Professional Development Needs of CTE Teachers in Idaho: A Literature Review

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Abstract
Career and Technical Education programs are pipelines for preparing students with skills for higher education and career readiness. With the inception of the Morrill Act of 1862, CTE as we know it today, has existed for more than 160 years. The purpose of this research was to review the existing literature related to CTE and CTE PD found in academic databases, books, dissertations, papers, and government reports. A synthesis of empirical manuscripts was completed. This literary review examined 80 articles and found overarching themes related to CTE and CTE PD. The themes are CTE characteristics, CTE PD, digital world/Generation Z students, college/career readiness, traditional/alternative certification, teacher community, laboratory safety, and administration.

Introduction
Technical training dates to ancient times. Evidence of technical training occurred when Noah was given detailed instructions for building an ark in Genesis 6:15-16 (English Standard Version Bible, 2016). Graduate students nearly 4,500 years later used the Archimedes principle to conclude that the ark would have had sufficient buoyancy to safely support the mass of animals (Youle et al., 2013; Bishop, 2020). As it was in ancient times, technical training continues to be essential and is currently known as Career and Technical Education (CTE).

CTE created a new path for education in the United States. The first American colleges were based on the English university model where the classics were studied (Seevers et al., 2007). However, engineers were needed to deal with practical problems of plant layout, machine design, and machine parts, but the traditional colleges prepared students for law, medicine, teaching, and the ministry (Gordon, 2014). Responding to the deficiency of industrial training Representative Justin Morrill of Vermont introduced what was known as the land-grant bill to Congress in 1857 (Seevers et al., 2007). The Morrill Act established land-grant universities and was passed by Congress and signed by President Abraham Lincoln into U.S. law in 1862 (Seevers et al., 2007). The land-grant bill donated federal land to each state and territory for an endowment to establish one college in each state to teach not only scientific and classical studies, but also agriculture, mechanic arts, and military tactics (Seevers et al., 2007; Gordon, 2014). As a result, CTE evolved to provide open educational systems that addressed employment needs (Gordon, 2014).

CTE has been identified as industrial education, manual education, career education, and was once named vocational education (Malkus, 2019; Hodge et al., 2020). CTE educators are a catalyst for preparing the next generation of high-skilled employees for the workforce. Delivering technical training will continue to be an important responsibility to serve society.

Significance

CTE programs need to update and evolve as technology, industry, and student characteristics evolve to ensure students are equipped to perform the skills needed in a career. The global population is projected to exceed nine billion by 2050 and may peak at more than 11 billion by the end of the century creating significant challenges to produce sufficient food, feed, fiber, and biofuel feedstock (Food and Agriculture Organization of The United Nations, 2017). Historically, CTE has been an evolving and adaptable educational delivery system and will continue to need to evolve with industry. Unprecedented challenges exist to fill open U.S. jobs across the country as there are more job openings than unemployed workers (Ferguson, 2022).

Over the next decade, on average, an expected 17,500 openings for CTE teachers are projected each year (U.S. Bureau of Labor Statistics, 2022). The National FFA Organization (2017) identified the shortage of qualified teachers as being the greatest challenge facing agricultural education. Moreover, Zirkle et al. (2019) determined there has been a national trend for teachers across all disciplines to leave the teaching profession for a variety of different reasons.

Evaluating the current PD needs of CTE professionals is imperative. There is a national focus on teachers leaving the profession, a growing population in need of food and fiber, workforce demands of high-skilled employees, attention to alternative vs. traditional certified teachers, and an evolving digital world. Evaluating current CTE teachers' PD needs is essential to help inform and guide future in-service learning activities to equip teachers for success in the profession.

Purpose and Research Objectives

The purpose of this article was to synthesize the literature related to CTE PD needs. Two objectives guided this study:

1. Examine the literature for CTE PD.
2. Determine common categories and themes across the literature.

Findings will be used to develop the framework to determine current PD needs for CTE educators.

Research Methodology

A synthesis of literature was conducted to accomplish the research objectives. Oosterwyk et al. (2019) determined there are five stages of syntheses: (1) define protocol, (2) search the literature, (3) select the papers, (4) analyze, synthesize, and interpret, and (5) write the review.

The Search Process

To ensure the rigor and reliability of the literature search, an adaptation of the Oosterwyk et al. (2019) guidelines was identified and served as a guide to locate relevant literature for this study.

Table 1

Synthesis of Literature Guidelines (Oosterwyk et al., 2019)

Major Stages	Activities
Define the protocol	• Agree on a detailed procedure • Specify primary goal • Define key concepts • Establish boundaries • Draft the research objectives • Specify type of review • Specify disposition
Search the literature	• Specify where to search • Identify the main sources • Specify terms to use • Specify dimensions to search • Specify timespan • Restrict search within bounds of research question • Minimize publication bias • Perform backward and forward search
Select the papers	• Specify inclusion/exclusion criteria • Review Title, Abstract, Keywords and apply screen (inclusion/exclusion criteria) • Review Introduction and Conclusion and apply screen • Review full papers for relevance, rigor, and credibility
Analyze, synthesize, and interpret	• Select and apply appropriate method
Write the review	• Specify structural elements • Consider presentation

The academic research databases, Educational Resources Information Center (ERIC) and Google Scholar were chosen for the literature search as they provide a broad range of publications. When using the ERIC database, the criteria was set to peer-reviewed only and full text within the last 12 years. The timeline criteria of 12 years was established to target CTE PD changes since a similar study was conducted by Cannon et al. (2010). Data that was published within this timespan was used, except for historical references, and references that included established methodological models found in the literature. Backward literature chaining of references led to 10 articles published before 2010 that provided information important to addressing trends in PD and CTE.

