

What is the evidence on technology-based or distance learning that can inform efforts to provide postsecondary education remotely?

The COVID-19 pandemic has caused an unprecedented disruption to labor markets in the United States (U.S.) and abroad, bringing about high unemployment and changes in the skills needed for employment at a time when workers, and those not working, face challenges gaining education, training, and skills. Postsecondary education provides opportunities for individuals to stay competitive in a changing workforce and obtain well-paying careers by affording them access to certificate programs that lead to industry-recognized credentials and postsecondary degrees. However, the introduction of many states' lockdown and shelter-in-place orders in March 2020 forced the closure of employment service providers, community colleges, and universities. As of March 2021, one year into the pandemic, more than half of 1,000 individuals surveyed believed they would need to acquire new skills due to the pandemic (Charles Koch Foundation, 2021). However, many of the institutions that provide postsecondary education remained physically closed or offered limited in-person services.

Distance or remote learning offers a flexible and convenient option to in-person education for many students, allowing access by individuals who otherwise would not have the opportunity to participate. However, there are challenges to remote postsecondary education in general, and even more can arise in postsecondary career and technical education (CTE), which consists of education and training focused on practical skills designed to help individuals succeed in the labor market. One key difference between traditional postsecondary education and CTE programs is that most CTE programs provide "hands-on" skills training, which can be difficult to acquire in a remote setting—particularly in sectors such as health science and medical technologies that require using laboratories and include a clinical experience component.

This review covers general postsecondary education and CTE since research in both areas can help to determine how best to build worker skills and provide education during the COVID-19 pandemic and beyond. In fact, although a gradual shift towards online programs for CTE learning has been occurring for years, the pandemic accelerated the transition from in-person delivery to hybrid delivery. Today, most postsecondary institutions intend to continue delivering programs through a hybrid model, incorporating both in-person and remote instruction and training (Briggs et al., 2021).

The objective of this rapid review is to identify and synthesize evidence on technology-based or distance learning that can inform efforts to provide remote postsecondary education. Drawing on findings from

Under **remote education strategies**, instructors provide some or all programming from a location other than where the student is.

Synchronous is when the instructor and students interact at the same time via a video, phone, or chat platform.

Asynchronous is when students work on their own and interact with the instructor at a different time.

Courses may be **fully remote**, meaning there is no in-person instruction, or may be **blended or hybrid**, meaning that at least some in-person instruction is replaced by meaningful online activities.

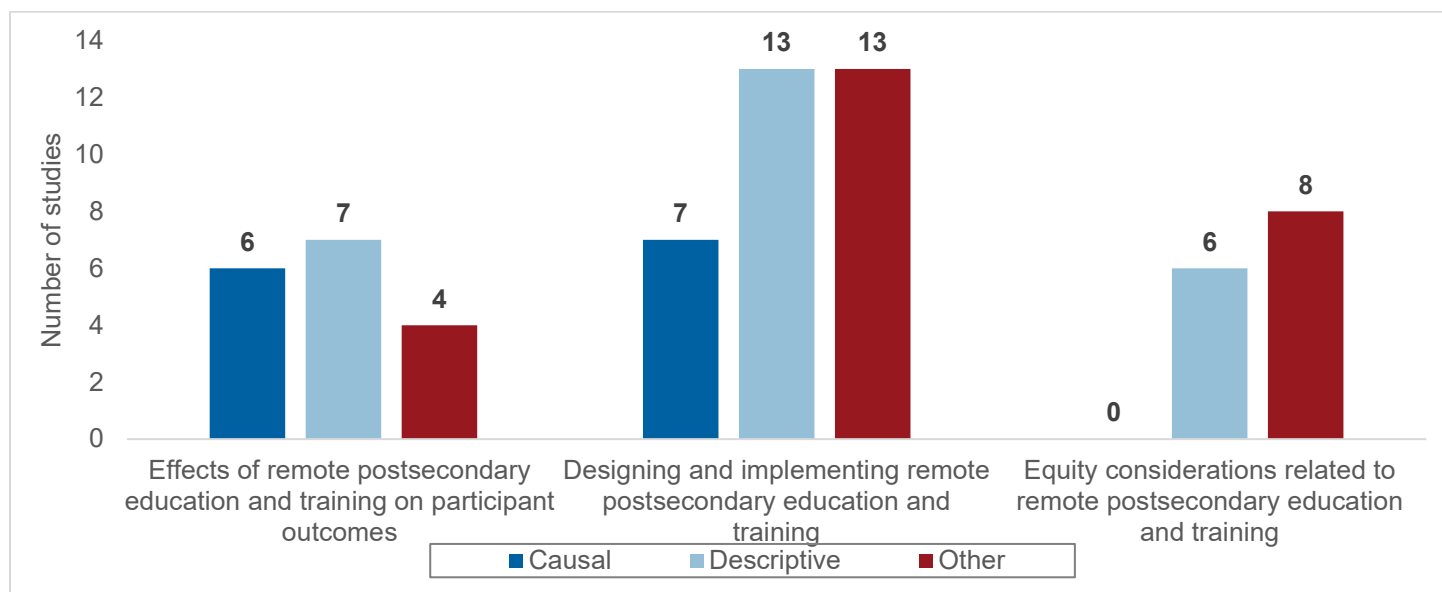
¹ This version includes literature published between January 1, 2005, and October 1, 2021. CLEAR continues to search for relevant literature and may update this synthesis as new research emerges.

postsecondary and training research fields,² and in consultation with the U.S. Department of Labor (DOL) and subject matter experts, this review summarizes the literature across three areas:

1. Effects of remote postsecondary education and training on participant outcomes
2. Designing and implementing remote postsecondary education and training
3. Equity considerations related to remote postsecondary education and training

The evidence presented here is from the Clearinghouse for Labor Evaluation and Research's (CLEAR)³ rapid review of 52 publications. Across the 52 publications, 11 were classified as causal, 23 were classified as descriptive (these include implementation studies, case studies, and descriptive quantitative analysis), and 18 were other types of publications (these include literature reviews, opinion pieces from subject matter experts, websites, and memoranda).⁴ Figure 1 shows the number of studies, classified by topic and type of research, including publications that addressed more than one topic. The synthesis includes a supplement that provides an overview of each study.

Figure 1. Types of studies by topic



Note: The total number of studies was 52, but 12 studies addressed more than one topic, so Figure 1 sums to 64.

² This review focuses on distance learning for adult learners. The What Works Clearinghouse conducted a complementary review on distance learning for primary, secondary, and postsecondary students. This effort and its findings are described in Sahni, S. D., Polanin, J. R., Zhang, Q., Michaelson, L. E., Caverly, S., Polese, M. L., & Yang, J. (2021). *A What Works Clearinghouse rapid evidence review of distance learning programs*. Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, What Works Clearinghouse. Available at https://ies.ed.gov/ncee/wwc/Docs/ReferenceResources/Distance_Learning_RER_508c.pdf

³ CLEAR is the U.S. Department of Labor's Clearinghouse for Labor Evaluation and Research. Its mission is to make research on labor topics more accessible to practitioners, policymakers, researchers, and the public, and to support evidence-informed decision making. CLEAR does this by conducting systematic evidence reviews, summarizing individual studies of programs, and synthesizing research across individual evidence bases. To date, CLEAR has conducted more than 20 evidence reviews and summarized more than 1,100 studies.

⁴ Some studies are classified in multiple categories. If a study contained any causal element, we classified it as causal. If a study was both descriptive and other, we classified it as descriptive for the purposes of this tally.

1. Effects of remote postsecondary education and training on participant outcomes

► **Research is mixed on retention and completion outcomes for comparisons of in-person and remote education and training.** Term-to-term retention (e.g., earning credits, not dropping out) and program completion are two common outcomes for education and training programs. Shea and Bidjerano (2014) found positive outcomes in their study comparing students in distance education and students not in distance education at community colleges nationwide. They found that students who had taken courses online attained associate degrees at higher rates than those who had not. One quasi-experimental study of a healthcare education program at a community college in the U.S. found that participants in a hybrid learning program had accumulated more credits, were more likely to complete the program, and were more likely to receive a diploma than healthcare students not enrolled in the hybrid learning program (Center for Applied Research, 2017).

Other studies contradict these findings. For example, a study of students seeking a four-year degree at a large for-profit university in the U.S. found that students in online courses were more likely to drop out of the institution than those taking the same courses in-person (Bettinger et al., 2017). Similarly, a large study across Washington State's community and technical colleges found that students who were enrolled in online courses were less likely to complete the course and more likely to eventually drop out of college than students in hybrid or in-person courses (Xu & Jaggars, 2011). Another study compared students in an in-person, introductory science course at a U.S. community college to a matched group of students who took the course online (students watched short, self-contained modules). Students taking the online version of the course were less likely to complete the course than the in-person students (Alamprese et al., 2017). A study comparing online and in-person students beginning for-credit programs at technical and community colleges between 2011 and 2012 found that students who started in online CTE courses were less likely to earn a degree or credential at the first college they attended (Anderson et al., 2021).

► **Research on employment outcomes is difficult to obtain and the limited research that looks at employment outcomes is mixed.** Employment and wages are desired outcomes in research focused on CTE programs. While researchers note that many CTE learners enrolled in programs report positive employment outcomes and greater increases in wages than before beginning their programs (Pham, Greaney, & Abel, 2020), few CTE programs have been evaluated for their causal impact on employment outcomes. Even fewer remote programs have been assessed for causal impacts, and those results are mixed. In Eyster and Kuehn's (2020) synthesis of Trade Adjustment Assistance Community College and Career Training (TAACCCT) findings from 23 reports, employment outcomes were not tested in 13 studies often because the study authors did not have access to employment or wage data (e.g., Unemployment Insurance, or UI, wage data). Of the remaining 10 studies, findings showed positive, negative, or no impacts on employment outcomes. Of the 18 studies with an online education or technology-enabled learning component, half did not test for employment impacts, five found positive impacts, three found no impact, and one found negative impacts on employment outcomes.

