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What's Being Taught? An Analysis of Corporate EdTech Certification Programs

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Corporate EdTech Certification Programs (CECPs) have the potential to disrupt the traditional ways professional development has been offered to teachers. With large companies creating CECPs to demonstrate the ways their products can be used for educational purposes, this study utilized a content analysis methodology to analyze which knowledge bases from the Technology, Pedagogy, and Content Knowledge (TPACK) framework were being integrated into CECPs. Overall, the knowledge bases that included technological knowledge were emphasized, and the ones connected to content knowledge were seldom addressed, if at all. The study is first contextualized, followed by a description of its methodology before reporting findings. The implications section identifies the collective strengths, weaknesses, opportunities, and threats of the CECPs before concluding with recommendations for stakeholders to improve and use CECPs for educational purposes.

Large technology companies' impact on education is unprecedented. Ranging from devices to videoconferencing applications to learning management systems, these companies' innovations impact the field of education in very real ways for teachers and students alike. With education and technology continuing to integrate, the term "edtech" has emerged as a catchall reference to the technologies being developed and used for educational purposes (Cherner & Fegely, 2018). This term now appears in educational policy and best teaching practices and is infused in teacher education programs (Williamson, 2019).

These technologies are not neutral, however. Companies have a profit motive for developing and selling them (Wright & Peters, 2017), and a multibillion-dollar edtech marketplace has emerged, in which technology companies sell products to educational organizations (Cherner & Mitchell, 2020). With their technologies being bought by schools and used by teachers and students, the technologies themselves influence the ways teaching and learning happens (Wright & Peters, 2017). Therefore, if educators – preservice and in-service teachers as well as teacher educators – are going to use edtech for teaching and learning, they must be aware of the influence of technology companies on education. They may have larger implications for them and their students.

Building educators' awareness around the edtech they use is important. The experiences students have with technology during their compulsory education can impact their preference for choosing certain technology brands in the future (Hinchey, 2008). For example, if students complete their secondary education primarily using Google Chromebooks that run on Google's operating system, they may prefer to use Google products during their postsecondary education and then on into their professional and private lives. In this way, the experiences students have with technology throughout their K12 education are formative to their consumer preferences later in life.

To support the adoption of their products, these companies have developed corporate educator certification programs (CECPs) that provide free or low-cost professional development opportunities. Teachers can complete these CECPs to earn certifications, digital badges, and other professional marks of distinction. At a time of increasing interest in using edtech to deliver high-quality instruction that cuts across geographic, social, and political barriers, CECPs have grown in popularity (McLeman, 2016; Tittel, 2013), though a critical analysis of them has yet to be conducted. In response, this study's research question was as follows: What types of knowledge do educators gain from completing corporate educator certification programs?

To conduct that analysis, this paper will first describe how CECPs are situated within the edtech marketplace. Next, the theoretical framework and methodology used to analyze CECPs are described, followed by the study's findings. To conclude, recommendations for using CECPs are offered.

Situating CECPs in the Edtech Marketplace

The edtech marketplace is valuable. HolonIQ (2019) estimates that its value will be \$404 billion by 2025. While both scholars and professionals have written about the edtech marketplace, Southwick's (2021) description represents a common view when describing it as "a diverse and rapidly growing industry with a large runway across the business lifecycle, from early-stage [startups](#) to middle-market companies to publicly traded companies" (para. 3), with the larger companies being Apple, Google, IBM, Lenovo, and Microsoft.

Notable examples of smaller stage startups that have grown to middle-market companies are Newsela (<https://newsela.com/signin>), Nearpod (<https://nearpod.com/>), and Hypothes.is (<https://web.hypothes.is/education/>). By focusing only on the companies that develop and provide technologies, Southwick's (2021) description overlooked other key stakeholders, such as politicians, philanthropists, activist groups, and news media (Cherner & Mitchell, 2020; Williamson, 2021). These stakeholders influence the climate around edtech, which can encourage or discourage its adoption in schools. When edtech's adoption is encouraged, the marketplace is further extended to include the supports educators may need to use edtech effectively with students.

Professional development is often identified as a key component to ensuring that the use of edtech is beneficial for teaching and learning (Bond et al., 2018) and not for entertainment purposes. Traditionally, professional development has been offered by school districts, at conferences, and through contracted providers, which will be discussed in the review of literature. However, professional development in the form of CECPs is a relatively new area, and though it has overlap with more traditional offerings, CECPs also include a stealth marketing component (Wright & Peters, 2017).

Essentially, CECPs provide educators with two benefits: (a) a pathway to earn professional credentials and (b) access to information. Depending on their career path and future aspirations, these credentials can be used for career advancement, continuing education units, annual professional growth, or other kinds of distinction. The access to information provides educators with advanced knowledge about the topics addressed in the CECP, which often focuses on the edtech provided by the company offering the CECP.

For example, Edmodo (<https://new.edmodo.com/>) is a learning management system used in public schools, which offers a certificate program for educators as its CECP. On its website, Edmodo (2020) explained that by completing its program educators earn

- "The Edmodo Certified Trainer digital badge: This can be shared on your website, blog, email signature, etc.
- Letter of completion: This letter explains, in detail, the work you have completed as a participant in the train the trainer course for the ECT program

- Certificate naming you an official ‘Edmodo Certified Trainer.’” (para. 3)

For educators who are interested in using Edmodo, these credentials could have great appeal, as they may be useful for career advancement while improving their use of Edmodo’s learning management system. Yet, the CECP does not conclude with the credentials only. Rather, Edmodo has expectations for teachers who complete their CECP that include hosting at least two face-to-face trainings focused on Edmodo to 10 or more educators annually and actively participating in its professional learning community. They also expect teachers to “‘Rep’ [sic] Edmodo with professionalism in Edmodo groups, communities, and face-to-face opportunities” (para. 5).

In this way, Edmodo directly benefits from educators who completed its CECP. They become its brand ambassadors, meaning that they are to promote Edmodo as part of the distinction they earned from being an Edmodo Certified Trainer. Though identifying the number of CECPs that use similar strategies is important, it falls outside the scope of this study. Yet, before that type of analysis can be conducted, it is important to first evaluate shifts in professional development (PD) before evaluating the knowledge included in CECPs.

A Review of Shifts in PD

PD for teachers is undergoing a fundamental shift. Whereas it used to be planned for them by school administrators, teachers are now able to seek out their own PD opportunities to address the needs of their students and improve their own teaching practices (Hord, 2015; Lieberman & Miller, 2016). Researchers have identified effective aspects of traditional PD (e.g., providing hands-on learning opportunities and aligning PD with classroom context; Yoon et al., 2020). They have also found teachers describing traditional PD as being shallow, rigid, top-down instruction produced by outsiders that is irrelevant to them and their students (Darling-Hammond et al., 2017; Darling-Hammond & Richardson, 2009).

Regarding PD, in general, researchers have found that it often has little impact on teachers’ practices (Darling-Hammond et al., 2017; Desimone & Garet, 2015), which can result in teachers viewing PD as being a required mandate to complete instead of an opportunity for professional growth (Bill & Melinda Gates Foundation, 2014). Merritt (2016) added that teachers have little time for PD, and she found that they wanted more access to PD, with a specific interest in materials and strategies for improving their instruction.