Additional databases searched include the *Journal of Career and Technical Education, Journal of Research in Technical Careers, Journal of Agricultural Education, Journal of Teacher Education, International Journal of Vocational and Technical Education, Journal of Teaching and Learning with Technology,* and *Career and Technical Education Research.* These journals were selected as they were peer-reviewed and frequently cited in CTE PD literature. The following keywords were used in the search: "(state) CTE Teacher PD," "Teacher PD," "Journal

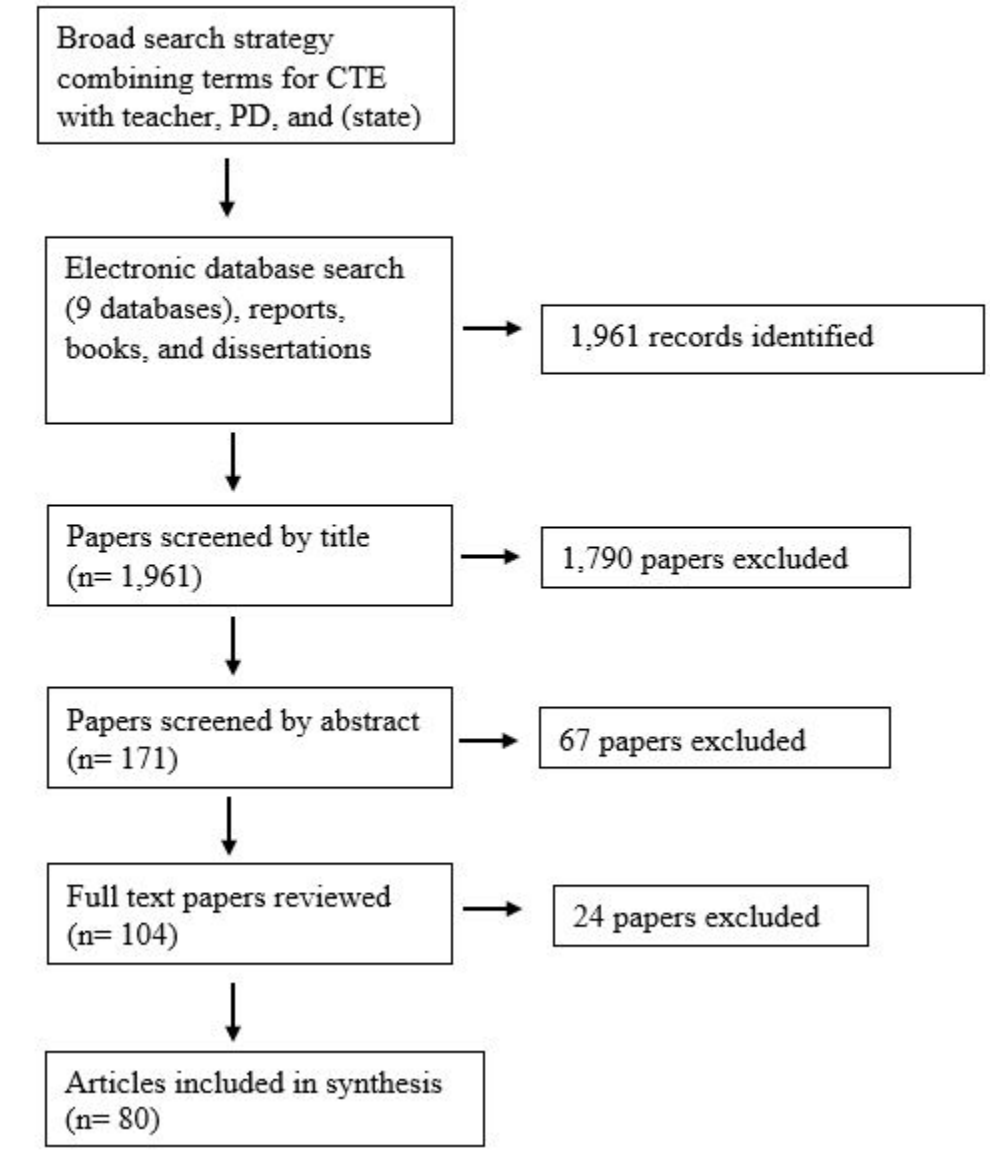
of Teacher Education CTE," "History of Career Technical Education," "CTE PD," and "CTE Teacher PD."

Article titles and abstracts were reviewed and if the articles did not clearly pertain to CTE or CTE PD, they were excluded from the study. Most of the literature focused on agricultural education. Cannon et al. (2010) determined few studies have been conducted to determine teacher in-service needs in CTE content areas other than agricultural education. Experiences and PD needs of agricultural education CTE teachers are unique, they have numerous professional responsibilities that require them to manage the total program, such as developing engaging learning activities in the classroom and laboratory, program budgeting, occupational analysis and curriculum development, supervising career and technical student organizations (CTSOs), developing a recruitment and public relations plan, and other associated CTE activities (Cannon et al., 2013).

The search was conducted from March 2022 to August 2022. In total, 1,961 publications (2010-2022) were identified from academic databases, journals, government databases, dissertations, and books. The researcher included current government and industry reports, papers, dissertations, and books in the synthesis of the literature to provide a broad context regarding CTE and how CTE programs relate to society and industry. All electronic articles identified were exported to the Zotero database manager for screening and reference. There were 1,881 articles excluded during the literature review process based on the eligibility criteria. The screening process resulted in 80 publications for the final analysis.