Several studies of remote CTE programs have examined employment outcomes for program participants before and after participation, and found positive results, but caution is needed since they

did not compare program participants to others not in the program. One example is a study of the Technology-Based Learning (TBL) Initiative in 16 states from 2009 to 2012, which found that program participants' employment increased from 56 to 79 percent and wages increased from \$19.59 to \$21.60 per hour, after completing remote CTE (Maxwell et al., 2013). Another study found that students in a hybrid healthcare education program at six community colleges in the U.S. were more likely to be employed after program completion. Participants employed at the start of the hybrid program earned, on average, \$2.21 more per hour and worked an average of 4.6 hours more per week (Center for Applied Research, 2017). Another study comparing online and in-person CTE students beginning for-credit programs at technical and community colleges between 2011 and 2012 found that students who started in online CTE courses were more likely to hold a job related to their program of study but earned less than those who started in-person CTE programs (Anderson et al., 2021).

Another study illustrated the potential of remote education and training to support employment in rural communities. Australian researchers (Wearne et al., 2010) found that a remote CTE program retained 20 out of 21 (95 percent) medical professionals in geographically remote areas where there was a shortage of such professionals. The authors noted that remote CTE allowed these workers to remain where there was demand for services without the need to relocate for needed training.

► **Research on other outcomes of remote postsecondary education and training, such as grades and exam scores, is mixed.** A randomized controlled trial (RCT) at a U.S. university assigned microeconomics students to either watch course lectures online or attend the same lecture in-person. Overall, the course exam scores did not differ for the two groups of students (Figlio et al., 2013). Another RCT found that students enrolled in a hybrid university statistics course had similar pass rates and final exam scores as students in the traditional in-person course (Bowen et al., 2012). A study at a U.S. university compared a remote asynchronous approach to in-person classroom instruction taught by the same instructor using the same materials. The study reported no significant differences in test scores and final grades, on average (Neuhauser, 2002). Benson et al. (2005) compared students enrolled in online CTE courses and students in campus based CTE courses in community colleges in the U.S. across several outcomes including knowledge of the course content and motivation. The authors observed no statistically significant differences in student achievement between online and campus-based students, and online CTE students appeared to be as motivated to learn as campus-based students.

Other studies have found lower grades among students in online community college courses than those attending in-person classes (Alamprese et al., 2017; Xu & Jaggars, 2011). One study at a for-profit university in the U.S. found that students who took an online course received lower grades than students who took the same course in-person (Bettinger et al., 2017). There is some evidence that hybrid courses, which sometimes contain additional learning time and instructional supports, increase learning more than fully remote courses (Protopsaltis & Baum, 2019; U.S. Department of Education, 2010).

A meta-analysis by Bernard and colleagues (reported in Bell and Federman, 2013) examined 232 studies that looked at student achievement, student attitude, and course completion among distance and in-person populations. They found no significant differences in overall achievement but did find that students in synchronous distance learning had more negative attitudes than students who were classroom-based. Another meta-analysis of 45 studies conducted in 2010 by the U.S. Department of

Education found evidence that students performed similarly in online and traditional classroom instruction. A more recent literature review of 30 studies found several that concluded that learning outcomes were the same for online and in-person courses (Castro & Tumibay, 2019).

2. Designing and implementing remote education and training

► **Combining asynchronous and synchronous online instruction using hybrid delivery models, fostering connections, and/or have students engage in reflective activities can address the challenge of keeping individuals engaged.** Allowing students to work on their own and interact with the instructor at different times can overcome scheduling and geographic distance challenges; however, this asynchronous approach also makes it difficult to promote engagement or a strong learning community. Supplementing instruction with in-person or synchronous online interactive components such as lab sessions with hands-on activities, live presentations with question-and-answer sessions, discussion boards, or interactive online quizzes can improve interaction and engagement between instructors and students. One example of a hybrid model designed to increase student engagement was a Graphics Communications Technology program in Michigan in which students rotated between in-person and remote learning (Association for Career and Technical Education, 2021).

Other strategies to improve engagement come from the gaming world. A study of remote education in a Swedish university suggested that digital badges could motivate students, and software visualizations (e.g., progress bars), might enhance virtual learning (Olsson et al., 2015). Another study comparing the effects of interactive visual learning tools in a postsecondary online course found that the tools increased students' attention, curiosity, and interest about the online activity (Ha & Im, 2020).

Reflective activities and active learning methodologies appear common among successful remote education programs. For instance, an experimental study of different online learning programs found that podcasts and reflective activities improved test scores and student motivation compared to using podcasts without reflective activities

(Yilmaz & Keser, 2016). Likewise, a 2019 study found that active learning methodologies in online classes led to significant increases in students' positive attitudes about the course, self-efficacy beliefs, and learning outcomes compared to those who did not receive the active learning methodologies (Jeong et al., 2019). A study of American graduate students in a remote education course that included case studies and problem-solving exercises found that students enrolled in the course were more satisfied and found the course more useful than students who only received the standard remote education course (Kim et al., 2012).

Student–instructor interaction is important in both asynchronous and synchronous remote instruction (Mupinga et al., 2009; Protopsaltis & Baum, 2019). One literature review of asynchronous interactions,

Online learning communities. A group of learners who meet online for a common educational interest.

Gamification. The use of game design elements in non-game settings, such as a digital badge indicating an accomplishment.

Reflective activities. Individual or group-based activities that encourage students to connect their learning with real-world implications. Examples include journaling or peer sharing.

Active learning exercises. Instructional methods that meaningfully engage students in the learning process. Examples include group discussions, case studies, and cooperative learning activities.

Flipped classrooms. An instructional method that uses class time for questions, discussion, and other engagement activities instead of lectures.

such as online discussion boards, found that poorly structured discussions confused or frustrated students (Mupinga et al., 2009). Facilitation techniques that occur in real time (that is, synchronously) can be used to make the instructor more accessible, encourage a sense of connectedness among students, support live collaboration, and transmit knowledge (Hai-Jew, 2009). Additionally, several studies suggest that interaction with peers is important. One study found that an online learning community project significantly improved university students' motivation to learn Chinese as a foreign language. Specific motivating features included access to learning resources and tools, opportunities to connect with other students enrolled in the course, and feedback from others (Cai & Zhu, 2012). Another study examining remote education in Australia observed that voluntary online learning communities tended to be more successful when they were presented as opportunities for interaction with peers (Carroll et al., 2013). In general, online courses should accommodate a range of student personalities and learning preferences to be most effective (Mupinga et al., 2006). In one study, factors influencing students' decisions to enroll in remote education included flexibility, convenience, time efficiency, learning and interaction preferences for online courses, and a preference to take easier courses online and more difficult courses in person (Jaggars, 2014).

► **Leveraging simulation technology can address the challenge of providing real-world and hands-on instruction.** Several small-scale descriptive studies highlight the potential of simulation technology in remote education in CTE. The healthcare field has embraced simulation technology to teach students how to react in a critical patient care situation while practicing in a safe and controlled environment (Center for Applied Research, 2017). Although simulation technology has been most rigorously studied in healthcare education, it can be made available to other sectors such as welding, aviation, and construction. Advanced, internet-enabled equipment in labs also allows students to conduct lab tasks remotely (The Hunt Institute, 2020). In a technology-enhanced biology course, it was found that laboratory instruction that incorporated simulated work environments provided students with industry experience that employers had identified as a priority in hiring (Alamprese et al., 2017). Similarly, in cosmetology, hair stylists hone their skills by cutting real hair, but virtual programs adapted their training by using mannequins (Association for Career and Technical Education, 2021). One U.S. community college developed “telepresence labs” in which students could remotely access a physical lab environment to complete course assignments (Eyster et al., 2020). In a case study of a remote CTE program for engineering students in Scotland, the authors argued that in-person practical program components could be enhanced through education technologies and multimedia (Connolly et al., 2011). A pilot remote CTE course at six European universities for automation technicians and vocational students reported using real and virtual simulations to provide students with practical experience. The program paired simulations with more traditional, classroom-based learning resources such as theory, exercises, and quizzes (Sanchez et al., 2007).

► **Effective online or virtual programs benefit from input from a variety of groups.** One literature review describing platforms and features for education suggested that remote courses must use input from trainers, trainees, and administrative staff when considering course content, design, and architecture (Bouras et al., 2007). While piloting and testing new curricula are critical to smooth implementation (Gan et al., 2013), input is important for identifying challenges or making program improvements after a remote program has been developed. For instance, an online nursing program in

the U.S. used faculty development, team building, and continuous quality improvement to successfully reach national online quality benchmarks (King & Nininger, 2019). In their description of a university-based blended workforce training program for allied health workers, Brandt et al. (2010) indicated the program required significant development and design considerations during the planning phase. For example, when collecting student feedback, authors noted how important it was to differentiate between challenges related to technology and those related to the instructional methods and learning activities. Another design consideration for which input is helpful is what type of information is being conveyed. One meta-analysis of 96 studies (Sitzmann et al., 2006), determined that when compared to in-person classroom instruction, remote education was more effective for teaching declarative knowledge (facts and principles) and less effective for teaching procedural knowledge (rules and procedures).

Employers are critical when it comes to workforce development and involving them in remote CTE program design can ensure that programs are aligned with industry needs. This would, in turn, enhance the employability of program graduates and provide employers with skilled workers (Gan et al., 2013). For example, a large component of the *Better Occupational Outcomes with Simulation Training* (BOOST) program, a TAACCCT-funded initiative targeting the health sector, was employer engagement. Local healthcare agencies and hospital staff (i.e., potential employers) were heavily involved and helped develop the content for the BOOST program. Employer involvement benefited students in that it raised awareness of the skill level of the students in the program, allowed students to interact with healthcare professionals prior to employment, helped the colleges secure clinical space, and helped students gain employment (Center for Applied Research, 2017).