Peltola et al. (2017) added that additional on-demand access to PD removes time constraints, which they found acted as barriers to PD and better supported their face-to-face instruction. Outside of access, Porter et al. (2000) found that teachers are more invested in PD when they have the ability to choose topics aligned to their values and goals. Supporting this idea, research by Al-Bargi (2021) detailed teachers’ preferences to either “be given the opportunity to select from a variety of sessions ... [or] be given the opportunity to send their own desired choice” of PD session

recommendations to the administrators to help address their specific needs with online teaching (p. 1167).

The literature has documented examples of online PD successes. An (2018) studied the impacts of an online PD and found significant increases from the presurvey to postsurvey in the teachers' understanding that games have educational benefits for students and the potential to develop "real-world skills" in students. Parson et al. (2019) found that when PD is offered online, over 83% of teachers indicated that it was either moderately or extremely beneficial to their teaching practice, and 90% of those teachers responded that the availability of online resources was either very or extremely important.

When offered online, the outcome of those PD sessions resulted in increased levels of student achievement and behavior, which were comparable to in-person PD offerings (Fishman et al., 2013, Webb et al., 2017). In fact, a study conducted by Grunwald Associates LLC and Digital Promise (2015) found that 72% of teachers surveyed independently learned from expert videos, online learning communities, and social media because they felt the need to stay current and enjoyed learning. Other researchers identified that earning certificates and digital badges were motivating factors for teachers if they were aligned to their classroom context (Beach, 2017; Singer, 2017).

While research on the topic of online PD during the COVID-19 pandemic is still emerging, Hartshorne et al. (2020) said, "There will be tremendous value in research published after the pandemic that looks back to find out what worked, what did not work, and what could be learned to improve current and future practice" (p. 138). From the research that has been published, Poce et al. (2021) found that online PD webinars were more likely to be attended by those who had preexisting comfort with e-learning, and Safi et al. (2020) found that self-directed, unstructured PD learning communities where teachers could share resources and pedagogical practices were useful for supporting those teachers implementing remote teaching. Cavanaugh and DeWeese (2020) found that teachers had a preference for PD resources in asynchronous video formats when searching for online teaching pedagogical resources. Overall, online PD has increased in popularity, and the adoption of edtech by schools has impacted the topics addressed by PD.

A Focus on EdTech

Edtech's roles in schools continues to expand, and teachers have requested PD about edtech that includes strategies for utilizing it for instructional purposes (Hall & Martin, 2008) along with best practices for integrating it into their planning processes (Bettis, 2015). To support their learning, Hew and Brush (2007) suggested that PD focused on edtech for teachers should address (a) teachers' technology knowledge and skills, (b) active learning strategies for using edtech, and (c) ensuring edtech's relevance to their immediate classroom needs. In addition, Kelley (2019) explained that PD focused on technology should emphasize the connections between pedagogy, content, and technology concepts.

In summary, researchers have identified multiple elements of effective PD, such as accessibility of materials, availability of content, and relevance to their contexts. In response, PD as a form of credentialing has become valued by teachers.

Certificate Programs in Education

In the context of PD, Besser and Newby (2020) explained that an emerging trend in education is “validating and credentialing learning taking place outside of traditional academic settings” (p. 79), which is called alternative credentialing. Though it is not new, alternative credentialing was first put forward in the early 1980s as a path for providing teachers PD opportunities (Green, 1980, as cited in Grant, 2016). In more recent times, alternative credentialing has taken the form of microcredentials that DeMonte (2017) described as “an approach to professional learning that provides teachers with the opportunity to learn and demonstrate competency in new skills, while also getting feedback from an outside evaluator and earning recognition for mastery by earning the micro-credential” (para. 1).

Once earned, teachers looking for a new position can include microcredentials on their resumes and professional portfolios as well as in their email signatures and their social media profiles (Besser & Newby, 2020). As researchers have found that educator preparation programs do not fully prepare preservice teachers for the classroom (Lampert, 2012; Zeichner, 2012), some schools have incentivized teachers earning these credentials in specific areas (Abramovich, 2016), and organizations including the National Educators Association (2021) offer micro-credentialing opportunities to teachers. As a result, microcredentials are becoming a viable alternative to more traditional PD, but they are not without critique.

Critiques of Microcredentialing in the Form of CECPs

CECPs are a form of microcredentialing for teachers that have grown in popularity (Gamrat et al., 2014; Law, 2015). Kelley (2019) explained CECPs as “A unique phenomenon occurring in education where large technology companies or vendors such as Apple, Google, and Microsoft are recruiting educators to participate in professional development programs designed to promote technology integration in their practice” (p. 1), and at the surface level, these CECPs appear to be partnering with educational entities to teach edtech-driven pedagogy (Apple, 2018; Google, 2018; Microsoft, 2018).

Carey and Stephaniak (2018) noted a debate within the education community as to the effectiveness of CECPs as PD due to the lack of research on their quality and design. Gras and Kitson (2021) said that online teacher certification programs often are incomplete and general, based on the time needed to complete them. Croninger et al. (2007) pointed out that alternative credentialing may lack research-based pedagogical best practices in the name of brevity.

Kelley (2019) added that, while technology companies may support teacher and student learning, they have a dual aim of promoting their products with schools. In response, Boninger et al. (2017) and Gregory (2017) called for the decoupling of technology companies and educational institutions. Specifically, Boninger et al. were concerned about stealth marketing elements embedded within CECPs that promote a company's products instead of high-quality pedagogy. Similarly, Gregory pointed out that curricula from for-profit educational entities in the form of CECPs may be informed by business interests, not research.

In summary, the shift in teacher preferences for PD has given rise to microcredentialing programs. While valuable, researchers found that technology companies have identified microcredentialing programs as a potential channel to promote their products in schools under the guise of PD, which has caused concern. To examine that concern, this study utilized the technological pedagogical content knowledge framework to analyze the actual knowledge bases emphasized by CECPs.

Using TPACK as a Framework for Analyzing Knowledge Bases

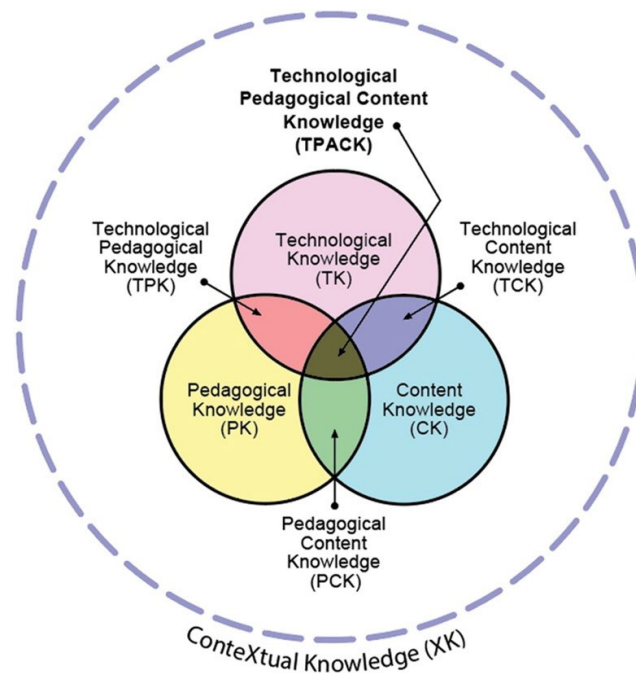
The technological, pedagogical, and content knowledge (TPACK) framework (Koehler & Mishra, 2009; Mishra & Koehler, 2006) identifies the interconnectedness of three core knowledge bases teachers need for delivering instruction in the digital age. Previous to TPACK, Shulman (1986, 1987) argued that teachers need deep knowledge about the content they teach, along with effective strategies for engaging students in that content.