Figure 1

Process of study selection (adapted from Page et al., 2021)



Eligibility Criteria

First, only manuscripts published in academic journals, textbooks, dissertations, government and scientific reports, and academic papers were included. Second, only publications focusing on CTE and PD in the United States were included. This choice was made because of the urgency to evaluate CTE programs in the region and focus on their unique needs. Third, there was no time restriction, however, if a database search would allow for a time parameter, the time selection was between 2010-2022. Fourth, only empirical manuscripts that included evidence-based data were included. The focus was on current needs in programs versus conceptual ideas and theory-building.

Methodological Quality

First, the abstracts were read as an initial review, allowing the researcher to identify the purpose of the study, the participant characteristics, and the results of the study. Then, if the data applied to CTE and CTE PD, the article went into a general concept matrix. Finally, categories of concepts were identified and provided the themes for the findings (Greiman, 2009). Many of the manuscripts reported similar information providing the researcher with repetitive sources. Some manuscripts could have had overlapping themes that were not applied to multiple themes during the coding process. For example, if an article mentioned PD theories but focused more on administration, the article was counted in the administration category.

Triangulation of the manuscripts established the credibility of the study. By triangulating the findings, it is possible to identify common themes in studies, giving the user more confidence in applying the resulting evidence (Corder & Irlbeck, 2018). Additionally, triangulation of studies using different methods to address the same question gives greater confidence that the results obtained are not simply due to the repetition of biases and limitations in design, methods, or analyses (Johnston et al., 2021). Detailed records of descriptions of the findings, reflective notes, and coding records were archived to provide dependability and confirmability.

Findings

The researcher begins with the history and evolution of CTE, followed by current CTE programs, and then identifies the eight categories or themes that emerged from the literature. Recommendations for future research are outlined based on the findings.

In total, 1,961 publications from 2010-2022 were identified from academic databases, journals, government databases, dissertations, industry reports, and books. There were 1,881 articles excluded during the literature review process. The screening process resulted in 80 publications for the final analysis.

Table 2

Publication outlets (26 Journals, 14 reports, 6 books, 1 dissertation)

Journal Title	Number of articles
Journal of Agricultural Education	19
Journal of Research in Technical Careers	6
Career and Technical Education Research	5
Journal of Career and Technical Education	3
International Journal of Vocational and Technical Education	2
Journal of Research on Technology in Education	2
Teaching and Teacher Education	2
Phi Delta Kappan	2
Journal of Physics Special Topics	1
Journal of Vocational and Technical Careers	1
The Researcher	1
Journal of Research in Science Teaching	1
Journal of Teaching and Learning with Technology	1
Online Journal of Workforce Education and Development	1
Journal of Teacher Education	1
Journal of the Scholarship of Teaching and Learning	1
Peabody Journal of Education	1
Computer & Education	1
Computers in School	1
Journal of Empowering Teacher Excellence	1
Science World: Future Science Leaders	1
Educational Researcher	1
Journal of STEM Teacher Education	1
Scientific Reports	1
LEARNing Landscapes	1
eSTEAMED Journal	1
Report Title	**Numbers of articles**
U.S. Bureau of Labor	1
An investigation of State Educational Twitter Hashtags (SETHs) as affinity spaces	1
National Research Council	1
The Evolution of CTE	1
Secondary career and technical education activity in 2021	1
Idaho Division of Career and Technical Education	1
Essential facts about the video game industry	1
Food and Agriculture Organization (FAO)	1
Understanding America's labor shortage	1
Reauthorization of the Perkins Act in the 115th Congress: The Strengthening Career and Technical Education for the 21st Century Act	1

Landscape of CTE Leaders	1
Tracking and the Future of Career and Technical Education: How Efforts to Connect School and Work Can Avoid the Past Mistakes of Vocational Education	1
National FFA Organization	1
Standard Quality Assessment Criteria for Evaluating Primary Research Papers From a Variety of Fields	1

Book Title	Number of articles
Teaching Your Occupation to Others: A Guide to Surviving the First Year	1
Generation Z Unfiltered: Facing Nine Hidden Challenges of the Most Anxious Population	1
Leadership for Learning: How to Help Teachers Succeed	1
The History and Growth of Career and Technical Education in America	1
Education through cooperative extension	1
Education through cooperative extension (Second edition)	1

Dissertation	Number of articles
Characteristics of high-quality CTE teachers	1

Note. Coder & Irlbec (2018), Page (2021), Greiman (2009), Oosterwyk (2019), Johnston (2021), focus on reference methodologies and were not included in the publication outlet table.

Research Objective One: Examine the literature for CTE PD

Literature was examined in the area of CTE PD. CTE program areas available in (state) are Agriculture, Food and Natural Resources, Business and Marketing Education, Engineering and Technology Education, Family and Consumer Sciences and Human Services, Health Professions and Public Safety, Middle School: First Steps, Individualized Occupational Training, and Trades and Industry (The (state) Division of Career and Technical Education, 2022). Not all states require CTE administrator certification, but the state of (state) does require CTE administrator certification, and formal CTE administrator training is available after certification (Conrad & Watkins, 2021).

The Carl D. Perkins Career and Technical Education Act (Perkins Act) is a federal law and legislative initiative that supports the development and improvement of CTE programs at the secondary and postsecondary educational levels (Fletcher & Tyson, 2017; Granovskiy, 2018). CTE continues to be viewed as necessary and important, the Perkins Act was reauthorized again, through the Strengthening Career and Technical Education for the 21st Century Act (Perkins V; P.L. 115-224) and went into effect July 1, 2019. Under Perkins V, states are allowed to reserve 5% more of their allocation for CTE programs in rural areas or areas with high numbers of CTE students, or for innovative CTE programs (Granovskiy, 2018).