► **Effective implementation of remote education and training must consider the technological literacy and training requirements for students and faculty.** Limited technological literacy of students and the lack of professional development for faculty and staff are commonly cited challenges in remote education and training (Briggs et al., 2021; Cropper et al., 2018; Gan et al., 2014; Gan et al., 2013). Multiple studies emphasized the need to provide teachers with training on how to use online teaching platforms, including strategies tailored to online environments, to help alleviate challenges with instructor willingness and ability to use technology (Connolly et al., 2011; Eyster, 2019; Eyster et al., 2020; Vogt, 2014; Zirkle & Fletcher, 2009). It is also important to assess prospective participants' technological skills prior to enrolling, provide extensive support for first-time instructors of an online or remote course, and provide technical assistance to both students and instructors when needed (Gan et al., 2013; Maxwell et al., 2013). Some research also suggests providing a digital "on-ramp" that ensures participants have the tools needed to succeed in a technology-based environment. Such efforts can include assessments, orientations, technology skill building exercises, and other activities to help students and/or faculty gain the necessary level of functionality and comfort needed to succeed (Gan et al., 2013).

► **Limited resources might constrain organizations' ability to provide remote CTE.** The literature cautions that costs may be higher to develop online courses that facilitate the interactions between students and instructors that are necessary for learning outcomes to match those of in-person instruction (Protopsaltis & Baum, 2019; Xu & Xu, 2020). In the U.S., the cost of equipment to implement remote CTE as well as administrative hurdles can be burdensome on institutions (Metz, 2010). For

example, some community colleges receiving TAACCCT grants from DOL struggled to implement online courses because they lacked internal capacity and infrastructure and there was a lengthy accreditation process (Eyster, 2019). However, as technology options become more widely available, institutions may be better able to cost-effectively provide remote CTE (Metz, 2010). Another consideration is that faculty compensation strategies do not always provide extra funding to prepare new courses. Thus, increasing faculty pay to convert courses to an online format and attend trainings may be one strategy to facilitate the shift to online instruction (Eyster et al., 2020).

3. Equity considerations related to remote education and training

► **Students in rural and low-income urban areas face myriad challenges due to a lack of broadband infrastructure, prohibitive costs of devices and internet services, and digital literacy gaps.** Research indicates that access to quality broadband is a significant barrier in rural and low-income urban communities where students are less likely to have reliable at-home access to high-speed internet due to inadequate broadband coverage, restricted access, and frequent outages (Association for Career and Technical Education, 2021; Cropper et al., 2018; Fernandez et al., 2020). Faster download speeds and stable connections can be crucial factors in deciding to enroll and actively participate in online programs (Association for Career and Technical Education, 2020; Skinner, 2019). Most educators rate their students' access to internet service as only somewhat reliable, with 14 percent categorizing it as not at all reliable (Association for Career and Technical Education, 2021). In fact, community colleges implementing remote education have found that rural students lack access to high-speed internet which limits enrollment and student participation (Eyster, 2019; Eyster et al., 2020). Without meaningful broadband adoption, learners in rural or low-income urban communities have limited exposure to technology, which creates digital literacy gaps (Briggs et al., 2021; Fernandez et al., 2020). These gaps are exacerbated when online programs do not embed technical supports in their programming (Gan et al., 2014).

Adult learners from low-income households are often more likely to use mobile devices to access coursework due to their relative versatility and access compared to desktop devices (Association for Career and Technical Education, 2020; Fernandez et al., 2020). Mobile devices have the potential to be powerful learning tools as they enable "anytime-anywhere" interaction with content and peers at a low marginal cost (Gan et al., 2014). For some learners, however, dependence on mobile devices can create barriers to access since not all cellphone users can afford data plans, and those who do may experience frequent service disruptions due to unpaid bills or exceeding data caps (Fernandez et al., 2020). Further still, the mobile user experience is not always the same as the computer user experience (Association for Career and Technical Education, 2020). Some states are addressing this disparity by designing and modifying workforce system platforms to assist users in accessing career services from a cell phone or tablet (Cropper et al., 2018).

To promote equity, online programs should consider whether they are asking students to engage with content in a way that requires substantial computing power, internet bandwidth, or digital literacy (Anderson et al., 2021). Additionally, having multiple points of access to high-quality internet is essential for active engagement in online programs. Noting that many learners cannot reliably travel to brick-and-mortar workforce centers, a key strategy for increasing internet access for learners in rural and low-

income urban communities is to collaborate with community partners like libraries and community centers to offer alternative sites for technology-based learning (Cropper et al., 2018). Laptop lending programs could also increase access (Eyster, 2019; Skinner, 2019). Thus, it is important to gain additional insight into what constitutes an appropriate level of technological literacy, where the skill gaps are, and how to tailor instruction and supports to increase literacy (Gan et al., 2013). Given the mobile dependence observed in low-income communities, it will be important for online programs to continue to develop strategies for increasing points of access that complement cellphone usage for learning opportunities.

► **To increase access and equitable opportunities, distance education programs should be tailored to the circumstances of a diverse group of learners.** CTE students are more likely than all students in community and technical colleges to be male, Black or Latinx, to have dependent children, to be first-generation college students, and to work more than 30 hours a week (Anderson et al., 2021). Another study of remote education offerings in postsecondary CTE (Benson et al., 2008) observed that *remote* CTE attracted more working professionals, students who were currently employed, students outside the college district, single parents, and part-time students, than in-person CTE. An analysis of adult learners focused on the role that significant life events, external commitments, and resilience played in student persistence in technology-based learning found that, in general, familial, financial, and community-based commitments did not significantly predict persistence, but external work commitments were negatively associated with persistence (Gan et al., 2014).

A literature review by Farmer (2009) emphasized the importance of designing remote education and training that considers the cultural context of the students, instructors, the current or intended workplace, and the profession. Research demonstrates that learners with disabilities, low-income adults, older adults, those living in rural or low-income urban areas, and those with limited English or computer skills are disproportionately impacted by shifts from in-person to remote instruction (Anderson et al., 2021; Briggs et al., 2021). A study examining the factors influencing how community colleges in the U.S. offer remote and blended CTE observed that community colleges with more White students were more likely to offer remote CTE than those with more students of color (Githens et al., 2014). As more CTE programs shift to online learning modalities, creating support structures for these learners will be especially important to create equitable opportunity for accessing and participating in education and training. As an example, a shift to remote learning caused by the COVID-19 pandemic benefited certain learners because there was an increased focus on accessibility of course materials through captioning, alternative text, and other accommodations (Association for Career and Technical Education, 2020). These accommodations benefited students with vision and/or hearing impairments, English learners, and students working in noisy environments (Association for Career and Technical Education, 2021). To promote equity, experts recommend the continued use of assistive technology to support and enhance instruction in online learning environments (Association for Career and Technical Education, 2021).

Where are the gaps in the research on remote postsecondary education and training?

- **There is a lack of causal research examining the effects of remote CTE as a delivery model on employment and earnings.** Descriptive studies suggest a positive association between participation in remote CTE programs and labor outcomes, but results from causal studies are mixed and the question remains as to whether CTE sectors (e.g., health science, information technology) can be delivered effectively through remote learning and for whom. Given that some form of remote learning is likely to endure, research is needed on how to effectively engage all learners in remote CTE, particularly those who have been traditionally underserved. Significant disparities in postsecondary CTE outcomes exist between students of color and White students within postsecondary CTE programs at community and technical colleges, and these gaps are wider in online programs (Anderson et. al, 2021). In addition, addressing the challenges for prospective learners who lack digital literacy and/or internet and computer access, is needed.
- **Research is needed to determine the most effective modes of remote delivery for various sectors.** Another important area for future research is more systematic investigation of which models of remote delivery (e.g., hybrid, combination of synchronous and asynchronous online education, and flipped classrooms) are effective in different fields. More rigorous causal research is needed to examine the *quality* of remote education and training by modality and its impact on employment, earnings, and other outcomes.
- **Practitioner and employer partnerships in the design of remote programs are needed.** Early evidence suggests that partnerships with employers and industry are beneficial to CTE learner outcomes when delivered remotely because the curriculum and skills can be better tailored to the employer needs, and there is the potential to leverage funding to support remote programs from the private sector. At the same time, employer acceptance of credentials obtained through remote modes is not universal, therefore, a better understanding of which employers are engaged, and what programs they are interested in, is essential to determine how they can contribute to course and program design.
- **Investments are needed to expand access for underserved populations.** Remote programs have the potential to increase access to education and training by providing adult learners with flexible and convenient learning opportunities that accommodate a variety of circumstances. However, these programs cannot reach their full potential without the foundation of a reliable broadband infrastructure in rural and low-income urban communities and accessible technology (Association for Career and Technical Education, 2020; Fernandez et al., 2020; Skinner, 2019). Investments are needed to develop such an infrastructure, especially in underserved communities that do not have the access to the technology required for remote courses. Understanding the full costs will allow providers and policymakers to better advocate for funding programs in their communities.

Rapid Evidence Review Supplement: Citations and Further Information

This supplement to the rapid review presents study summaries and citations reviewed for the synthesis. The first section summarizes studies and publications incorporated into the synthesis. The second lists citations used for background information. The final section describes the approach used to create the rapid review.