As schools adopted digital technologies, Mishra and Koehler (2006) were among those who identified the need for teachers also to have deep knowledge about technology for effectively integrating technology for instructional purposes, which was later labeled TPACK. As shown in Figure 1, TPACK is represented as a three-bubble Venn diagram, with each bubble representing a specific knowledge base.

The technological knowledge base represents educators' abilities to select and use digital tools and devices in the classroom. The pedagogical knowledge base is their abilities to plan and utilize instructional strategies to engage students in learning, and the content knowledge base is their deep understanding of the subject matter they teach. The areas of overlap symbolize where two or more knowledge bases combine, creating unique areas of emphasis.

For instance, the overlap between pedagogical knowledge and technology knowledge is technological pedagogical knowledge, which is the use of different digital tools for teaching and learning. Graham et al. (2009) explained that TPACK is achieved when a "teacher knows how technological tools transform pedagogical strategies and content representations for teaching particular topics and how technology tools and representations impact a student's understanding of these topics" (p. 71).

Figure 1
Revised Version of the TPACK image. © Punya Mishra, 2018.
Reproduced with permission.



TPACK's final element is the dashed segments that form a circle around the Venn diagram, and it represents educators' contextualized knowledge, which includes a teacher's knowledge of available technologies, access to those technologies, and possible challenges about using them, among other factors (Mishra, 2019). This contextualized knowledge is important because, for example, teachers at a school with access to advanced technologies, such as virtual reality, need TPACK differently than at a school where teachers and students share class sets of tablets.

With its well-defined knowledge bases, researchers have adopted TPACK to analyze different types of content. For example, Koushki et al. (2020) employed a statistically validated checklist based on TPACK's knowledge bases to analyze a syllabus used in information technology courses. From their analysis, Koushik et al. determined that technological content knowledge was the base most frequently addressed by the syllabus, and technological knowledge was the base least addressed. The implications were that the syllabus emphasized how to use technology for locating content, but not how to use the actual technology.

In another study, Zhang et al. (2019) analyzed the discourse of 934 teachers taking an online PD. To analyze the discourse, the researchers developed a coding scheme that operationalized each of TPACK's inner knowledge bases based on the context of the PD, and it included examples of ways a knowledge base could be expressed. For example, they operationalized technological knowledge as "Knowledge of using

emerging technologies” (p. 3443), and the example they provided was, “Teachers can use special functions in electronic whiteboards, such as the spotlights, to highlight important teaching content” (p. 3343). Using this coding scheme, they identified the preponderance of comments focused on pedagogical content knowledge (53.5%). Next were pedagogical knowledge (15.5%) and technological pedagogical content knowledge (15.3%). None of the other knowledge bases eclipsed more than 6.5%.

They also found that younger teachers more often provide discourse connected to the pedagogical knowledge and pedagogical content knowledge bases, while the older teachers’ discourse was more distributed across the content knowledge, pedagogical content knowledge, and technological knowledge. Their conclusions were that the facilitators of the PD should offer more support to the younger teachers about the knowledge bases that went unaddressed. In summary, the works of Koushki et al. (2020) and Zhang et al. (2019) demonstrate ways researchers have used TPACK for content analysis, and this current study continued the application of TPACK for that purpose.

Methodology

This study used a deductive approach to qualitative content analysis as its research methodology for identifying the types of knowledge taught by CECPs. In brief, qualitative content analysis is a process where researchers classify nonnumerical data into categories and then look across their classifications to identify patterns and themes in the data (Neuendorf & Kumar, 2015; Stemler, 2015). A deductive approach draws from previous research and theories to serve as the foundation for the categories needed to classify data (Zhang & Wildemuth, 2009; Zhang et al., 2019). For example, Zhang et al.’s study analyzed data in the form of teachers’ discourse collected from a PD and classified it based on TPACK’s knowledge bases demonstrates this approach. The current study was similar in that it focused on a PD for teachers and analyzed it using TPACK’s knowledge bases. It differed in that the PD took the form of CECPs and its focus was on the actual information from those CECPs, not the teachers’ discourse.

Researchers’ Positionality Statement

Qualitative research commonly positions researchers as being a tool for research (Coffey & Atkinson, 1996; Merriam & Grenier, 2019), meaning that the researchers’ own positionalities – identities, background knowledge, and beliefs – inform their interpretation of the data. While removing the researchers’ positionalities is not possible in the context of qualitative data analysis, researchers can disclose their positionalities as related to the topic, so readers will have a deeper understanding of how the researchers interpreted the data and came to their findings.

In the context of this study, the researchers all have classroom teaching experience in K-12 settings and hold terminal degrees in education granted from an accredited institution in the southern United States. Their interest in this study is situated in the intersection of technology and PD, as they all agree that technology’s role in education will continue to grow

well into the foreseeable future and that it can be an effective tool for teaching and learning. In reflection, they have each experienced both high-quality and low-quality PD sessions, and they share an interest in PD taking the form of CECPs, along with the implications that can arise from the corporatization of PD. The following bullets describe the researchers and their individual interests in this study:

- Todd directs a graduate program focused on educational innovation, and he deeply believes that PD is most relevant to educators when it provides them an experience with a tool or strategy that they can integrate into their teaching practice.
- Alex is an assistant professor and prepares preservice teachers for K-12 classrooms. Alex sees PD as being valuable when it aligns to teachers' contexts and can improve teachers' self-efficacy and effectiveness with new tools or strategies in the classroom.
- Lynsey is an industry-based researcher with a company that uses data analytics to evaluate the effectiveness of PD. Lynsey has a keen interest in using data to evidence the impact of PD on teachers' performance in the classroom and help school districts take action to provide personalized professional learning opportunities that are relevant to teachers' needs.
- Cory is an assistant professor, and he focuses on science, technology, engineering, and mathematics education. From his perspective, PD must provide useful information to teachers that they can implement in their classroom for him to consider the PD as being effective.

Our collective hopes are that this study will inform both how companies create CECPs and the ways K-12 schools and educator preparation programs use them.

Data Collection

With the study's focus being PD offerings for teachers in the form of CECPs, we were intentional in selecting well-known educator certification programs. To locate them, we first entered keyword combinations, consisting of *educator certification program*, *technology*, and *corporate*, into multiple search engines including [Google](#), [Bing](#), and [DuckDuckGo](#). We were purposeful in selecting these search engines, as Google and Bing are the two most popular search engines in the world, with Google having 86.6% market share and Bing having 6.7% of it (Statista, 2021).