Additionally, Perkins V more clearly defines the purpose of CTE to include academic knowledge, and has added the need for employability skills (Valentine & Kosloski, 2021). After the reauthorization of Perkins in 2006, there was a call to administrators and teachers to improve and modernize CTE programs and align workforce skills to the labor market (Bird & Rice, 2021)

Ferguson (2018) offered that policymakers, business leaders, educators, and parents seemed to agree that value was apparent in both academic knowledge and career preparation in schools. Keily (2021) reviewed 2021 legislative activity concerning secondary CTE and found an increase in attention from policymakers. Lawmakers in 46 states introduced at least 315 bills concerning CTE in 2021 (Keily, 2021).

Research Objective Two: Determine common categories and themes within the data
Common categories and themes emerged through the synthesis of the literature on CTE PD. The topics that emerged were classified into themes in eight broad categories: CTE characteristics, CTE PD, digital world/Generation Z students, college/career readiness, traditional/alternative certification, teacher community, laboratory safety, and administrator support.

CTE Teacher PD
PD is an integral component of teacher growth and is important for improving the quality of CTE education in U.S. schools (Desimone, 2011). The understanding that CTE curriculum needs to be fluid and change over time is not a new concept. Foster (1997) argued that for the U.S. to remain globally competitive, employees need to change to meet industry demands. Providing teachers with up-to-date knowledge and skills that align with industry will help equip students for employment.

Conrad and Watkins (2021) found the power of CTE programs rested in the strength of the teachers and administrators working to provide quality CTE for students. PD is important for improvement. Staff development lies at the heart of educational efforts to improve student achievement (Supovitz & Turner, 2000). Without frequent updates and training, any employee can become outdated and unable to provide recommendations for current practices (Seevers et al., 1997).

CTE teachers have numerous professional responsibilities including developing engaging learning activities in the classroom and laboratory, program budgeting, occupational analysis and curriculum development, supervising CTE organizations, developing recruitment, and public relations plans (Cannon et al., 2013) and one of the most critical areas of concern for the new teacher of vocational subjects is safety (Bott, 1998).

CTE Teacher PD Needs
PD is an influential factor in student learning and has elements that provide an overarching context for instructional improvement (Glickmen, 2002). Arnett-Hartwick and Cannon (2020) determined that pre-service and beginning technical education teachers benefit from professional organizations where they can network and 'bounce' ideas off each other, share lessons or projects, and seek or give advice. A sense of community is noted in the literature as an important factor in evaluating student persistence and success within postsecondary Agriculture, Food, and Natural Resources education degree programs (McKim et al., 2018). Moreover, a sense of community is beneficial for educators– deliberate efforts to incorporate opportunities for new teachers to network with other teachers are needed as a part of the PD program (Westfall-Rudd, 2011; Easterly & Myers, 2017). One of the most profound findings of McKendree and McKim's (2021) analysis of PD of teachers was how participatory PD challenged teachers in new and exciting ways. An opportunity to utilize their expertise, coupled with a desire for peer learning,

teachers learned from each other and changed their own perspectives of school-based agriculture education (McKendree & McKim, 2021).

Williams (2019) discovered when CTE teachers were asked to rank the importance of PD activities, 54.8% ranked "collaborating with experts in their CTE program area" as being the most important PD activity. Fletcher and Tyson (2017) recommended that business and industry partners play a stronger role in the development of curricula, preparation, and training of both students and teachers, and work-based learning experiences (i.e., internships, job shadowing, mentoring) of students as a strategy to solve some of the skills-gap reported in recent literature.

In a study of 181 secondary skilled and technical teachers, Cannon et al., (2010) determined CTE teachers viewed three of the top five perceived in-service needs as follows:

- developing curriculum-based school-to-work and/or school-to-career activities;
- establishing and organizing co-op/internships, and
  providing guidance and career exploration activities to students (Cannon et al., 2010).

In a follow-up study, Cannon et al., (2012) found that school superintendents had similar perceptions as teachers, with the top priorities being:

- developing curriculum-based school-to-work and school-to-career activities; and
- providing guidance and career exploration activities to students.

PD can improve teacher competence in the laboratory where safety and liability are a concern for CTE teachers. CTE teachers whose instructional practices occur in a laboratory are most vulnerable to liability issues and should take proactive measures to reduce risk (Wells & Hainline, 2021; Saucier et al., 2014). Saucier and McKim (2011) recommended agricultural mechanics coursework be integrated into teacher preparation in agricultural education programs and focus on areas related to laboratory and equipment maintenance and laboratory safety.

PD needs of teachers vary. Lieberman and Pointer Mace (2008) concluded that in most schools teachers were given a "one size fits all" set of PD workshops and called for reform to collaborative teacher communities. PD needs of agriculture teachers at the beginning of their careers differ from experienced teachers regarding their PD needs (Sorenson et al., 2014).

Support from school administrators is important for CTE programs. Cannon et al. (2013) determined that school principals serve as instructional leaders and have the responsibility to determine the training needs of CTE teachers and, input from principals and other stakeholders is foundational for CTE in-service planning. An advisory board that includes guidance counselors, administrators, other school counterparts, parents, and community employers can be established to align curriculum to workforce needs, creating a prime opportunity to educate and promote CTE programs to these stakeholders (Arnett-Hartwick & Cannon, 2019). Mundt and Connors (1999) evaluated a population of National Vocational Agricultural Teachers Association Outstanding Young Member Award winners and determined building the support of faculty, counselors, and administrators within the school system was among the top four of their problems and challenges.