CITATIONS AND STUDY SUMMARIES

This supplement presents the publication summaries using the same organization as the rapid review with an additional category for other citations supporting the synthesis. Within each section, summaries are alphabetical. Bolded text in the summaries denote the data source(s), timing, location, and analytic method for studies that included this information. Publications are cross listed in multiple sections, though the publication is summarized only on its first appearance. The subsections are as follows:

1. Effects of remote postsecondary education and training on participant outcomes.
2. Designing and implementing remote postsecondary education and training.
3. Equity considerations related to remote postsecondary education and training.

1. Effects of remote postsecondary education and training on participant outcomes

Alamprese, J. A., Costelloe, S., Price, C., & Zeidenberg, M. (2017). *Evaluation of the Community College Consortium for Bioscience Credentials (c³bc): Final report*. Abt Associates.

<http://www.skillscommons.org/bitstream/handle/taaccct/15589/Forsyth%20TCC%20-%20Final%20Evaluation%20-%202017.02.24.pdf?sequence=1&isAllowed=y>

- Type of research: Causal (matched comparison group) and descriptive (implementation)
- Summary: The study analyzed the effect of online introductory science courses on student learning at a community college in the U.S. The study used a quasi-experimental design in which the treatment group, comprising students who enrolled in an online course, was matched to a comparison group of similar students taking the same courses in person. Using student records data, the study found that students who participated in the online course were less likely to complete the course and had lower grades compared to the students who took the course in person.

Anderson, T., Briggs, A., & Spaulding, S. (2021). Racial and ethnic equity gaps in postsecondary career and technical education: considerations for online learning.

<https://www.urban.org/research/publication/racial-and-ethnic-equity-gaps-postsecondary-career-and-technical-education>

- Type of research: Descriptive (quantitative)
- Summary: The researchers presented **differences in means** conditional on program and student characteristics to show the different outcomes for various racial groups who start in online CTE versus in-person CTE in the **U.S.** Using **student level data** from the **Beginning Postsecondary Survey**, they showed that students exhibited statistically different outcomes across racial groups and within online and in-person CTE. White students benefited the most of all racial groups from online CTE but had worse outcomes than White students who started in in-person CTE. The same pattern was true for Black and Latinx students.

Bell, B. S., & Federman, J. E. (2013). E-learning in postsecondary education. *The Future of Children*, 23(1), 165–185. <https://www.jstor.org/stable/23409493>

- Type of research: Other (literature review)
- Summary: The study reviewed **literature and meta-analyses** on e-learning in postsecondary education to determine whether e-learning produced the same learning outcomes as other delivery mediums and whether e-learning features influenced its effectiveness. The study found that e-learning outcomes can be as strong as other delivery forms when other variables are held constant. The authors also discussed how to design e-learning programs to be more effective and how cost factors into the use of e-learning. Overall, the study found that e-learning can be an effective delivery method in postsecondary education, but that effectiveness depended on course type and context.

Benson, A. D., Johnson, S. D., Taylor, G. D., Treat, T., Shinkareva, O. N., & Duncan, J. (2005). Achievement in online and campus-based career and technical education (CTE) courses. *Community College Journal of Research and Practice*, 29(5), 369–394.

<https://eric.ed.gov/?id=ED493603>;

<https://naspa.tandfonline.com/doi/abs/10.1080/10668920590921589#.XymNxyhKiHs>

- Type of research: Causal (matched comparison group) and descriptive (case study)
- Summary: This study examined the effectiveness of online CTE in providing training to students in postsecondary education in the **U.S.** It used a quasi-experimental design to compare outcomes for those enrolled in online courses and those in campus-based courses. The authors used the **Motivated Strategies for Learning Questionnaire; the Course Interaction, Structure, and Support questionnaire; and instructor-developed pre- and post-tests** designed to assess knowledge of content being delivered, **and course projects** to assess student outcomes. The authors also used **case studies** to describe each of the courses examined in the study. The authors observed no statistically significant differences in student achievement between online and campus-based students, and students enrolled in online CTE courses appeared to be as motivated to learn as campus-based students. The qualitative

findings suggested online CTE courses did not necessarily give students the ability to complete courses at their own pace but did provide flexible options for students.

Bettinger, E. P., Fox, L., Loeb, S., & Taylor, E. S. (2017). Virtual classrooms: How online college courses affect student success. *American Economic Review*, 107(9), 2855–2875.

<https://scholar.harvard.edu/files/online-inperson-bflt.pdf>

- Type of research: Causal (instrumental variables)
- Summary: The study examined the effect of taking a course online on student outcomes, compared to taking a course in person. The study subjects were primarily four-year degree-seeking students at a large for-profit university in the **U.S.** The researchers used **student records data** and **instrumental variables regression** to determine if there was a difference in student outcomes in the course, student outcomes during their college career, and overall college persistence for those who took a course online versus in person. The authors conclude that students in the online course were more likely to drop out of the institution and had lower grades, on average, than those taking the in-person course.

Bowen, W.G., Chingos, M. M., Lack, K. A., & Nygren, T. I. (2012). *Interactive learning online at public universities: Evidence from randomized trials*. Ithaca S+R. [https://sr.ithaka.org/wp-](https://sr.ithaka.org/wp-content/uploads/2015/08/sr-ithaka-interactive-learning-online-at-public-universities.pdf)

[content/uploads/2015/08/sr-ithaka-interactive-learning-online-at-public-universities.pdf](https://sr.ithaka.org/wp-content/uploads/2015/08/sr-ithaka-interactive-learning-online-at-public-universities.pdf)

- Type of research: Causal (randomized controlled trial)
- Summary: The study examined the effect of a hybrid (online plus in-person) statistics course on student learning outcomes compared to an in-person-only statistics course. The authors conducted a **randomized controlled trial** (RCT) at six public universities in the **U.S.**, using **student records data and student surveys**, and found that learning outcomes were not statistically different between the treatment and control groups. The study also found that teaching large introductory courses with a hybrid learning format could reduce instructor compensation costs.

Castro, M. D. B., & Tumibay, G. M. (2019). A literature review: Efficacy of online learning courses for higher education institution using meta-analysis. *Education and Information*

Technologies. <https://doi.org/10.1007/s10639-019-10027-z>

- Type of research: Other (literature review)
- Summary: The study focused on how to improve the quality of online higher education courses. The researchers conducted a **review of existing literature** to examine methods for designing and developing high-quality courses. The authors considered **30 studies** that examined the effect of online postsecondary courses on student outcomes. The authors reported results from several studies showing that learning outcomes were the same for online and in-person courses. The authors concluded that online education would likely grow in the coming years and recommended creating high-quality online learning courses by encouraging critical thinking, student engagement, and online learning communities.

Center for Applied Research. (2017). *Midlands Technical College TAACCCT Better Occupational Outcomes with Simulation Training: Program evaluation final report*. Center for Applied Research.

<https://www.skillscommons.org/bitstream/handle/taaccct/15679/BOOST%20Final%20Evaluation%20Report.pdf?sequence=1&isAllowed=y>

- Type of research: Causal (matched comparison group)
- Summary: The researchers used **propensity score matching** to estimate the effectiveness of a hybrid healthcare education program (Better Occupational Outcomes with Simulation Training, or BOOST) at six community colleges in the **U.S.** The treatment group participated in the hybrid healthcare education program through BOOST, while the comparison group participated in the traditional in-person healthcare education program. Using **student records data**, the researchers found that students who participated in BOOST attended college longer, were more likely to earn a diploma or certificate, and graduated more quickly than those who did not. However, students participating in BOOST were less likely to earn a degree and transferred to two- and four-year institutions at lower rates than those who did not participate in BOOST.

Eyster, L. & Kuehn, D. (2020). A Synthesis of Findings from the Round 3 Trade Adjustment Assistance Community College and Career Training Third-Party Impact Evaluations. Prepared for the US Department of Labor, Chief Evaluation Office. Washington, DC: Urban Institute.

https://www.dol.gov/sites/dolgov/files/OASP/evaluation/pdf/ETA_Round3TAACCCTImpactSynthesis_Report_Sep2020.pdf

- Type of research: Other (synthesis)
- Summary: This report synthesized findings from **23 Round 3 third-party evaluations** which provided quasi-experimental impact analyses on the impacts of TAACCCT on education and employment outcomes of participants in the **U.S.** Of the 23 programs reviewed, 18 included online and/or hybrid learning. Summarizing findings from causal studies, the authors discussed the effects of each program on educational and employment outcomes including credential completion, credits earned, program completion persistence, retention, dropout rates, and GPA. The review also summarizes the methodologies implemented by each third-party evaluator and the limitations of each study.

Figlio, D., Rush, M., & Yin, L. (2013). Is it live or is it internet? Experimental estimate on the effects of online instruction on student learning. *Journal of Labor Economics*, 31(4), 763–

784. <https://www.journals.uchicago.edu/doi/full/10.1086/669930>

- Type of research: Causal (randomized controlled trial)
- Summary: The authors used an **RCT** to determine the effects of taking a class in person versus online. The authors randomly assigned students in a large introductory microeconomics course at a university in the **U.S.** to either a treatment group that watched the lectures online or a control group that attended the lectures in person. Using **student records data** and course **test scores**, the study found that students attending lectures online had average test scores similar to students who attended the same lectures in person. The study found that

underprepared students in the online course performed worse than similarly underprepared students attending the in-person course. Additionally, Hispanic students, males, and low achievers performed better in the live course.