In response to the query, the search engines largely reported results for more traditional educator preparation programs offered by universities, with an emphasis on graduate programs focusing on instructional technology and school administration, along with a limited number of initial teacher licensure programs. Because this study was focused on CECPs, we added the names of the largest 10 technology companies in the United States based on their brand value (Wood, 2020), so their search would be better aligned to the study's focus and research questions. The 10 largest companies included Apple, Microsoft, Google, Facebook, IBM, Instagram, Accenture, Intel, Adobe, and Salesforce. Of them, only Apple,

Google, and Microsoft offered a CECP that was designed for K-12 teachers. Next, as each of the CECPs offered by these companies included multiple courses, we chose to focus on the introductory or foundations courses because they represented a “starting point” for the larger CECP. The specific courses analyzed were:

- Apple: Learn Skills for Mac (Apple Teacher, 2020)
- Google: Fundamentals Training (Google for Education, 2020)
- Microsoft: Hybrid Learning: A New Model for the Future of Learning (Microsoft, 2020)

This decision was made to help bound the data based on that commonality. With the data identified, we next developed a coding scheme to analyze the CECPs.

Data Analysis

When conducting a deductive content analysis, Zhang and Wildemuth (2009) recommended developing a coding scheme, which is an instrument researchers will use to classify the data. When creating it, researchers must develop operationalized categories based on the research and theory they will use. The operationalized indicators in the coding scheme must be clear and precise to improve the validity. In this study, we adopted TPACK’s knowledge bases and operationalized them by paraphrasing or directly quoting from previously published research and theories about TPACK to create a coding scheme. Table 1 shows the indicator for pedagogical knowledge as an example.

Table 1
Representative Example of the Coding Scheme’s Dimension for Pedagogical Knowledge

Category	Definition
Pedagogical Knowledge	“The teacher’s knowledge of and skill in the use of teaching methods and other pedagogical strategies that are not subject specific” (Gudmundsdottir, 1987, abs.)
Yes No	If yes, please provide an example:
Pedagogical Technological Knowledge	Using technology in non-subject-specific ways to facilitate learning (Koehler & Mishra, 2009)
Yes No	If yes, please provide an example:

In this indicator, we operationalized TPACK’s pedagogical knowledge dimension by quoting Gudmundsdottir (1987) because this research was formative to that knowledge base, which served as a foundation for TPACK. Next, we paraphrased Koehler and Mishra’s (2009) seminal

article about TPACK for the pedagogical technological knowledge base. For each knowledge base, we also created a row where we could bold the “Yes” to indicate if the data did align to the knowledge base or “No” if it did not align. When “Yes” was bolded, we agreed to include an example of where and how that knowledge base appeared in the data. In this way, we could efficiently identify if and how the knowledge base existed in the data. Similar indicators for each of TPACK’s knowledge bases were developed for the coding scheme.

Once a coding scheme has been developed, Zhang and Wildemuth (2009) suggested piloting it with a subset of data before using it to analyze all the complete data set. In this study, two researchers piloted the full coding scheme to analyze the first two modules of each CECP identified and then analyzed the results. By two researchers coding each of the first two modules, they could compare use of the coding scheme at two levels. First, they could analyze if there was agreement in their identification of a knowledge base existing within the data. Second, when a “Yes” was bolded, they could check if the data that aligned to the knowledge was the same for both researchers. These steps enabled further calibration and refining of the coding scheme before analyzing the complete data set.

After piloting the coding scheme, the data were aggregated in an electronic spreadsheet, and we used descriptive statistics to determine the degree to which data were aligned. In brief, each “Yes” was quantified to a 1 and each “No” was quantified to a 0. A Pearson Correlation Coefficient, a commonly used statistical operation for determining interrater reliability, was then used to identify the degree to which the researchers’ classifications were aligned, with 0.7 being the target (Mukaka, 2012). Based on the piloting, only a limited number of dimensions for the coding scheme met that target. In response, we discussed the low rates and determined that the coding scheme needed to be further operationalized.

As an example, we identified the pedagogical knowledge and pedagogical technological knowledge bases as having caused confusion. Using the term *collaboration* as an example, multiple modules across the CECPs referred to collaboration as a pedagogical strategy, such as having students work together to solve a problem or share information. The CECPs, however, seldom explained how to use the technologies they were highlighting for collaboration, only that the technologies could be used for collaboration. This gap presented a challenge when categorizing those instances as either pedagogical knowledge, meaning collaboration as a teaching strategy, or if they were pedagogical technological knowledge, meaning guidance about using the technologies for collaboration.

With qualitative content analysis being an iterative process that requires refinement of the coding scheme based on its use (Neuendorf & Kumar, 2015), we then added to our coding scheme what we termed “look-fors,” which are germane statements that provide examples of the phenomenon. Table 2 shows the updated dimensions for both pedagogical knowledge and pedagogical content knowledge. In addition, the [appendix](#) includes the final coding scheme we used.

Table 2
Representative Examples of the Coding Scheme’s Dimensions With Look-Fors

Category	Definition
Pedagogical Knowledge	“The teacher’s knowledge of and skill in the use of teaching methods and other pedagogical strategies that are not subject specific” (Gudmundsdottir, 1987, abs.)
Look Fors	General teaching strategies that are not content-area specific (e.g., think-pair-share, I Do, You Do, We Do, jigsaw, etc.) Popular teaching strategies that do not require technology (e.g., Keegan strategies, Marzano’s high yield strategies, inquiry-based instruction, etc.)
Yes No	If yes, please provide an example:
Pedagogical Technological Knowledge	Using technology in non-subject specific ways to facilitate learning (Koehler & Mishra, 2009)
Look Fors	General technology-specific teaching strategies (e.g., WebQuest, Padlet, Digitized Gallery Walk, etc.) Other technologies that interface with students but are not content specific, such as taking attendance, classroom management, and grading (e.g., Class Dojo, Edmodo, TeacherKit, etc.)
Yes No	If yes, please provide an example:

With the look-fors in place, we again piloted the coding scheme using the same subset of data. When analyzing results, our analysis was correlated across all dimensions at 0.70% or above. With a satisfactory level, we used the coding scheme to analyze the remaining data set.

Findings

In this section, each of the TPACK knowledge bases are reported based on the content analysis, which was guided by the following research question: What types of knowledge do educators gain from completing corporate educator certification programs?

To structure this section, each knowledge base is introduced by explaining the way it was positioned in the coding scheme, along with its look-fors. Next, the occurrence of that knowledge base is reported across the different CECs, including examples about the ways it appeared in the CECs.

Technological Knowledge

The foundation of technological knowledge is rooted in the ability to use technology. Further, as Koehler et al. (2013) pointed out, it includes being able to identify when to use and not use technology. In relation to this study, we adopted that definition and formally operationalized technological knowledge as the ability to use technology for noninstructional tasks that are still essential to being a member of the school community. The look-fors included answering email, sharing files over digital platforms, and efficiently using search engines. As shown in Table 3, technological knowledge was identified in 100% of the modules across the Apple and Google CECPs, and it was not found in the Microsoft CECP.

Table 3
Identification of the Technological Knowledge Across the CECPs

Knowledge Base	Apple	Google	Microsoft
Technological Knowledge	100%	100%	0%
Pedagogical Knowledge	0%	34.6%	35%
Content Knowledge	0%	3.8%	1.2%
Pedagogical Content Knowledge	0%	0%	0%
Pedagogical Technological Knowledge	75%	76.9%	75%
Technological Knowledge	100%	100%	0%
Technological Pedagogical Knowledge	75%	26.9%	0%

When identifying examples of technological knowledge, the CECPs often provided step-by-step instructions for using a technology, without contextualizing it to be used for teaching or learning. For example, in Apple Teacher’s (2020) module on iMovie, a video-editing tool, it offered suggestions for improving the narration of a story when using the tool: “Modify transitions to help tell your story. Choose transition styles to complement a storyline, for example, use cross-dissolve to signify the passing of time” (p. 5).