Additionally, administrative support can help with teacher retention. Hasselquist and Graves (2020) identified that school administrative support influenced teachers' job satisfaction and sense of worth, and encouraged teachers to remain in the profession, while unclear administrative expectations were noted as a reason for changing careers.

Several factors were identified in the literature related to teacher retention such as administrative, financial, collegial, and community support as well as teacher empowerment. Hasselquist and Graves (2020) found new insight regarding mid-career CTE teachers. The key experience for this group was the setting of boundaries and saying no to non-essential activities and opportunities, allowing them to establish priorities (Hasselquist & Graves, 2020).

Cannon et al. (2010) determined that limited studies have been conducted on teacher in-service needs in CTE content areas other than agricultural education. A few studies conducted on the teacher in-service needs of CTE programs in the areas of business/marketing, food, and technology emerged and their in-service needs compared to the needs in agricultural programs. Koundinya and Martin (2010) identified food safety as a critical PD area for CTE teachers reaching beyond the classroom with implications for international trade and public health. Kitchel et al. (2009) determined that business/marketing CTE teachers' in-service priorities were as follows:

- co-op/internship management;
- developing curriculum-based school-to-work/career activities;
- obtaining external funding; and
- public relations as top in-service priorities.

Arnett-Hartwick and Cannon (2019) found when evaluating novice and veteran teachers that PD was recognized as a problem area for technology education teachers because the PD needs of these teacher groups vary.

CTE College/Career Ready

Stone (2017) offered that as a nation, the US cannot compete with less developed nations on labor costs, so it must compete on the quality of goods and services produced. This market position requires a highly skilled workforce with a range of mid-level trade, technical, and professional skills as well as high-level skills, usually associated with a university education (Stone, 2017). State CTE administrators, university teacher educators, and educational professionals need to provide timely learning opportunities to meet the PD demand of CTE teachers. CTE programs are tasked with ensuring students are college and/or career-ready. Ames (2022) determined that CTE programs prepare students for careers without reducing college readiness.

Student career and college readiness and placement is a focus area in CTE literature. Stone (2017) reported middle-skill occupations represented viable career pathways; between 19%-30% of expected openings will require some level of postsecondary education, including community college degrees, diplomas, certificates, and other forms of formal and nonformal education and training for entry (e.g., registered nurse). Alston et al. (2020) noted that it is critical to attract high-caliber CTE students who can navigate complex issues and problems. Bartholomew (2014) highlighted creativity, problem-solving, manual dexterity, and spatial perception as some of the

positive skills gained by students benefiting from hands-on learning in CTE courses that will translate to the workplace.

Perceptions of college readiness and participation of CTE students vary among college professors. Community college faculty acknowledge the benefit of CTE programs as a path to prepare students for industry-required competencies, but they also offer that CTE programs must support students social and emotional development, providing an equitable education to promote life-long learning, sustainable employment, and growth (Gauthier, 2021). Relative to college prep students, CTE students were significantly less likely to transfer to a four-year college, but significantly more likely to earn either an associate degree or a certificate without transferring (Dietrich et al., 2017).

Lambeth et al. (2018) determined the CTE National Agenda needed revision since its inception in 2008 to reflect the contemporary issues and policies for the CTE profession, and that research and scholarship in academia conducted by professors should reflect focused and directed inquiry into the needs of CTE. Through collaborations with university faculty, secondary teachers, and state CTE administrators; research has shown continuing PD education can drive programs to be relevant and stay abreast as industry changes (Webb et al., 2019 & Cannon et al., 2012).

University faculty are influential. Miller and Mills (2019) found that faculty who were seen as caring made an impact on student engagement. The faculty who were seen as most caring were described as using humor, bringing in relatable examples, and interacting regularly with students (Miller & Mills, 2019). Cooperative land-grant university systems are examples of how knowledge and skills are disseminated from university faculty to the people. Similarly, the research and scholarship from the university faculty is disseminated to CTE professionals at the secondary level through PD.

PD needs are hierarchical and faculty PD is also important. Foor and Cano (2011) determined that faculty also benefit from PD. Ultimately, personal growth and satisfaction is the best predictor of a faculty member's level of overall job satisfaction (Foor & Cano, 2011).

Traditional and Alternative Certification

Traditional certification involves teacher preparation through a professional educational teacher preparation program, such as a university. Alternative certification is defined as teacher preparation through emergency certification, temporary certification, work-based programs, and structured university and/or private providers of alternatively labeled certification pathways (National Research Council, 2010).

Traditionally and alternatively certified CTE teachers may have different PD needs. Ritz et al. (2013) offered that some school districts employ teachers who lack proper certification due to a shortage of teacher education program graduates who decide to pursue a teaching career. Nearly a decade later the same phenomenon is occurring. A nationwide teacher shortage is causing an increase in practicing teachers with alternative certification causing diverse PD needs among alternative and traditionally certified teachers (Coleman et al., 2020; Stair et al., 2019; Smalley et al., 2019).

Bowling and Ball (2018) determined that research in education broadly indicated a lack of consistency within the current alternative certification pathways and a lack of consistent/positive influence on student outcomes within alternatively certified teachers. Kerna (2012) determined that CTE instructors have the industry experience and in-depth content knowledge that was critical in the vocational classroom, but they were missing basic knowledge of pedagogical theory. Duncan et al. (2013) determined that the pedagogical means of educating students in CTE programs has drastically changed during the last century due to the variation in traditionally and alternatively certified teachers.