Maxwell, N., Sattar, S., Rotz, D., & Dunham, K. (2013). *Evaluation of programs funded by technology-based learning (TBL) grants*. Mathematica Policy Research. <https://www.mathematica.org/our-publications-and-findings/publications/evaluation-of-programs-funded-by-technologybased-learning-tbl-grants>

- Type of research: Descriptive (quantitative)
- Summary: This report evaluated the outcomes of technology-based learning (TBL) funded by the U.S. Department of Labor (DOL) in the **U.S.** Using **administrative data and survey data** on program satisfaction, the authors analyzed the characteristics and outcomes of students participating in TBL programs, as well as their satisfaction with the programs **from 2009 to 2012**. The report noted a demographically diverse set of students, with over half ages 25 to 44, over 60 percent White, 43 percent low-income, 56 percent employed, and 87 percent enrolled in a degree program. Nearly 75 percent reported being satisfied with their program, and around 90 percent would recommend the program to others. However, participants who were younger, less educated, non-White, had no previous experience with TBL, and were not in hybrid programs tended to be less satisfied. Nevertheless, 79 percent of participants continued in existing employment or secured new employment after program participation, with hourly wages increasing from \$19.59 to \$21.60 on average. These results suggest that despite disparities in satisfaction levels, TBL was largely successful in upskilling and securing higher-paying jobs for participating students.

Neuhauser, C. (2002). Learning style and effectiveness of online and face-to-face instruction. *American Journal of Distance Education*, 16(2), 99–113. https://doi.org/10.1207/S15389286AJDE1602_4

- Type of research: Causal (comparison group)
- Summary: The study compared learning outcomes for students in two sections of a course at a private university in the **U.S.** The treatment group took the class asynchronously online, while the comparison group took the course in a more traditional face-to-face format. The same instructor taught both formats of the course, and students in both groups used the same instructional materials. The authors analyzed **student surveys and course data** to determine the effects of taking the course online versus in person. The study found no significant difference in retention rate, student outcome metrics, or perceived learning effectiveness between the two groups.

Protopsaltis, S., & Baum, S. (2019). *Does online education live up to its promise? A look at the evidence and implications for federal policy*. Center for Educational Policy Evaluation. <https://jesperbalslev.dk/wp-content/uploads/2020/09/OnlineEd.pdf>

- Type of research: Other (literature review)
- Summary: The authors conducted a **literature review** to determine whether the increased use of online education has led to enhanced learning and greater access to postsecondary

education. The literature review determined that students with weak academic preparation, as well as low-income students and those from underrepresented backgrounds, tend to perform more poorly in fully online education environments than in in-person courses. Additionally, employers tend to attribute a lower value to degrees earned online. The literature review found that frequent engagement between students and instructors was key to increasing student achievement and a sense of fulfillment when taking online courses. Given these findings, the authors concluded that weakening federal requirements for student and instructor interaction for online classes would likely lead to a lower quality of education compared with in-person instruction.

Shea, P., & Bidjerano, T. (2014). Does online learning impede degree completion? A national study of community college students. *Computers & Education*, 75, 103-111.

<https://www.sciencedirect.com/science/article/abs/pii/S0360131514000438>

- Type of research: Causal (matched comparison group)
- Summary: This study used a nationally representative sample of community college students from **the Beginning Postsecondary Student Survey** to examine the relationship between enrollment in distance education and degree attainment in the **U.S.** The authors used a **propensity score matching** method to create an appropriate comparison group using demographic, education and other information. The authors found that students who took some of their early courses online or at a distance had a significantly better chance of attaining a community college credential than did their classroom-only counterparts.

U.S. Department of Education. (2010). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies*. <https://repository.alt.ac.uk/629/>

- Type of research: Other (meta-analysis)
- Summary: Researchers conducted a **meta-analysis** of existing literature about online learning to determine whether a difference in learning outcomes was present between in-person and online instruction. Using 50 independent estimates from **45 experimental or quasi-experimental studies**, the researchers found that students participating in online education performed slightly better than those participating in in-person instruction, and that the difference was larger when comparing hybrid models to in-person instruction. However, the authors suggested caution when interpreting these results because many hybrid programs included elements such as additional learning time or different instructional content that were not available to students in in-person courses.

Wearne, S., Giddings, P., McLaren, J., & Gargan, C. (2010). Where are they now? The career paths of the remote vocational training scheme registrars. *Australian Family Physician*, 38(1/2), 53–56.

<https://search.informit.org/doi/abs/10.3316/INFORMIT.711674372039846>

- Type of research: Descriptive (qualitative and quantitative)
- Summary: The study discusses the Remote Vocational Training Scheme (RVTS) as a model for remote education to train doctors in remote communities. An online **survey** was sent to medical practitioners in **Australia** to gather information about the effectiveness of the RVTS

training and whether training participants continued to practice in rural and remote communities. The study found that the RVTS was effective in training practitioners and can aid in providing access to health care and training in rural areas.

Xu, D., & Jaggars, S. (2011). *Online and hybrid course enrollment and performance in Washington State community and technical colleges*.

<https://academiccommons.columbia.edu/doi/10.7916/D8862QJ6>

- Type of research: Descriptive (quantitative)
- Summary: This report examined enrollment patterns and academic outcomes for students receiving online, hybrid, and face-to-face courses at **Washington State** community and technical colleges. The authors used a **student-level data set** comprising 51,017 students who were enrolled in one of the state's 34 community or technical colleges in **2004 and tracked their outcomes through spring 2009**. Analysis of enrollment patterns suggested that students who were employed more hours, dual enrolled before entering college, eligible for financial aid, and never enrolled in remedial education were more likely to enroll in online courses. Students enrolled in hybrid and face-to-face courses were similar. **Regression analyses** further suggested that students who enrolled in online courses were more likely to fail or withdraw from their course and were less likely to return the following term.

2. Designing and implementing remote postsecondary education and training

Alamprese, J. A., Costelloe, S., Price, C., & Zeidenberg, M. (2017). *See section 1*.

Association for Career and Technical Education (ACTE). (2021). *High-quality CTE during COVID-19: challenges and innovations*. https://www.acteonline.org/wp-content/uploads/2021/04/HighQualityCTE_COVID_ChallengesAndInnovations_March2021_Final.pdf

- Type of research: Descriptive (quantitative)
- Summary: The authors **surveyed CTE professionals** on their use of a variety of CTE delivery methods to educate learners during COVID-19. The most common methods of CTE delivery were in-person and hybrid/blended learning. The authors showed that enrollment declined in the last year. The key challenges in remote CTE delivery during the pandemic included motivating and engaging learners, providing hands-on learning and lab hours, providing work-based learning experiences, and preparing learners for certification and other performance assessments. Moreover, students' access to the internet and online technology tools were also cited as common issues in remote CTE, as well as supporting special and underserved populations.

Bouras, C., Giannaka, E., & Tsiatos, T. (2007). *Chapter XI: An integrated architecture for supporting vocational training*. IGI Global.

<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.144.2760&rep=rep1&type=pdf>

- Type of research: Other (literature review)

- Summary: This literature review described how CTE has been adapted for remote learning and outlined a framework for supporting remote CTE. The authors noted that although CTE is essential as the labor market becomes more specialized, many workers cannot participate due to time and distance constraints. These factors make remote CTE an attractive option in many countries. The authors divided current technologies for supporting remote CTE into three categories: (1) synchronous (text/voice chat), (2) asynchronous (email, forums, glossaries, etc.), and (3) collaborative (shared whiteboard, application sharing, multimedia presentation, etc.), arguing that remote CTE should integrate all three types of technologies. For implementing remote CTE, the authors stressed that remote CTE should consider the technological needs of several stakeholders, including vocational center administrative staff, trainers, and trainees. Considering these stakeholders will improve overall training by decreasing the learning curve on technologies, providing effective web-based training support, and promoting the personalized nature of the web-based training process for trainees.

Brandt, B. F., Quake-Rapp, C., Shanedling, J., Spannaus-Martin, D., & Martin, P. (2010). Blended learning: Emerging best practices in allied health workforce development. *Journal of Allied Health*, 39(4), 167E–172E.

<https://www.ingentaconnect.com/content/asahp/jah/2010/00000039/00000004/art00016>

- Type of research: Descriptive (implementation)
- Summary: This paper details the Center for Allied Health Programs at the University of **Minnesota's** experiences in implementing a blended workforce training program to allied health workers. The findings led the authors to suggest that a quality blended program requires significant development and design considerations during the planning phase, as well as faculty commitment. For example, when collecting student feedback, the study concluded it was important to differentiate between challenges related to technology and those related to the instructional methods and learning activities.

Briggs, A., Anderson, T. & López, D. (2021). *Online Career and Technical Education Programs during the Pandemic and After*. <https://www.urban.org/research/publication/online-career-and-technical-education-programs-during-pandemic-and-after>

- Type of research: Descriptive (quantitative and qualitative)
- Summary: The authors surveyed **community and technical colleges** in **December 2020** in the **U.S.** to gather insights on their approaches to online learning. This study included information on the availability of online and hybrid programs before the pandemic, shifts occurring during the pandemic, and plans for course delivery after it ends, as well as challenges, opportunities, and considerations in remote CTE. The authors showed that a large share of programs plan to move to hybrid instruction after the pandemic ends, and that providing hands-on training, employer engagement, and student access to technology were among the largest challenges faced by CTE providers.

Cai, S., & Zhu, W. (2012). The impact of an online learning community project on university Chinese as a foreign language students' motivation. *Foreign Language Annals*, 45(3), 307–329.

<https://doi.org/10.1111/j.1944-9720.2012.01204.x>

- Type of research: Descriptive (quantitative and qualitative)
- Summary: The study examined changes in students' motivation for learning Chinese as a foreign language before and after participating in an online learning community at a public university in the **U.S.** Students completed a **questionnaire** before and after engaging in the online community. Using quantitative data from the questionnaire, the authors concluded that students had higher motivation for learning Chinese after participating in the online community. From qualitative data the authors identified motivating features such as access to learning resources and tools, opportunities to connect with other students, and feedback from others.