In this context, the term “story” was referred to as the product for using iMovie, and the recommendations were for improving its overall quality. The Google for Education’s (2020) Bring Meetings Online unit also offered suggestions for using their tool. When introducing Google Meet, a video-

conferencing tool, the CECP explained that with it, “you can see and hear the other person and have a conversation as though you were in the same room... You can have up to 250 different people in the same video call... At the same time. Together” (Google for Education, 2020, p. 3). The CECP followed that statement with technical instructions for using the tool in that way.

Pedagogical Knowledge

When operationalizing pedagogical knowledge, we drew from Gudmundsdottir’s (1987) work, when she described it as “the teacher’s knowledge of and skill in the use of teaching methods and other pedagogical strategies that are not subject specific” (abstract). This quotation emphasizes that pedagogical knowledge is focused on instructional techniques that can be used across the content areas, such as the think-pair-share, jigsaw, and fishbowl strategies. Moreover, when planning instruction, teachers need to build their understanding of their students’ learning needs, and generic strategies can be used for that purpose, such as fostering relationships with students and gathering information about them to inform instruction. In all, we identified pedagogical knowledge in the courses offered by Microsoft and Google more frequently than Apple’s course ([Table 3](#)).

While the original intention of this category was focused more on teaching strategies, the CECPs did not name specific teaching strategies; rather, they offered best practices for teachers to use when planning instruction and responding to student work. The Microsoft (2020) modules suggested that teachers survey their students to better understand the pressures and responsibilities that impact them outside of the classroom, so they can be mindful about those elements when planning instruction. In a later module, Microsoft (2020) referenced Backward Design principles along with the Universal Design for Learning Framework to plan and deliver differentiated lessons. Moreover, the Google for Education (2020) course connected to pedagogical knowledge when emphasizing the importance of providing students with rich feedback. It also highlighted the need to ensure that the purpose for a learning activity was clearly stated for students.

Content Knowledge

To begin, we operationalized content knowledge based on Ball et al.’s (2008) work, which defined it as knowledge of the subject and its organizing structures. From this operationalization, we understood “subject” to be a content area commonly taught in schools (e.g., English language arts, social studies, or physical education) and “organizing structures” being a subject’s subdisciplines, such as English language arts being grammar, literature, and writing; social studies involving government, civics, and history; and physical education including team sports, nutrition, and personal fitness. Based on that understanding, content knowledge then consists of the theories, principles, and information that form the basis of a subject area, and it appeared the fewest times across the CECPs ([Table 3](#)).

When identifying examples of content knowledge, we looked for the name or direct connection to a subject area, along with a specific reference to information about it. For example, Google for Education's (2020) Build Interactive Lessons unit stated, "As a teacher, you have the opportunity to shape your students' understanding of the world around them. This is especially true for educators teaching Earth science, where students are introduced to the complexity of our planet and the interdependence of human and natural systems" (p. 5) This quotation referenced information that is specific to a subject area, without implications for teaching that information or using technology for any instructional purpose. Though rare, Google included the most instances of content knowledge in its CECP, followed by Microsoft. No such references were identified in Apple's CECP.

Pedagogical Content Knowledge

For this knowledge base, we used Shulman's (1987) seminal work that focused on teacher knowledge. In brief, Shulman argued that teachers must have a deep understanding of both their content and pedagogical strategies if they are to plan engaging and effective learning experiences for students. We defined pedagogical content knowledge as a practical way of knowing subject material and teaching strategies needed to design student learning experiences. For a piece of content to be classified in this knowledge base, it must provide an example of a teaching strategy focused on a specific content area, such as using Socratic Circles to facilitate a discussion about a civics-related topic or using Writer's Workshop to revise an expository essay in English language arts. In our analysis, none of the CECPs provided any support, guidance, or connections to pedagogical content knowledge (Table 3).

Pedagogical Technological Knowledge

To operationalize pedagogical technological knowledge, we pulled from Koehler and Mishra's (2009) work. They explained this knowledge base as the use of technology to promote student learning that was not directly tied to or connected with a specific content area. In addition, we emphasized that pedagogical technological knowledge is reflected in teaching strategies that utilize technology in ways that can cut across content areas. When developing look-fors, strategies such as Digital Gallery Walks (Fegely & Cherner, 2019) and webquests (Dodge, 1995) were identified, along with tools positioned for students to share ideas, including digital collaborative boards like [Padlet](#) and [Dotstorming](#). Pedagogical technological knowledge was the second most identified knowledge base in our analysis, and Table 3 shows the frequency it was found across the CECPs.

Two clear examples of technological pedagogical knowledge come from Apple Teacher's (2020) module about Pages, its word processing program, and Microsoft's (2020) module on engaging students in hybrid learning. When explaining Pages, Apple Teacher (2020) provided generic ideas for using the software. For vocabulary instruction, as an example, Apple Teacher (2020) suggested that teachers can use Pages to supplement their vocabulary instruction. Specifically, it recommended that teachers can have students take pictures of the vocabulary words they are studying and

then upload them into a Pages document. Once in the document, students can further manipulate them. After uploading them, students can write definitions for the word, label certain parts of the images, and use the word in a sentence. In this example, Apple Teacher (2020) suggested that students incorporate multiple components from the Frayer Model for vocabulary instruction (Overturf et al., 2013) and into a Pages document. Unlike the Apple CECP that provided program-specific ideas for using Pages, Microsoft addressed this knowledge base in a more generalized manner.

In its module about engaging hybrid learners, Microsoft (2020) explained, “Instructors must consider how to keep students engaged synchronously and asynchronously. Additionally, educators need to present their course bi-modally for students who are physically on campus as well as students who are attending remotely” (para. 1). The modules then list strategies teachers can use when engaging students across those contexts, such as grouping strategies for students who are attending the class online and in-person along with planning activities that use materials in the classroom and those that are commonly available in households. In the same module, Microsoft (2020) provided strategies for checking student comprehension, and they recommend specific tools that can be used for that purpose: [Microsoft Forms](#), [Polly Polls](#), [Pear Deck](#), [Nearpod](#), [Kahoot](#), and [Quizlet](#). In these ways, the technological pedagogical knowledge provided by Microsoft included generic strategies along with specific tools.

Technological Content Knowledge

Drawing from Herring et al. (2016), we operationalized the technological content knowledge base as using technology to access and interact with materials that are specific to a subject area. This operationalization is two-fold, which we addressed with look-fors. To access these materials, we explained it as students viewing information, with examples including encyclopedia entries, video documentaries, and preserved artifacts. For interacting with those materials, we envisioned students using virtual reality to visit a location of significance digitally, augmented reality to examine a digital replication of an object, and simulations to experience an event of some kind. Of the CECPs, only Apple and Google include this knowledge base in their modules (Table 3).

In their unit about the benefits of the digital classroom and 21st century work habits – Get Ready to Use Technology in the Classroom – Google for Education (2020) highlighted its popular video-sharing platform by quoting an educator who said, “YouTube has a lot of channels with creators making educational content ... places like MIT, Stanford and Khan Academy” (p. 5). This quotation connects to technological content knowledge by naming a digital location for accessing information, YouTube in this instance. It did not provide implications for using YouTube for teaching or learning, only that it included content created by individuals with highly reputable affiliations.