Duncan et al. (2013) found that traditionally certified business teachers, marketing teachers, family and consumer science teachers, health professions teachers, technology education teachers, and trade and industry teachers had higher perceived levels of self-efficacy for all areas examined except, "use of non-computer technology in teaching." The researchers identified the reasoning for this could be alternatively certified teachers have more industry and career experience (Duncan et al., 2013). Alternatively certified agriculture teachers may have additional training needs. Touchstone (2015) revealed that alternatively certified agriculture teachers have higher needs for skills in FFA, SAE, classroom management, and curriculum development.

Digital World/Generation Z

Mohr and Mohr (2017) described Generation Z students as digital natives, who were born between 1995-2010. Understanding generational shifts in student characteristics is a key component of effective PD. Generation Z students require creative approaches that combine social interactions, technology, and assignments that simulate real-life work situations or are community outreach projects (Mohr & Mohr, 2017). Elmore and McPeak (2019) offered Generation Z students need to be taught differently than past generations, mere verbal instruction may not only be redundant but disengaging to today's 'screenagers'. Elmore and McPeak (2019) noted that educators should incentivize learning by giving students the opportunity to solve real problems and serve real people.

Bunch et al. (2014) compared the effectiveness of lecture and discussion teaching methods and digital game-based learning on student achievement in agriculture and mathematics. The researchers found that using a game intended for learning did not diminish student achievement. They recommended providing prolonged and sustained PD opportunities for teachers to learn how to use a digital game-based delivery method effectively to increase student achievement in agriculture and mathematics (Bunch et al., 2014). Games have always been a part of human culture and now digital games are used by two-thirds of Americans- people of all ages, races, genders, and backgrounds (Entertainment Software Association, 2022). Content in a digital platform is an accepted and familiar platform for Generation Z students.

After evaluating smartphone availability and usage by agricultural teachers, Smith et al. (2018) determined PD opportunities provided by teachers who integrate technology successfully, can provide an opportunity to help teachers accept and use technology in their curriculum. Integrating online videos in the classroom is educationally beneficial and engaging. To capitalize on the potential of online videos, educators can access YouTube, Ted-Ed, Vimeo, Hulu, or other options. YouTube is among the best options because it is user-friendly and presents a variety of topics (Riley, 2017). Digital video is progressing to virtual reality. Researchers have found that

immersive media technology such as virtual reality, can complement traditional curriculum and provide insight not accessible otherwise (Pimentel & Kalyanaraman, 2022).

Some educators have found ways to use social media both in student activities and professional learning (Carpenter et al., 2020). Prestridge (2022) determined that online resources and an increase in accessibility have led teachers to go online to connect, share ideas, and expand their own professional learning opportunities on social media platforms. Social media platforms reported to be used by teachers are the Global Read Aloud Project which connected classrooms around the world (Carpenter & Justice, 2017), teachers are using Twitter (Xing & Gao, 2018; Rosenberg et al., 2016), Facebook (Kelly & Antonio, 2016), Pinterest (Schroeder, 2019), Reddit, and Instagram as tools for learning (Staudt & Carpenter, 2020).

Common categories and themes emerged through the synthesis of the literature on CTE PD. The topics that emerged were classified into themes in eight broad categories: CTE, PD needs, digital world/Generation Z, college/career readiness, traditional vs. alternative certification, community of teachers, laboratory safety PD, and administrator support. The categories were created by repeating traits within the category across all literature. For example, social network sites, digital gaming, and video were combined into digital world/Generation Z. Five of the manuscripts reviewed included more than one of the categories.