Carroll, D., Ng, E., & Birch, D. (2013). Strategies to improve retention in postgraduate business students in distance learning courses: An Australian case. *Turkish Online Journal of Distance Education*, 14(1), 140–153. <https://dergipark.org.tr/en/pub/tojde/issue/16895/176020>

- Type of research: Descriptive (qualitative)
- Summary: The study assessed what factors contributed to retaining **Australian** postgraduate business students in distance education courses. The researchers gathered qualitative data through 45-minute **in-depth interviews** with both active and exited students. Major personal factors related to retention included family and employment commitments, student motivation, and student goals. Institutional factors such as program design, course relevance, student support, orientation programs, and faculty responsiveness also contributed to retention. The authors also offered several suggestions to improve retention.

Center for Applied Research. (2017). *See section 1.*

Connolly, T., Gould, C., Baxter, G., & Hainey, T. (2011). Learning 2.0: Using web 2.0 technologies for learning in an engineering course. In R. Babo & A. Azevedo (Eds.), *Higher education institutions and learning management systems: Adoption and standardization* (pp. 50–73). IGI Global.

<http://doi:10.4018/978-1-60960-884-2.ch003>

- Type of research: Descriptive (case study)
- Summary: The authors examined student satisfaction with the use of online education in vocational training in **Scotland**. After completing online training modules, students completed **questionnaires** to rate their levels of satisfaction and knowledge gains. The study found that the online training produced satisfactory student learning and satisfaction outcomes, leading the authors to conclude that online education could supplement or replace certain aspects of vocational training. Increased use of online education in vocational training could improve access to training by providing increased flexibility for students.

- Cropper, P., Robinson, D., Farrell, M., Webster, R., Germain, J., Cummings, K., & Benson, V. (2018). *Technology-Based Learning in the Public Workforce System: Emerging Policy and Practices in States and American Job Centers*.
https://www.dol.gov/sites/dolgov/files/OASP/evaluation/pdf/ETA_TBlinPWSEmergingPolicyPracticesInStatesAndAJCs_Report_Aug2020.pdf
- Type of research: Descriptive (qualitative)
 - Summary: This report documented how technology-based learning (TBL) is used in select **states** and **American Job Centers (AJCs)**. It discussed the circumstances under which TBL was adopted, factors that shaped its adoption, explored policies and practices that promoted the use of TBL in occupational training, and described promising strategies implemented in select states to increase remote access to TBL.
- Eyster, L. (2019). *A synthesis of findings from the rounds 1 and 2 Trade Adjustment Assistance Community College and Career Training third-party evaluations*. Urban Institute.
<https://www.urban.org/sites/default/files/publication/103143/a-synthesis-of-findings-from-the-rounds-1-and-2-trade-adjustment-assistance-community-college-and-career-training-third-party-evaluations.pdf>
- Type of research: Other (synthesis report)
 - Summary: The study synthesized findings from **nine first-round and 72 second-round evaluations** of TAACCCT grantees in the **U.S.** Of the programs reviewed, 49 percent included online learning and 62 percent included hybrid learning. Summarizing findings from causal and descriptive studies, the authors described instances in which grantees used online or hybrid programs to provide interactive and hands-on vocational training. The authors noted several key considerations for developing and implementing online and hybrid programs such as digital skills and access to technology.
- Eyster, L., Biggs, A., Durham, C., Hafford, C., & Spievack, N. (2020). *Systems change in community colleges: Lessons from a synthesis of round 3 TAACCCT third-party evaluation findings*. Urban Institute.
<https://www.urban.org/sites/default/files/publication/103148/systems-change-in-community-colleges-lessons-from-a-synthesis-of-the-round-3-taacct-third-party-evaluation-findings.pdf>
- Type of research: Other (synthesis report)
 - Summary: The study synthesized findings from **56 third-party evaluations** of TAACCCT Round 3 grantees at community colleges in the **U.S.**, of which 32 provided online learning or supports. The authors reported several ways that grantees changed their systems to better serve adult learners seeking to participate in their programs, including the use of specialized educational software and online resources for remediation and basic skills training. Findings from the synthesis indicated that some online programs had trouble accessing rural participants who had limited Internet access and broadband service, as well as participants with low levels of technological skills. The synthesis described lessons learned from the implementation of online or hybrid programs at several community colleges.

Gan, K. N., Schneider, G., Harvill, E. L., & Brooke, N. (2013). *Exploring the Role and Adoption of Technology-Based Training and Employment Services*. Final Report. Abt Associates.
https://wdr.doleta.gov/research/FullText_Documents/ETAOP_2015-09_Attach.pdf

- Type of research: Descriptive (qualitative)
- Summary: The researchers conducted this study to collect descriptive information about the use of technology-based learning (TBL) at the state and local levels of the workforce system. Data about state policies and support for TBL were collected in an online survey of **state workforce agency (SWA) administrators**, and data about local implementation of TBL were collected in an online survey of the **Executive Directors of Local Workforce Investment Boards**. This report provided a description of SWAs' efforts to promote and support TBL, as well as actual adoption and use of TBL at the local level in providing Workforce Investment Act (WIA) services.

Gan, K. N., Schneider, G., Epstein, Z., & Silverman, A. (2014). *Technology-Based Learning (TBL) in Workforce Development and Education: A Review of the Research Literature*. Prepared for the U.S. Department of Labor. Cambridge, MA: Abt Associates Inc.
https://wdr.doleta.gov/research/FullText_Documents/ETAOP-2020-08_TBL_Report-3_TBL_in_WD_and_Ed_Literature_Review.pdf

- Type of research: Other (literature review)
- Summary: The authors conducted a **literature review** to examine the factors that drive consideration and ultimately the adoption (or not) of technology-based learning (TBL) from the perspective of both the learner and the institutional provider in the **U.S.** They also explored the available research to determine how effective TBL appears to be in achieving important workforce-related outcomes. The literature review found that technological literacy and the cost of providing TBL are the most often cited barriers by learners and providers, respectively. Although the causal literature they review was dated, they found that blended/hybrid and synchronous TBL were most likely to produce results as effective as traditional learning.

Ha, Y., & Im, H. (2020). The role of an interactive visual learning tool and its personalizability in online learning: Flow experience. *Online Learning*, 25(1), 205–226.
<https://doi.org/10.24059/olj.v24i1.1620>

- Type of research: Causal (randomized controlled trial)
- Summary: This **RCT** analyzed the effect of interactive online learning tools on learning in college students in the **U.S.** from a flow perspective. Flow is a state of complete engagement with a task or activity at-hand. In Study 1, the authors administered a **questionnaire** and **quiz** after allowing students to explore a website for 10 minutes in a lab setting. Study 1 found that students with an interactive website had higher engagement, better performance on a post-test, greater focus, and found the website more useful than those who did not have an interactivity component. In Study 2, the authors used a questionnaire and quiz after allowing students to explore a website with personalized difficulty levels for 20 minutes in a lab setting. Study 2 found that students who had a personalized experience had higher levels of curiosity, greater feelings of the site's usefulness, and were more satisfied with their experience.

Hai-Jew, S. (2009). Real-time in cyberspace: Effective, live synchronous e-learning. In V. X. Wang (Ed.), *Handbook of research on e-learning applications for career and technical education: Technologies for vocational training* (pp. 128–143). IGI Global. <http://doi:10.4018/978-1-60566-739-3.ch010>

- Type of research: Other (literature review)
- Summary: The **literature review** discussed using live interaction during online instruction to improve learning. The author discussed using webinars, conversations, simulations, and demonstrations to maximize the use of learning time and learning for participants. Strategies for maximizing synchronous learning time were considered for improving online education with live collaborative technologies.

The Hunt Institute (2020). *Impact of COVID-19 on Career & Technical Education Courses*. <https://hunt-institute.org/resources/2020/12/impact-of-covid-19-on-career-technical-education-courses/>

- Type of research: Other (opinion piece)
- Summary: This publication discussed the challenges in CTE posed by the COVID-19 pandemic, particularly regarding enrollment, funding, and student engagement. The authors also discussed the shifts in CTE delivery methods during the pandemic, providing some anecdotal examples of these shifts. The piece provided a list of policy considerations including increasing investment in virtual and remote learning tools, providing flexible guidance for districts on work-based learning, using videos and tutorials, modifying requirements for certification, providing additional funding and support to CTE programs, assessing remote CTE program quality, and ensuring equitable access among students.

Jaggars, S. S. (2014). Choosing between online and face-to-face courses: Community college student voices. *American Journal of Distance Education*, 28(1), 27–38.

<https://www.tandfonline.com/doi/abs/10.1080/08923647.2014.867697>

- Type of research: Descriptive (qualitative)
- Summary: This study reported on the experiences of community college students with online and face-to-face learning. The author conducted **interviews** with online faculty, support, and administrative staff, and 47 students who were taking at least one online course in 2011 at a community college in **Virginia**. The students shared two primary reasons for taking online courses: (1) flexibility, convenience, and time efficiency and (2) learning and interaction preferences favoring online courses. Students preferred to take courses that appeared easier to them online. Some students also shared that they choose to take face-to-face courses to maintain a connection to their campus and peers and develop a stronger connection with their instructor.

Jeong, J. S., Gonzalez-Gomez, D., Canada-Canada, F., Gallego-Pico, A., & Bravo, J.C. (2019). Effects of active learning methodologies on the students' emotions, self-efficacy beliefs, and learning outcomes in a science distance learning course. *Journal of Technology and Science Education*, 9(2), 217–227. <https://doi.org/10.3926/jotse.530>

- Type of research: Causal (randomized controlled trial)

- Summary: The study examined how active teaching methodologies in a distance learning course affected students' emotions, self-efficacy, and learning outcomes. The researchers **randomly assigned** university students in **Spain** into a treatment group and a control group. The control group students completed an undergraduate environmental sciences course asynchronously; they were encouraged to engage in discussion boards and activities in a textbook and could get feedback and assistance from instructors as needed. The treatment group used an engaged learning methodology that featured case studies and several interactive learning options. Both groups completed a **questionnaire** on their experiences at the end of the course. Students who participated in the treatment group reported more positive emotions like confidence, passion, and tranquility, and fewer negative emotions like boredom, concern, nervousness, and fear, than students in the control group.