Regarding engaging and transacting with technology, Apple Teacher’s (2020) module on Numbers, its spreadsheet software, provides a clear example. When discussing Numbers, Apple Teacher (2020) encouraged students to “explore how civic engagement has changed over time. Enter

public voting data from multiple years into a table, then use charts to show the percentage of eligible voter turnout over the years” (p. 4). In this instance, students were to gather data and input it into the software to portray graphically the data in chart form. In both the YouTube and Numbers examples, no pedagogical strategies were recommended; rather, only ways for accessing and interacting with that data were suggested.

Technological Pedagogical Content Knowledge

The final knowledge base, technological pedagogical content knowledge, is demonstrated when the inner three core knowledge bases – technological, pedagogical, and content – are used to create a learning experience. As Koehler and Mishra (2009) explained, technological pedagogical content knowledge is not achieved only by identifying those core knowledge bases within a learning experience; rather, it “emerges from interactions among content, pedagogy, and technology knowledge” (p. 66) and the use of those interactions to create learning experiences. It requires a deep understanding of the relationship between technology, pedagogy, and content and the ways each knowledge base blends and complements the other knowledge bases to create learning experiences for students.

In this study, the look-fors we developed included instances where technology and content were combined to create a meaningful learning experience for students, such as having students complete a webquest about a topic specific to a content area or activities where students engaged a piece of virtual reality that is specific to a discipline and then reflected on the experience with classmates. Looking across the CECs, both Apple and Google included instances where technological pedagogical content knowledge was identified (Table 3).

In their module about Garageband, a tool for editing audio tracks, Apple Teacher (2020) recommended leveraging it to assess students’ fluency rates. Specifically, they suggest that reading teachers “record a student reading a passage, then after the student has practiced a few times, record again and compare the results.” In their work about TPACK, Cherner and Smith (2016) explained that while pedagogical knowledge includes instructional strategies, it extends to additional areas, including assessment and developing literacy skills. In the Garageband example, Apple Teacher (2020) positioned their tool to be used for assessing students’ fluency skills. We saw the example aligning to the technological pedagogical content knowledge dimension, with the content being the reading, a subject area common in elementary schools; the pedagogy being assessment; and the technology being Garageband.

In another example, Google for Education’s (2020) module focusing on moving student work online, they include strategies for flipping the classroom, which is a strategy where teachers assign students reading and activities to be completed outside of the classroom. That way, teachers can use class time for more activities and learning experiences instead of only reviewing content (Schmidt & Ralph, 2016). Google for Education’s (2020) module included a recommendation from a teacher about her use of implementing this approach:

I teach Science, and for me it's very important to flip my classroom so my students have more "hands-on" time in the classroom with experiments and labs. To do this I provide YouTube videos and links for my students to view at home in Classroom. Then, when they come to class, they already have covered the content. (p. 3)

In this example, the teacher actualized the flipped classroom by having her students view YouTube videos about science topics prior to class, which allowed her to utilize her instructional time with students better. Furthermore, the teacher combined her pedagogical knowledge for using the flipped classroom approach with her content knowledge for selecting of videos from YouTube, which requires technological knowledge for using the video-hosting platform to locate and share videos with her students.

Discussion

The CECPs represent an emerging form of PD that can impact the way educators use technology. As CECPs are the products of the corporations that developed them, this section uses a technique commonly employed in business settings to analyze the CECPs based on their strengths, weaknesses, opportunities, and threats (SWOTs; Gürel, 2017).

Leigh (2010) explained that SWOT analyses are comprised of four elements, with the strengths and weaknesses focusing on internal factors, and opportunities and threats focusing on external factors. Table 4 further defines each element.

Table 4
Defined Elements of a SWOT Analysis

SWOT Element	Definition
Strengths	Internal areas that enhance the entity's success and value
Weaknesses	Internal shortcomings that prevent the entity's success and value
Opportunities	External places where the entity has room to gain additional success
Threats	External factors that can impact the entity's potential for success

Even as SWOTs are often used in business settings, researchers have critiqued SWOTs because they do not identify underlying reasons for an entity's performance and tend to stay at a surface level (Hill & Westbrook, 1997). Panagiotou (2003) cited SWOTs as being overly simplified, meaning that a thorough examination is seldom undertaken as part of the analysis. Nixon and Helms (2010) added that SWOTs only capture a moment in time; they do not look for historical trends or predict change. Last, the elements that comprise the SWOTs are not examined in relation

to one another; rather, they are treated as disparate markers (Popescu & Scarlat, 2015). While these researchers' points are well made and supported in their respective works, SWOTs are still commonly used to understand a phenomenon, so implications connected to it can be made. For that reason, we prepared a SWOT analysis on which to further our discussion of CECPs.

Looking across the CECPs, their collective strength is the focus on technology. TPACK domains that included technology were found across the CECPs at higher rates than the domains that did not include it. When digging deeper into the data, Microsoft's CECP was found to not include technology to the same extent as the CECPs from Apple and Google. Of TPACK domains that included technology, pedagogical technological knowledge was the domain most frequently identified within the CECPs' modules, and one main strength of the CECPs was the support they provided regarding the use of technology for instructional purposes. Outside of TPACK, another strength of the CECPs was brand recognition. As explained in the methodology, the companies that provide these CECPs are popular and large, and their products have been widely adopted. These companies can leverage their brand to promote these CECPs, which is a strength.

Across the CECPs, TPACK dimensions that included a focus on content without technology was their weakness, with content knowledge and pedagogical knowledge being rarely identified and pedagogical content knowledge not being identified by any CECP. This finding is problematic because TPACK has an intentional focus on context, as symbolized by the dotted line that encircles the knowledge bases in the framework illustration (Figure 1). Thus, the CECPs are providing support to content-area teachers who are interested in using the technologies in the disciplines. This omission results in the CECPs offering only general approaches for using technology in the classroom. The CECPs seldom mentioned grade levels, as little guidance was provided about the appropriate ages for when students should use the technologies.

Another weakness was the amount of research used to support the pedagogical strategies for integrating the technologies highlighted by the CECPs. In this analysis, little evidence of research was found in the Apple and Google CECP. Notably, the Microsoft CECP included multiple inaccuracies related to research. Microsoft (2020) often made unsubstantiated claims about educational research to promote its products and status.

For example, it referenced a report titled "Resilience and Transformation for the Future of Learning" that was used as the basis for its claims. In its fourth module focused on hybrid learning, it says, "A crucial component of success in a hybrid environment will be students' comfort level with communicating online and collaborating with peers" (para. 4). We read the report to verify the claim and did not find any evidence to support it.

Later in that same module, it referenced an author named Darby who is quoted regarding a Vygotskian theory. Again, no reference of any kind to Darby's work was offered, and the module confused components of Vygotsky's theories of Social Interaction with those of the Zone of Proximal

Development. Though these instances were limited to Microsoft's CECP, none of the CECPs used research to round their claims.