Table 3

Matrix of Synthesis Themes

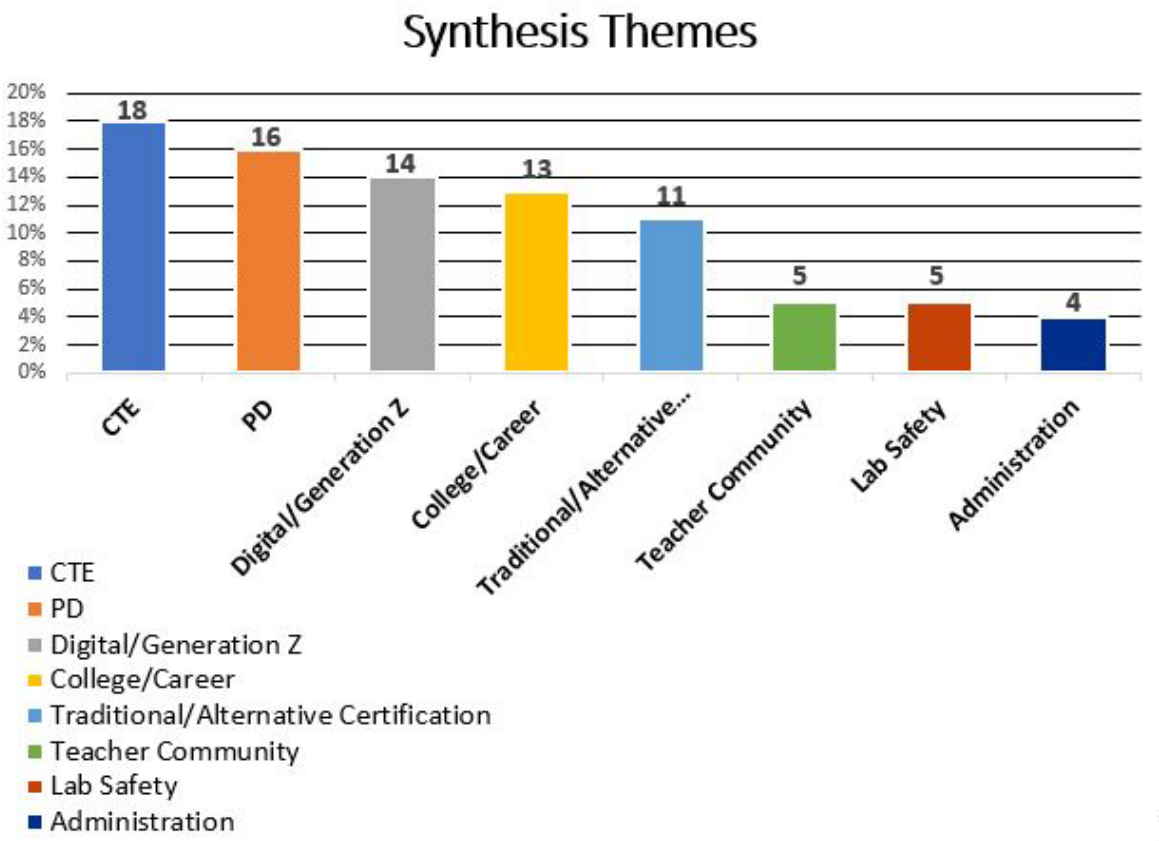
Author	Journal, Paper, Report
CTE (18 articles)	
Bird, T. D., & Rice, A. H. (2021)	*Journal of Agricultural Education*
English Standard Version Bible (2016)	Book
Food and Agriculture Organization (FAO) (2017)	Report
Ferguson, S., (2022)	Report
Gordon, H. R., (2014)	Book
Granovskiy, B. (2018)	Report
Ferguson, M., (2018)	*Phi Delta Kappan*
Hodge, E., Dougherty, S., & Burris, C. (2020)	Report
Idaho division of Career and Technical Education. (2022)	Report
Keily, T., (2021)	Report
Lambeth, J. M., Joerger, R. M., & Elliot, J. (2018)	*Journal of Research in Technical Careers*
Malkus, N. (2019)	Report
Seevers, B., & Graham, D., & Conklin, N. (2007)	Book
United States Bureau of Labor Statistics. (2022)	Report
Valentine, K. S., & Kosloski, M. F. (2021)	*Journal of Research in Technical Careers*
Youle, O., Raymer, K.M., Jordan, B., & Morris, T. (2013)	Paper
Zirkle, C., Jeffery, J., & Shrewe, L. (2019)	*Career and Technical Education Research*
Bishop, Y. (2022)	*eSTEAMED Journal*
PD Needs (16 articles)	
Arnett-Hartwick, S. E., & Cannon, J. (2019)	*Journal of Research in Technical Careers*
Cannon, J. G., Kitchel, A., & Duncan, D. W. (2010)	*Journal of STEM Teacher Education*
Cannon, J., Tenuto, P., & Kitchel, A. (2013)	*Career and Technical Education Research*
Desimone, L. M. (2011)	*Phi Delta Kappan*
Foor, R. M., & Cano, J. (2011)	*Journal of Agricultural Education*
Foster, P.N., (1997)	*Journal of Vocational and Technical Education*
Glickmen, C., (2002)	Book
Lieberman, A., & Pointer Mace, D. H. (2008)	*Journal of Teacher Education*
Miller, A. C., & Mills, B. (2019)	*Journal of the Scholarship of Teaching and Learning*
National FFA Organization. (2017).	Report
Seevers, B., & Graham, D., Gamon, J., Conklin, N. (1997)	Book
Sorensen, T. J., Lambert, M. D., & McKim, A. J. (2014)	*Journal of Agricultural Education*
Stone III, J. R. (2017)	*Peabody Journal of Education*
Supovitz, J. A., & Turner, H. M. (2000)	*Journal of Research in Science Teaching*
Webb, R. C., Westfall-Rudd, D. M., Scherer, H. H., & Rudd, R. D. (2019)	*Journal of Agricultural Education*
Williams, C. C. (2019)	Dissertation
Digital world-Generation Z (14 articles)	

Bunch, J. C., Robinson, J. S., Edwards, M. C., & Antonenko, P. D. (2014)	*Journal of Agricultural Education*
Carpenter, J. P., & Justice, J. E. (2017)	*LEARNing Landscapes*
Carpenter, J. P., Morrison, S. A., Craft, M., & Lee, M. (2020)	*Teaching and Teacher Education*
Elmore, T., & McPeak, A. (2019)	Book
Entertainment Software Association, E. (2022)	Report
Kelly, N., & Antonio, A. (2016)	*Teaching and Teacher Education*
Pimentel, D., & Kalyanaraman, S. (2022)	*Scientific Reports*
Riley, J. (2017)	*Journal of Teaching and Learning with Technology*
Rosenberg, J. M., Greenhalgh, S. P., Koehler, M. J., Hamilton, E. R., & Akcaoglu, M (2016)	*E-Learning and Digital Media*
Schroeder, S., Curcio, R., & Lundgren, L. (2019)	*Journal of Research on Technology in Education*
Staudt Willet, K. B., & Carpenter, J. P. (2020)	*Journal of Research on Technology in Education*
Smith, H. E., Stair, K. S., Blackburn, J. J., & Easley, M. (2018)	*Journal of Agricultural Education*
Xing, W., & Gao, F. (2018)	*Computers & Education*
Mohr, K. A., & Mohr, E. S. (2017)	*Journal of Empowering Teacher Excellence*
College/career readiness (13 articles)	
Alston, A. J., Roberts, R., & English, C. W. (2020)	*Journal of Research in Technical Careers*
Ames, T. (2022)	*Journal of Career and Technical Education*
Bartholomew, S. (2014)	*International Journal of Vocational and Technical Education*
Cannon, J. G., Kitchel, A., & Duncan, D. W. (2010)	*Journal of STEM Teacher Education*
Cannon, J. G., Kitchel, A., & Duncan, D. W. (2012)	*The Researcher*
Cannon, J.G., Kitchel, A., & Tenuto, P. (2012)	*Journal of Career and Technical Education*
Dietrich, C., Lichtenberger, E. and Kamalludeen, R., (2017)	*Journal of Career and Technical Education*
Fletcher Jr, E. C., & Tyson, W. (2017)	*Journal of Research in Technical Careers*
Gauthier, T. (2021)	*Journal of Research in Technical Careers*
Gordon, H. R., (2014)	Book
Kitchel, A., Cannon, J., & Duncan, D. (2009)	*Career and Technical Education Research*
Stone III, J. R. (2017)	*Peabody Journal of Education*
Webb, R. C., Westfall-Rudd, D. M., Scherer, H. H., & Rudd, R. D. (2019)	*Journal of Agricultural Education*
Traditional vs. alternative certification (11 articles)	
Bowling, A. M., & Ball, A. L. (2018)	*Journal of Agricultural Education*
Cannon, J., Tenuto, P., & Kitchel, A. (2013)	*Career and Technical Education Research*
Coleman, B. M., Bunch, J. C., & Thoron, A. C. (2020)	*Journal of Agricultural Education*
Conrad, M., & Watkins, L. (2021)	Report