Kim, H. J., Pederson, S., & Baldwin, M. (2012). Improving user satisfaction via a case-enhanced e-learning environment. *Education + Training*, 54(2/3), 204–218. <https://doi.org/10.1108/00400911211210305>

- Type of research: Causal (pre/post)
- Summary: The study sought to assess the experiences of graduate students at a university in the **U.S.** when participating in a course that featured a case-enhanced e-learning environment. Students were non-randomly divided into a comparison group that only received a tutorial and an intervention group that received a tutorial and a learning module using case studies. Students completed **surveys and pre- and post-tests** to measure their experiences with the case-enhanced e-learning environment. The researchers found that the intervention group scored higher in terms of favorable user perceptions than the comparison group. Both the intervention group and comparison group displayed growth in knowledge between the pre- and post-test, but there was no significant difference in knowledge acquisition between the two groups.

King, T. S., & Nininger, J. M. (2019). Quality improvement in online course development: Igniting the online teaching team. *CIN: Computers, Informatics, and Nursing*, 37(7), 349–356. https://journals.lww.com/cinjournal/Abstract/2019/07000/Quality_Improvement_in_Online_Course_Development_4.aspx

- Type of research: Descriptive (case study)
- Summary: The study presented how a college used the “Plan-Do-Study-Act” (PDSA) quality improvement cycle to offer a high-quality online nursing program in the **U.S.** The researchers discussed how the implementation and use of the PDSA improvement cycle in the program allowed for the delivery of quality online instruction and how other institutions may follow a similar model. The authors argued that quality improvement in online programs is necessary going forward and the PDSA cycle offers one model for doing so.

Maxwell, N., Sattar, S., Rotz, D., & Dunham, K. (2013). *See section 1.*

- Metz, K. (2010). Benefits of online courses in career and technical education. *Techniques: Connecting Education and Careers*, 85(6), 20–23. <https://files.eric.ed.gov/fulltext/EJ909583.pdf>
- Type of research: Other (Issue brief)
 - Summary: This paper discussed the benefits of providing online CTE courses for students in the **U.S.** The paper suggested that offering online CTE may allow students to work at their own pace and require students to pass the same exam for certification as those in classroom-based courses. Although the cost of equipment to implement online CTE can be burdensome on school districts, inexpensive technology options can provide students with the opportunity to take online CTE courses.
- Mupinga, D. M., Nara, R. T., & Yaw, D. C. (2006). The learning styles, needs, and expectations of online students. *College Teaching*, 54(1), 185–189. <https://www.tandfonline.com/doi/abs/10.3200/CTCH.54.1.185-189>
- Type of research: Descriptive (quantitative)
 - Summary: The study examined the learning styles, needs, and expectation of online college students, and how that information can be used in designing effective online instruction. The sample consisted of 131 undergraduate students taking online courses at **Indiana State University's** Department of Industrial Technology Education. Students took a **Myers-Briggs personality assessment** to determine personality type and answered **open-ended questions** about their needs and expectations as online students. The authors found no predominant learning style among online students. They did find, however, that online learners frequently expected regular and prompt communication with the professor, prompt feedback on assignments, clear expectations from professors, and academic rigor. Students stated that their needs included technical help, flexible instructors, course information in advance, sample assignments, additional reference materials, and a universal course management platform for all online classes.
- Mupinga, D. M., Bartlett II, J. E., & Bartlett, M. E. (2009). Facilitating scholarly discussion boards for human resource education. In V. X. Wang (Ed.), *Handbook of research on e-learning applications for career and technical education: Technologies for vocational training* (pp. 225–235). IGI Global. <https://www.igi-global.com/chapter/facilitating-scholarly-discussion-boards-human/19975>
- Type of research: Other (literature review)
 - Summary: The **literature review** discussed different asynchronous communication tools that instructors can use to improve online CTE when delivering a course over the internet. The review also considered how to encourage scholarly discussion in classes using discussion boards. The authors concluded, based on their review of the literature, that discussion boards were a useful tool for encouraging student participation for in-person, online, or hybrid courses.
- Olsson, M., Mozelius, P., & Collin, J. (2015). Visualization and gamification of e-learning and programming education. *The Electronic Journal of e-Learning*, 13(6), 441–454. <https://academic-publishing.org/index.php/ejel/article/view/1947>

- Type of research: Causal (randomized controlled trial)
- Summary: The study discussed and presented data on the use of visualization and gamification in an online computer science course in the **U.S.** Students were **randomly assigned** into a control group that participated in an online lecture-style course and a treatment group whose online course environment included visualization features (such as progress bars) in addition to the lecture-style course presentation. The authors administered **evaluation questionnaires** to each group at the end of the course. The researchers found that visualization using a progress bar and completion badges helped students find the courses more fun and entertaining. Gamification and visualization may offer some assistance in increasing student engagement in online courses.

Protopsaltis, S., & Baum, S. (2019). *See section 1.*

Sanchez, J., Vargas, H., & Dormido, S. (2007). Web-based learning resources for vocational training on control and measurement systems: The AutoTECH Project. *2007 European Control Conference (ECC)*, Kos, Greece, 1831–1838. <https://ieeexplore.ieee.org/abstract/document/7068249>

- Type of research: Descriptive (case study)
- Summary: The authors examined a set of virtual and interactive laboratories and simulations for students learning about control and measurement systems as part of automation technician and other vocational training in the **European Union**. The online trainings were designed to encourage ongoing vocational education. The paper discussed several web-based learning systems developed for this purpose.

Sitzmann, T., Kraiger, K., Stewart, D., and Wisher, R. (2006). The comparative effectiveness of web-based and classroom instruction : A meta-analysis. *Personnel Psychology* 59, 623-664. DOI: [10.1111/j.1744-6570.2006.00049.x](https://doi.org/10.1111/j.1744-6570.2006.00049.x)

- Type of research: Other (meta-analysis)
- Summary: The authors conducted a literature search for studies published from **1996 to 2005**, as well as unpublished studies. Analyzing data from **96 publications**, the authors compared the effectiveness of web-based to classroom instruction. They found that web-based instruction was more effective than classroom instruction for teaching declarative knowledge, the methods were equally effective for teaching procedural knowledge, and participants were equally satisfied with both as well. The authors also tested and presented on factors (e.g., practice, feedback, interaction, learner control), that changed these main findings.

Vogt, R. (2014). Experiences with blended learning program delivery for apprenticeship trades: A case study. *International Journal of Higher Education*, 3(4), 85–95. <https://eric.ed.gov/?id=EJ1067494>

- Type of research: Descriptive (case study)
- Summary: This case study of a blended apprenticeship program in **Canada** examined the experiences of the individuals who designed the program, the apprentices who participated, and other stakeholders. The findings suggested that apprentices viewed the ability to remain at home in their community to complete their training as a strength of a blended approach.

Some of the challenges related to designing the program included finding an available subject matter expert and an instructor who was prepared to use the required technology for teaching.

Xu, D., & Xu, Y. (2020). The ambivalence about distance learning in higher education: Challenges, opportunities, and policy implications. In L. W. Perna (Ed.), *Higher education: Handbook of theory and research*, vol. 35. Springer. https://doi.org/10.1007/978-3-030-11743-6_10-1

- Type of research: Descriptive (quantitative) and Other (literature review)
- Summary: The authors conducted a literature review on the access, cost, and student performance in online higher education in the **U.S.** The authors supplemented the review with descriptive data from the U.S. Department of Education's **Integrated - Education Data System**. The authors found that online learning could increase access to higher education for adults with multiple responsibilities. However, it is important to design online courses to provide adequate student support, particularly for less-prepared students. Failure to properly support students taking courses online can be detrimental to their success. The authors noted that designing and administering courses to provide these student supports can be more expensive than in-person courses.

Yilmaz, F. G. K., & Keser, H. (2016). The Impact of reflective thinking activities in e-learning: A critical review of empirical research. *Computers & Education*, 95, 163–173. <https://doi.org/10.1016/j.compedu.2016.01.006>

- Type of research: Causal (randomized controlled trial)
- Summary: This study examined the impact of e-learning with reflective thinking activities on student academic success, social presence perception, and motivation. The researchers **randomly assigned** students at a state university in **Turkey** into three groups: one group learned through a podcast with reflective thinking activities, one group learned through a podcast without reflective learning activities, and one group used web-based videos without reflective learning activities. The authors collected data on student achievement using **achievement, success, and social presence tests** and on motivation and opinions using the **Instructional Materials Motivation Survey** and **student opinion forms**. The treatment group that received the podcast with reflective thinking activities performed better on a post-test and had higher measures of motivation than the other two groups.

Zirkle, C., & Fletcher Jr., E. C. (2009). *Utilization of distance education in career and technical education (CTE) teacher education*. IGI Global. <https://www.igi-global.com/chapter/utilization-distance-education-career-technical/19958>

- Type of research: Other (literature review)
- Summary: This paper examined the development of remote CTE and its influence over the teacher learning community in the **U.S.** The authors found that the research on remote CTE education has been mixed, detailing numerous benefits as well as barriers to remote CTE learning. The authors focused on one barrier of successful remote CTE delivery: teacher involvement in remote learning. The authors argued that CTE teacher preparation programs

should equip teachers with the knowledge, skills, and temperament needed to teach online programs for remote CTE to be successful.