If the major weaknesses are the lack of context and connection to the content areas and grade levels along with little connection to research, they result in opportunities for the CECPs to improve. For example, the CECPs can offer scenarios that features teachers from across the content areas and grade levels using the technologies with their students. These scenarios can include a rationale as to why the technology is appropriate to use for teaching a topic, as well as offering example lesson plans that make use of the technology. These scenarios can be presented in short videos that show students using the technologies with their classmates and teachers as they engage the content.

The scenarios can also offer assessment strategies that leverage the technology to measure student learning. Because none of the CECPs offer this level of support, it provides a way for the CECPs to better serve teachers, students, and the field of education. The CECPs can also infuse research throughout their modules. Though Microsoft's CECP included unfounded claims and errors, it was the only CECP that attempted repeatedly to include research. The opportunity from that weakness is then to cite research and include short synopses of it that support the pedagogical strategies and scenarios being introduced.

Finally, the threats to these CECPs are largely other companies entering this space. For example, Adobe offers a host of programs that educators can use with their students, and it has the potential to launch a competing CECP. As more CECPs being available, the number of teachers who complete a specific CECP is reduced, along with the potential adoption rate of the technologies featured in them.

The quality of the CECPs represents another concern. If the lack of research is identified by teachers, it can threaten the creditability of the CECPs. While this study was conducted by trained researchers, teachers who do not share a researchers' expertise in scholarly works may overlook these shortcomings. If researchers continue to raise these concerns, it may erode the use of these CECPs by teachers. Though the CECPs did not provide data about the numbers of educators using them, the rise of edtech and amount of money being invested suggest that the CECPs have a niche in the marketplace, and they will likely continue to exist well into the foreseeable future. As such, the following section offers recommendations for improving and using the CECPs.

Implications

Currently, the shortcomings in CECPs' teaching of all areas of TPACK do not make them the ideal tool for preservice or early-career teachers who are still developing their abilities to contextualize the information offered by the CECPs within a content area. On the other hand, the CECPs are more ideal for in-service teachers and teacher educators who can understand the information provided by the CECPs and apply it to their content area. With the CECPs analyzed in this study being at an introductory or foundational level, it is especially important that the

information they provide includes ideas for using it within a content area. That way, preservice and early-career teachers can use the ideas as models for integrating the technologies within their teaching practices. To facilitate that dynamic, this section provides recommendations to the CECPs' developers, educator preparation programs, and schools.

Recommendations for CECP Developers

While we found that the CECPs offered value regarding ways to use their technologies for educational purposes, those instances were not contextualized to specific content areas. The result then is that educators are left to make the connections to their own practice. While licensed teachers are capable of creating lesson plans for their students that combine content with pedagogy, more support should be offered to them as they blend technologies into their instruction.

As the CECPs in this study were positioned to introduce educational technologies, that work is incomplete if they do not provide the content-area specific resources for integrating their technologies into classroom instruction, especially for preservice and early-career teachers. For example, Apple Teacher (2020) can provide lessons that demonstrate ways to use Garageband in science, social studies, English language arts, physical education, math, art, theater, and band. Similarly, while the Microsoft CECP highlighted its products such as Teams, it needs to demonstrate ways students and teachers can utilize Teams in a specific content area.

The CECPs can also help offer grade-level recommendations about when their products may be used in the classroom. To fully maximize CECPs, they should offer lesson plan ideas for specific content areas and grade levels that utilize their products, and they can align those lesson plans to academic standards to further support teachers.

To build credibility as alternative credentialing programs, CECPs should focus claims of their products' effectiveness on independent peer-reviewed research. In the era of "fake news" and critical media literacy, the evaluation of information's sources is growing as a K-12 area of emphasis (Share & Mamikonyan, 2020), and the number of unattributed and unsubstantiated claims revealed in this analysis reflects poorly on both the CECPs' overall value and their motivations. In response, we recommend that CECP developers soften the language of their current claims (e.g., add the qualifier "may" to claims not supported by the literature) and foster the evaluation of their products through large-scale, multi-institution scientific studies.

Recommendations for Educator Preparation Programs

It has been well-identified that technology is not fully integrated into educator preparation programs, with recent scholars continuing to find that technology is taught in stand-alone classes that largely separates technology from the content areas (Clausen et al., 2021; Landon-Hayes et al., 2020). The content analysis from this study points to the parallel problem of CECPs' separating instruction of edtech from the content

areas. CECPs necessitate supplementary pedagogical instruction to prepare educators to integrate technology effectively into their course content, which gives teacher educators an opportunity to leverage CECPs in response to the lack of technological integration that Clausen et al. and Landon-Hayes et al. found in educator preparation programs.

Instructional methods classes in educator preparation programs can use CECPs as a roadmap for providing preservice teachers with specific technology integration examples in their content classes. Methods classes provide teacher educators with a way to utilize CECPs. These methods classes focus on preparing preservice teachers to plan and implement lessons in their content area. With the CECPs not deeply addressing TPACK's content knowledge base yet addressing technological knowledge, teacher educators can have their preservice teachers complete one or more modules of a CECP that focuses on a specific technology before coming to class. Then, in class, the preservice teachers can first reflect about the knowledge they learned about a technology from the CECP. The teacher educator can model a way to utilize the technology for content area instruction. For example, the Google CECP promoted Google Meet, a tool for video conferencing. After learning about that tool, teacher educators preparing preservice social studies teachers could use it to host a moderated debate.

To model their use of Google Meet, teacher educators could divide their in-person class of preservice teachers into four teams and give each a topic that they have already studied, such as climate change policy or the Bill of Rights. In addition, the teacher educator could provide each team with the prompts for the debate, and then provide the teams time to prepare their stance and response to the prompts. When ready, the teacher educator would launch Google Meet, and each team would join the meeting from a different location in the classroom.

At this point, the teacher educator could state the first prompt and allow each team to give a 90-second response to it. After all teams have responded, the teacher educator could allow the teams to respond to one another in a point-counterpoint format for 3 minutes, and the teams would work together as part of that debate. After time has expired, the teacher educator would repeat that process for the next questions. When complete, the teacher educator can have students reflect on the activity, with a focus on the technology and academic content and skills included in it.

In this activity, teacher educators would be engaging each of the TPACK knowledge bases. Technological knowledge base would be addressed by having students interact with one another using Google Meet. Though this activity could have been conducted without Google Meet, the skills gained from this experience is not only the technical features of using the tool. In addition, students learn to communicate using a video-conferencing platform, such as the etiquette for speaking, listening, and exchanging ideas in a synchronous digital context. In the future, students will need these skills to be successful postsecondary students and employees in the work force (Van Laar et al., 2017).

Next, teacher educators would be demonstrating their pedagogical knowledge base through the social interaction and collaboration woven into the debate. Forming teams positions the students to work together when planning their response to the prompts. In addition, during the point-counterpoint debate, students share ideas that they can build on or refute to advance their own team's position in the debate.

Finally, the content knowledge base would be addressed by having students demonstrate an understanding of the debate's topics when making their opening statement in response to the prompt, along with considering those topics from multiple perspectives during the point-counterpoint debate. In this example activity, teacher educators would use the CECP to prepare their preservice teachers' knowledge of the tool before demonstrating a method for using it to engage students in their content area.