Duncan, D., Cannon, J., & Kitchel, A. (2013)	*Career and Technical Education Research*
Krista, D. K. (2012)	*International Journal of Vocational and Technical Education*
National Research Council. (2010)	Report
Ritz, R., Burris, S., Brashears, T., & Fraze, S. (2013)	*Journal of Agricultural Education*
Smalley, S., Hainline, M. S., & Sands, K. (2019)	*Journal of Agricultural Education*
Stair, K., Figland, W., Blackburn, J., & Smith, E. (2019)	*Journal of Agricultural Education*
Touchstone, A. J. (2015)	*Journal of Agricultural Education*
Community of teachers (5 articles)	
Arnett-Hartwick, S., & Cannon, J. (2020)	*Online Journal of Workforce Education and Development*
Easterly III, R. G., & Myers, B. E. (2017)	*Journal of Agricultural Education*
McKendree, B., & McKim, A. J. (2021)	*Journal of Agricultural Education*
McKim, A. J., Sorensen, T. J., McKendree, R., & Pauley, C. M. (2018)	*Journal of Research in Technical Careers*
Westfall-Rudd, D. M. (2011)	*Journal of Agricultural Education*
Laboratory safety PD (5 articles)	
Bott, P.A., (1998)	Book
Koundinya, V., & Martin, R. A. (2010)	*Journal of Agricultural Education*
Saucier, P. R., & McKim, B. R. (2011)	*Journal of Agricultural Education*
Saucier, P. R., Vincent, S. K., & Anderson, R. G. (2014)	*Journal of Agricultural Education*
Wells, T., & Hainline, M. S. (2021)	*Journal of Agricultural Education*
Administrator support (4 articles)	
Hasselquist, L., & Graves, N. A. (2020)	*Career and Technical Education Research*
Mundt, J.P., & Connors, J. (1999)	*Journal of Agricultural Education*
Cannon, J., Tenuto, P., & Kitchel, A. (2013)	*Career and Technical Education Research*
Arnett-Hartwick, S. E., & Cannon, J. (2019)	*Journal of Research in Technical Careers*

Figure 2

Categories of themes from the synthesis of the literature



Conclusions

The reauthorization of the Perkins Act demonstrated that CTE programs are essential and are worth investing in to address industry workplace needs and college readiness. This synthesis of the literature revealed continual challenges in CTE PD, such as laboratory safety, administration support, curriculum development to match industry needs, college readiness, industry partnerships, teacher retention, and effective PD. Categories related to CTE PD have emerged from the literature that are relatively new concepts in the last decade. The categories included: the use of digital media by teachers and students, the characteristics of Generation Z students, and learning how to establish boundaries and prioritize activities.

Implications for Research and Practice

Conrad and Watkins (2021) found the power of CTE programs rests in the strength of the teachers and administrators working to provide quality CTE for students. Based on the findings of this study, there are five recommendations for future research.

First, reevaluating current CTE teachers' PD is recommended to help guide future in-service learning activities. Sorensen et al. (2014) determined the need for periodic PD needs assessments to be conducted within individual states.

Second, it is recommended to evaluate how PD activities are offered to ensure the activities are effective for teachers. Lieberman and Pointer Mace (2008) concluded that in most schools

teachers are given a "one size fits all" set of PD workshops and call for reform to collaborative teacher communities. Variations in PD needs of traditionally and alternatively certified teachers and veteran and novice teachers were recognized in the literature. Future research is recommended in individual schools to identify specific PD needs.

Third, further research is recommended on the topic of training teachers to establish priorities in their programs to promote better work/life balance to prevent teacher burnout. Fourth, it is recommended to conduct further research on the characteristics of Generation Z students and the use of digital platforms for teacher and student learning.

Fifth, it is recommended to explore college/career readiness further. Literature triangulation revealed a need to evaluate college or career exploration of CTE students, perhaps focusing on programs offered through guidance counselors to prepare students for post-graduation choices. The research suggested CTE pathways do not affect student college readiness, yet faculty suggested that CTE programs must support students' social and emotional development, providing an equitable education to promote life-long learning, sustainable employment, and growth (Gauthier, 2021). Additionally, CTE students were significantly less likely to transfer to a four-year college but significantly more likely to earn either an associate degree or a certificate without transferring (Dietrich et al., 2017).

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