3. Equity considerations related to remote postsecondary education and training

Anderson, T., Briggs, A., & Spaulding, S. (2021). *See section 1.*

Association for Career and Technical Education (ACTE). (2020). *High-quality CTE: planning for a COVID-19-impacted school year*. <https://files.eric.ed.gov/fulltext/ED605947.pdf>

- Type of research: Other (planning guide)
- Summary: This publication captured the breadth of issues important to maintain CTE program quality within any education environment. The authors discussed potential issues associated with in-person, fully remote, and blended/hybrid CTE delivery models. They also discussed the overarching considerations that cut across all three instructional scenarios, specific issues relevant to each scenario, and access and equity implications. The planning guide concluded with discussion and links to resources and tools.

Association for Career and Technical Education (ACTE). (2021). *See section 2.*

Benson, A. D., Johnson, S. D., Duncan, J., Shinkareva, O. N., Taylor, G. D., & Treat, T. (2008). Community college participation in distance learning for career and technical education. *Community College Journal of Research and Practice*, 32(9), 665–687.
<https://www.tandfonline.com/doi/abs/10.1080/10668920600859848?journalCode=ucjc20>

- Type of research: Descriptive (quantitative)
- Summary: This article examined the status and potential future trends of distance learning in postsecondary CTE in the **U.S.** Using data from a **questionnaire** given to member institutions of the **American Association of Community Colleges**, the authors calculated descriptive statistics to analyze institutional trends in offering CTE to students during the **2001–2002** academic year. The article reported that 76.3 percent of responding colleges offered distance learning for CTE, with increasing student access to the programs and reaching new students being the primary reasons for offering distance learning. For those that did not offer distance learning, the most common reasons were the lack of faculty interest or expertise, program costs, and limited demand from students. Among colleges that offered distance learning, 19 percent were credit enrollment and 10 percent were noncredit enrollment. About 89 percent of colleges reported expecting moderate to large increases of distance CTE enrollments. Most community colleges reported that distance CTE attracted working professionals (reported by 79 percent of respondents), employed students (73 percent), students outside the college district (57 percent), single parents (57 percent) and part-time students (56 percent). About half of the colleges offered no distance CTE credited degree programs and 81 percent did not offer noncredit credential/licensure programs.

Briggs, A., Anderson, T. & López, D. (2021). *See section 2.*

Cropper, P., Robinson, D., Farrell, M., Webster, R., Germain, J., Cummings, K., & Benson, V. (2018). *See section 2.*

Eyster, L. (2019). *See section 2.*

Eyster, L., Biggs, A., Durham, C., Hafford, C., & Spievack, N. (2020). *See section 2.*

Farmer, L. (2009). Culturally-sensitive e-learning practices for career and technical education. In V. X. Wang (Ed.), *Handbook of research on e-learning applications for career and technical education: Technologies for vocational training* (pp. 144–154). IGI Global. <https://www.igi-global.com/chapter/culturally-sensitive-learning-practices-career/19968>

- Type of research: Other (literature review)
- Summary: Based on a **review of the literature**, the study author examined a framework for culturally sensitive distance education in vocational training. The term “culture” is framed in the context of the beliefs, values, and behaviors of organizations and professions. The author discusses strategies for addressing culturally based barriers to learning and for making online learning more inclusive and accessible.

Fernandez, L., Reisdorf, B.C., & Dutton, W. H. (2020). Urban internet myths and realities: A Detroit case study. *Information, Communication, and Society*, 20(13), 1925–1946. <https://doi.org/10.1080/1369118X.2019.1622764>

- Type of research: Descriptive (case study)
- Summary: The study sought to collect information on internet access and use in disadvantaged communities. The researchers used **surveys** of **Detroit** residents to understand how people in certain communities use internet access when it is available to them. The study found that people in low-income urban communities regularly used the internet for self-improvement and betterment. It also found that many people were dependent on mobile internet or were without home internet, which reduced their engagement in online activities.

Gan, K. N., Schneider, G., Harvill, E. L., & Brooke, N. (2013). *See section 2.*

Gan, K. N., Schneider, G., Epstein, Z., & Silverman, A. (2014). *See section 2.*

Githens, R. P., Sauer, T. M., Crawford, F. L., Cumberland, D. M., & Wilson, K. B. (2014). Online workforce development in community colleges: Connection with community, institutional, and governance factors. *Community College Review*, 42(4), 283–306. <https://journals.sagepub.com/doi/full/10.1177/0091552114534724>

- Type of research: Descriptive (quantitative)
- Summary: This study examined the factors influencing how community colleges in the **U.S.** offer online and blended workforce development programs. Using institutional, social, and economic data gathered **from the American Association of Community Colleges, National Center for Education Statistics Integrated Postsecondary Education Data System, U.S. Census Bureau, U.S. Bureau of Labor Statistics, and U.S. Bureau of Economic Analysis**, the

authors examined the relationship between program offerings and community college characteristics. Findings suggested that community colleges with more White students were more likely to offer online occupational training programs than those with more students of color.

Skinner, B. T. (2019). Making the connection: Broadband access and online course enrollment at public open admissions institutions. *Research in Higher Education*.

<https://rd.springer.com/article/10.1007/s11162-018-9539-6>

- Type of research: Descriptive (quantitative)
- Summary: This article examined the relationship between access to high-speed internet and the decision to enroll in online courses in the **U.S.** Using data from the **National Broadband Map, the Integrated Postsecondary Education Data System, the Bureau of Labor Statistics, and the State Higher Education Executive Officers Association**, the author constructed regression models to analyze the relationship between markers of high-speed internet (download speed, upload speed, number of providers) and the number of students enrolled in online courses. The article reported a positive correlation between download speed tiers and the number of students enrolled in online programs, but that the correlation decreased as speeds increased. Neither upload speed nor provider count was significantly predictive of online course enrollment.

Other citations supporting this review

Charles Koch Foundation and the SkillUp Coalition (2021, February). New poll: Over half of Americans under 40 believe they will need to upskill. <https://charleskochfoundation.org/news/new-poll-over-half-of-americans-under-40-believe-they-will-need-to-upskill/>

Pham, M., Greaney K. C., & Abel, L. (2020) California community colleges produce positive employment outcomes: Results from the career technical education outcomes survey. *Community College Journal of Research and Practice*, 44(1), 52-60.

<https://www.tandfonline.com/doi/full/10.1080/10668926.2019.1650843>

ABOUT THE RAPID REVIEW

CLEAR's rapid review of evidence on programs or strategies related to providing remote career and technical education was created by Mathematica under the CLEAR contract with the U.S. Department of Labor (DOL), Chief Evaluation Office (CEO). The contents of the review do not represent the views or policies of DOL.

Due to the rapid turnaround for this review, the evidence scan did not follow CLEAR's documented systematic approach. The evidence scans for this review had four components. First, CLEAR conducted a literature search using the Scopus database and Google Scholar covering the dates since 2005. The search terms used for each strategy are provided in Table 1. Second, CLEAR reached out to six experts in the education field to seek input on programs and studies to include in the review. Third, citations from relevant studies were used to identify additional studies for review. Fourth, CLEAR reviewed studies from DOL's TAACCCT program. This version of the brief was last updated with literature published before October 1, 2021.

Table 1. Keywords used in database searches by topic

Topic	Topic search terms ^a	Search location
Career and technical education	("career and technical education" OR "workforce development training" OR "occupational training" OR "vocational training" OR "technical credential*" OR "sector-based training" and "sectoral training") w/4 (Online OR "web-based" OR "distance learning" OR "online learning" OR "web-based learning" OR "distance education" OR "online education" OR "web-based education")	Scopus
	("career and technical education" OR "workforce development training" OR "occupational training" OR "vocational training" OR "sectoral training") AND ("distance learning" OR "online learning" OR "web-based learning" OR "distance education" OR "online education" OR "web-based education")	Google Scholar
Postsecondary education	("Post-secondary" OR "community college" OR college OR university OR "higher education" OR "mid-career") AND ("web-based" OR "distance learning" OR "online learning" OR "web-based learning" OR "distance education" OR "online education" OR "web-based education")("impact stud*" OR "meta-analy*" OR metaanaly* OR "random* control* trial*" OR "RCT*" OR "Quasi-experiment*" OR "regression discontinuity" OR "causal evidence" OR "comparison group" OR "comparison school*" OR (study w/4 effect*) OR (study w/4 efficacy) OR (study w/4 impact*) OR (evaluat* w/4 effect*) OR (evaluat* w/4 efficacy) OR (evaluat* w/4 impact*) OR (research w/4 effect*) OR (research w/4 efficacy) OR (research w/4 impact*))	Scopus

^aTopic search terms are searched in title, abstract, subject, and keyword fields in the Scopus searches.

CLEAR project staff screened the abstracts of studies identified by the search to consider whether they investigated relevant strategies that took place in [OECD](#) countries; 52 publications were screened into the review and summarized.

Due to the rapid nature of this review, studies identified for review were not assessed according to CLEAR's causal evidence guidelines. Instead, reviewers used a short rubric to summarize information for each study. Each citation is classified by study type: causal, descriptive, or other. **Causal** research can

assess the effectiveness of a strategy—in other words, whether there is a cause-and-effect relationship between the strategy and the results or impacts. High quality causal research (impact studies) can produce the most credible type of evidence. **Descriptive** research does not determine cause-and-effect relationships but uses quantitative methods to identify trends, correlations, projections, and costs and benefits of actions taken. CLEAR also categorized qualitative studies under the descriptive category for the purposes of this rapid review. CLEAR’s rapid reviews also summarize **Other** publications that describe how, where, and why strategies are implemented and include opinion pieces by subject matter experts (SMEs). This type of research does not aim to identify cause-and-effect relationships or use quantitative or qualitative methods but can be useful to identify emerging strategies potentially worthy of future replication and additional study. For more information on how CLEAR reviews and rates different types of studies, see CLEAR’s reference documents at <https://clear.dol.gov/about>.

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