Using this type of instruction in the methods classes, teacher educators would be able to (a) fully integrate technology throughout educator preparation programs as recommended by TPACK (Koehler & Mishra, 2009; Mishra & Koehler, 2006), and (b) meet the specific needs of their preservice teachers by addressing the shortcomings of CECPs' lack of pedagogical instruction for the content areas. Along with using CECPs in methods courses, teacher educators can use them as part of school-based experiences that are commonly required of preservice teachers to complete an educator preparation program and earn a teaching license.

As preservice teachers complete school-based experiences – including observations, internships, apprenticeships, and so forth, – teacher educators can use CECPs to supplement their experience. Al-Bargi (2021) and An (2018) identified that PD providing teachers choice and readily available online appeals to teachers, and CECPs include those characteristics. To leverage them as part of school-based experiences, teacher educators can ask their preservice teachers to document the different types of technologies they observed being used in the school and how they were being used. Next, after the experience, teacher educators can debrief with their preservice teachers via one-on-one, in small groups, or whole class conversations if in person or through email, discussion board entries, or blog posts if online, about their observations. Through the debriefing, teacher educators can document the different technologies named and provide links to CECPs, if available, for the preservice teachers to learn more about the technologies. After they complete the CECPs, teacher educators can then engage them in ideating ways those technologies can be used in the content-area classroom, based on both their school-based experience and the CECPs. In this way, the teacher educators can contextualize the CECP through the preservice teachers' school-based experiences.

Recommendations for Schools

Like educator preparation programs, schools must supplement the CECPs to ensure that in-service teachers have the understanding and efficacy needed to integrate edtech into their instruction. With substantial content linkage models absent in CECPs, in-service teachers who did not grow up in the current era of technology may not have a context for integrating

technology into their instruction. As such, these in-service teachers may not use technology in ways that would bring TPACK in their teaching. In that regard, schools must first realize that there are shortcomings of CECPs. Instead of indiscriminately incentivizing their in-service teachers to complete CECPs, schools can provide supplementary PD that works in tandem with the CECPs to support teachers.

For the PD sessions, they could include CECP modules that in-service teachers complete independently. Then, in either a face-to-face or online setting, teachers could be divided based on content area, and experts in that content such as instructional coaches, curriculum coordinators, or seasoned tech-savvy teachers could lead brainstorming and discussion sessions on how the edtech overviewed in the CECP modules could be effectively integrated into specific lessons or instructional strategies, while keeping in mind TPACK.

For example, after completing the Google for Education (2020) module Using Google Docs and Drive to Motivate Group Collaboration, social studies teachers could meaningfully share their content integration insights in a synchronous online PD session facilitated through a video conferencing platform. In a synchronous online think-pair-share format outlined by Fegely and Cherner (2021), the social studies teachers would be given a think question in the whole group meeting area from the leader of the PD session, such as, “How would you integrate collaborative group activities facilitated by Google Drive into teaching geography?” The teachers would then make notes detailing their initial ideas.

The teachers would next be paired in breakout rooms. In the breakout rooms, the pairs of teachers would discuss their initial responses to the question, comparing and contrasting their ideas, and adding to their integration strategies based on the alternative perspectives and feedback of their partner. Finally, the leader of the PD session would close the breakout rooms and everyone would return to the whole group meeting area. The pairs would then share their ideas that they brainstormed, offering a wide variety of integration ideas to the group, such as having students (a) collaboratively create interactive map quizzes in Google Slides with hyperlinks to correct or incorrect slide-based feedback and scoring, (b) collaboratively build study guides in Google Docs on chapter content, and (c) pool the class’s research data on elevation levels of the Appalachian Mountains in Google Sheets to make graphs of elevations across each state. In this way, teachers would learn from each other on how to integrate technology with their content knowledge in the PD session.

Conclusion

CECPs are likely to have an impact on both PD and the way technologies are used in schools. This study demonstrated that only certain of the TPACK knowledge bases are being emphasized, while other knowledge bases are not being addressed. To improve the CECPs, their developers can address the shortcomings by contextualizing the way the technologies are presented by providing examples that situate them within specific content areas and grade levels. They can also reference credible, accurate research that supports the pedagogical strategies being emphasized. That way, as the stakeholders named in the implications engage these CECPs, they will

be doing so in a way that benefits not only their use of technology but overall instructional practices in the classroom.

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Appendix Complete Coding Scheme

Deductive Categories	Module Being Coded:
Content Knowledge	Knowledge of the subject and its organizing structures (Ball et al., 2008)
Look Fors	<ul style="list-style-type: none"> • Name of specific content areas (e.g., science, social studies, ELA, math, PE, etc.) • Content-area specific references (e.g., the Great Wall, spine, Edgar Allan Poe, etc.)
Yes No	If yes, please provide an example:
Pedagogical Content Knowledge	A “practical” way of knowing subject material and teaching strategies needed to design student learning experiences (Shulman, 1987)
Look Fors	<ul style="list-style-type: none"> • Methods for teaching content-area specific knowledge (e.g., diagramming a sentence, solving equations, developing timelines, etc.) • Methods developed for teaching content-area specific topics and skills (e.g., writer’s workshop, Socratic circles, etc.)
Yes No	If yes, please provide an example:
Pedagogical Knowledge	“The teacher’s knowledge of and skill in the use of teaching methods and other pedagogical strategies that are not subject specific” (Gudmundsdottir, 1987, abs.)
Look Fors	<ul style="list-style-type: none"> • General teaching strategies that are not content-area specific (e.g., think-pair-share, I Do, You Do, We Do, jigsaw, etc.) • Fostering relationships with students and planning instruction based on students’ needs
Yes No	If yes, please provide an example:
Pedagogical Technological Knowledge	Using technology in non-subject specific ways to facilitate learning (Keohler & Mishra, 2009)
Look Fors	<ul style="list-style-type: none"> • General technology-specific teaching strategies (e.g., WebQuest, Padlets, Digitized Gallery Walk, etc.) • Other technologies that interface with students but are not content specific, such as taking attendance, classroom management, and grading (e.g., Class Dojo, Edmodo, TeacherKit, etc.)
Yes No	If yes, please provide an example:
Technological Knowledge	Using technology to perform specific tasks and recognizing when technology could be used to complete tasks (Koehler et al., 2013)
Look Fors	<ul style="list-style-type: none"> • Using technology to complete general tasks without a specific content-area or instructional context and/or educational purpose (e.g., using Gmail to communicate, using MS Teams to collaborate, using Google Search to locate information, etc.)
Yes No	If yes, please provide an example:
Technological Content Knowledge	The use of technology to access and interact with materials that are specific to a subject area (Herring et al., 2016)

Deductive Categories	Module Being Coded:
Look Fors	<ul style="list-style-type: none"> • Technology that provides access to or information about topics connected to a content area (e.g., online encyclopedia, search engines, the NASA app, etc.) • Technology that allows students to interact with content-area knowledge (e.g., students using VR to study visit a museum, accessing a library of literature, browsing a database of primary resources, etc.)
Yes No	If yes, please provide an example:
Technological Pedagogical Content Knowledge	The interaction of TK, PK, and CK needed to create a learning experience for students (Koehler & Mishra, 2009)
Looks Fors	<ul style="list-style-type: none"> • Teachers design instruction using technology to enhance student learning experiences specific to a content area (e.g., webquest about George Washington, teachers leading a VR experience with students in a specific content-area environment, students are part of a virtual pen pals writing activity, students sharing their writing online and getting feedback from peers, etc.)
Yes No	If yes, please provide an example: