation for Economic Co-operation and Development. (2025b). Preparing teachers for digital education: Continuing professional learning on digital skills and pedagogies. *OECD Education Policy Perspectives, No. 122*. OECD Publishing. https://doi.org/10.1787/af442d7a-en

Pan, Y., Cui, L., Qian, T., & Tang, F. (2021). Artificial intelligence in education: A review. *IEEE Access, 9*, 120928–120944. https://doi.org/10.1109/ACCESS.2021.310982

Santos, O. C., Boticario, J. G., & Pérez-Marín, D. (2023). Generative artificial intelligence in education: Opportunities, challenges, and implications. *British Journal of Educational Technology, 54*(5), 1172-1190. https://doi.org/10.1111/bjet.13395

Sun, J. C., & Pratt, T. L. (2024). Navigating AI integration in career and technical education: Diffusion challenges, opportunities, and decisions. *Education Sciences, 14*(12), 1285. https://doi.org/10.3390/educsci14121285

Trust, T., Maloy, R. W., & Edwards, S. (2022). Preparing teachers to teach with artificial intelligence: Emerging trends from a systematic literature review. *Computers & Education: Artificial Intelligence, 3*, 100070. https://doi.org/10.1016/j.caeai.2022.100070

World Economic Forum. (2023). *The future of jobs report 2023*. https://www.weforum.org/reports/the-future-of-jobs-report-2023

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2022). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education, 19(*1), 1-47. https://doi.org/10.1186/s41239-021-00302-x