Innovation Configuration

Use of Technology in the Preparation of Pre-Service Teachers

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October 2014
CEEDAR Document No. IC-11

IDEAs that Work

Office of Special Education Programs
U.S. Department of Education

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Recommended Citation:

Dieker, L. A., Kennedy, M. J., Smith, S., Vasquez III, E., Rock, M., & Thomas, C. N. (2014). *Use of technology in the preparation of pre-service teachers* (Document No. IC-11). Retrieved from University of Florida, Collaboration for Effective Educator, Development, Accountability, and Reform Center website: http://ceedar.education.ufl.edu/tools/innovation-configurations/

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Table of Contents

List of Tables

Innovation Configuration for the Use of Technology in the Preparation of Pre-Service Teachers

This paper features an innovation configuration (IC) matrix that can guide teacher preparation professionals in the development of appropriate use of technology in the preparation of pre-service teachers. This matrix appears in the Appendix.

An IC is a tool that identifies and describes the major components of a practice or innovation. With the implementation of any innovation comes a continuum of configurations of implementation from non-use to the ideal. ICs are organized around two dimensions: essential components and degree of implementation (Hall & Hord, 1987; Roy & Hord, 2004). Essential components of the IC—along with descriptors and examples to guide application of the criteria to course work, standards, and classroom practices—are listed in the rows of the far left column of the matrix. Several levels of implementation are defined in the top row of the matrix. For example, no mention of the essential component is the lowest level of implementation and would receive a score of zero. Increasing levels of implementation receive progressively higher scores.

ICs have been used in the development and implementation of educational innovations for at least 30 years (Hall & Hord, 2001; Hall, Loucks, Rutherford, & Newton, 1975; Hord, Rutherford, Huling-Austin, & Hall, 1987; Roy & Hord, 2004). Experts studying educational change in a national research center originally developed these tools, which are used for professional development (PD) in the Concerns-Based Adoption Model (CBAM). The tools have also been used for program evaluation (Hall & Hord, 2001; Roy & Hord, 2004).

Use of this tool to evaluate course syllabi can help teacher preparation leaders ensure that they emphasize proactive, preventative approaches instead of exclusive reliance on behavior reduction strategies. The IC included in the Appendix of this paper is designed for teacher preparation programs, although it can be modified as an observation tool for PD purposes.

The Collaboration for Effective Educator, Development, Accountability, and Reform (CEEDAR) Center ICs are extensions of the seven ICs originally created by the National Comprehensive Center for Teacher Quality (NCCTQ). NCCTQ professionals wrote the above description.

The use of technology has exploded throughout every avenue of society and education; teacher education is no exception. However, a close examination of the evidence base for the use of technology in teacher preparation course work and field experiences reveals that implementation is well ahead of corresponding scientific evidence (Smith & Kennedy, 2014). Using practices without evidence is problematic because teacher preparation programs are held accountable for their graduates and how well they improve achievement outcomes for K-12 students. Thus, teacher educators must be aware of emerging trends in technology; at the same time, they must understand the potential, as well as the pitfalls, of purchasing, adopting, and using a wide array of tools (Clark, 2009).

For this IC, we reviewed practices related to the use of technology in teacher education to impact the practice of pre-service teachers. We also noted the underlying theory for each technology as it relates to research evidence and usability for faculty in higher education. With the ongoing evolution of technology, this paper is one that we could update almost daily. However, this statement is not an excuse to ignore the current literature base or adopt untested technologies that seem powerful. Instead, using research and theories as the foundation for each section on the use of technology in teacher education throughout the past decade, we have provided a summary of the existing research, clearly defined practices, and considerations for teacher educators to incorporate these practices into their programs. The broad categories of research and use of technology in teacher education to date are (a) podcasts,
(b) video case studies, (c) online delivery of content, (d) technology-based support,
(e) supervision and feedback, and (f) virtual learning or simulation experiences.

Podcasts

Podcast Practice Defined

A podcast is an audio recording of a topic that individuals upload to the Internet for dissemination. An enhanced podcast is an audio track supplemented with visuals (i.e., text, images, or both). Creating audio-only or enhanced podcasts for use in higher education and teacher preparation is not difficult because many instructors already take advantage of opportunities to record regular class lectures using Audacity (http://www.audacity.soundforge.net) and other programs. After recording content, they can sync audio tracks to their slides using GarageBand and upload to iTunes U or a course management system (e.g., Blackboard). Although there is not yet a published study of precisely how widespread the use of podcasting is in teacher preparation, anecdotal and empirical evidence from other fields in higher education (Evans, 2008) suggests that a substantial number of teacher educators use podcasts in some form within teaching.

Podcasts are easy to create and consume, can be any length and cover any topic, and may include any number of instructional approaches (Evans, 2008). These attributes make podcasts attractive tools to incorporate into pre-service instructors' arsenals.

Podcast Research Defined

Researchers have found through comprehensive reviews of the use of podcasts in higher education that the vast majority of studies have evaluated users' satisfaction with podcasts in their courses but have not included controlled experiments to determine if podcasts produced a direct impact on learning (Heilesen, 2010; Hew & Cheung, 2013). Simply recording a lecture and posting it online offers teacher educators no guarantee that the resulting podcast contains instructional features that augment learning and engagement (Clark, 2009; Kennedy, Thomas, Aronin, Newton, & Lloyd, 2014; Mayer, 2009). Generic podcasts are seductive as instructional tools, but teacher education professionals must hold higher standards of evidence while creating and selecting instructional materials to use in courses (Kennedy, Kellems, Thomas, & Newton, in press). One strategy that teacher educators can use to move from generic podcasts to an impacting practice is the use of Content Acquisition Podcasts (CAPs; Kennedy & Thomas, 2012).

Content Acquisition Podcasts

CAPs combine the typical features of podcasts with visual supports. However, CAPs are more than generic, enhanced podcasts because they reflect Mayer's (2008) cognitive theory of multimedia learning (CTML) and accompanying evidence-based instructional design principles. Informed by this theory and its principles, CAPs contain only the most essential content for a topic and present viewers with clear images to help illustrate and represent information. See https://vimeo.com/72518420 for a sample CAP. In this sample, and in any CAP (see www.SpedIntro.com), note the rich images, sparing use of text, pace of narration, explicit instructional cues, and depth of content. CAPs are not intended to replace course textbooks or lectures; instead, teacher educators can use CAPs to augment and enrich existing instructional methods.

Mayer (2009) asserted that multimedia instruction should be designed to maximize learners' available cognitive resources by using visual and auditory inputs concurrently and strategically, not redundantly. In practice, this means that multimedia instruction is a combination of highly scripted narration and carefully selected and arranged images that facilitate efficient interconnectivity between working and long-term memory (Mayer, 2009). The applied arm of Mayer's theory is his 12 evidence-based instructional design principles (see https://vimeo.com/89716786 for an introduction). Table 1 features a presentation of these principles as well as the effect sizes for each principle as calculated by research that Mayer and colleagues conducted. These principles help instructional designers make good decisions about how and where to arrange images on the screen and how to select, prepare, and organize content within the instructional module.

Table 1

Linkage of CAP Production Steps to Mayer's CTML and Instructional Design Principles

Triarchic Model of Cognitive Load (DeLeeuw & Mayer, 2008)	Research-Based Instructional Design Principles and Effect Sizes (ES)* (Mayer, 2009)	Brief Description of Mayer's Instructional Design Principles (Mayer, 2009)
Limit Extraneous Processing	Coherence Principle ES = .97; 14 studies	Excluding irrelevant or extraneous information enhances instructional materials.
	Signaling Principle ES = .52; 6 studies	Instruction that contains explicit cues to signal key content enhances learning.
	Redundancy Principle ES = .72; 5 studies	Inclusion of extensive text (i.e., transcription) on the screen along with spoken words and pictures hinders learning. Carefully selected words or short phrases, however, augment retention.
	Spatial Contiguity Principle ES = 1.12; 5 studies	On-screen text and pictures should be in proximity to one another to limit eye shifting during instructional presentations.
	Temporal Contiguity Principle ES = 1.31; 8 studies	Pictures and text shown on screen should correspond to the audio presentation.
Manage Essential Processing	Modality Principle ES = 1.02; 17 studies	People learn better from spoken words and pictures than they do from pictures and text alone.
	Segmenting Principle ES = .98; 3 studies	People learn better from multimedia presentations divided into short bursts versus longer modules.
	Pre-training Principle ES = .85; 5 studies	Each CAP begins with an explicit statement of purpose and an advance organizer for the term.
Foster Generative Processing	Multimedia Principle ES = 1.39; 11 studies	People learn better from pictures and spoken words than from words alone.
	Personalization, Voice, and Image Principles ES = 1.11; 11 studies	Narration presented in a conversational style results in better engagement and learning than more formal audio presentations. People learn better from clearly spoken narration with respect to rate and accent. People learn better when images are not abstract and clearly represent the presented content.

**Note*. Effect sizes are summaries of the empirical research reported in "Applying the Science of Learning: Evidence-Based Principles for the Design of Multimedia Instruction," by R. E. Mayer, 2008, *American Psychologist, 63*, pp. 760-769.

To date, 12 studies that report empirical data of CAPs to improve teacher candidates' learning and/or application of skills (we briefly discuss 10 here) are published, in press, or in review. In the forthcoming narrative, we have organized and discussed studies that demonstrate CAPs' capacity to impact teacher candidate learning and knowledge of content and application of skills.

Impact of CAPs on teacher candidate learning. In the first empirical study of CAPs' impact on teacher candidate learning, Kennedy, Hart, and Kellems (2011) randomly assigned 79 students enrolled in two sections of an introductory special education course to either watch two CAPs on the principles of No Child Left Behind (NCLB) and traumatic brain injury (TBI) or hear audio-only podcasts of the same content. Kennedy and colleagues (2011) used a researcher-created dependent measure of knowledge in a pretest-posttest design to evaluate group differences following treatment. All research activities occurred during a regularly scheduled meeting of the course, and participants wore headphones at individual laptop stations to help ensure fidelity of implementation of the two treatment conditions (Note: This is the same for all forthcoming mention of studies by Kennedy et al., 2011). Participants in the CAP group significantly outperformed colleagues in the audio-only condition with an effect size (i.e., Cohen's *d)* of .64 for NCLB and .82 for the TBI experiment. This study provided preliminary evidence that Mayer's (2008) instructional design principles could be used to reshape a generic enhanced podcast and deliver content important for an introductory course in special education teacher preparation.

Researchers conducted a follow-up study of CAPs' impact on teacher candidate learning of the characteristics of students with learning disabilities (LD) and autism (Kennedy et al., 2014) and positive behavioral interventions and supports (PBIS; Kennedy & Thomas, 2012). In this study, 164 teacher candidates enrolled in an introductory special education course at two universities were randomly assigned to either watch three CAPs or read a practitioner-friendly chapter of the same content. Again, using a researcher-created dependent measure of knowledge and carefully controlled experimental procedures, participants completed a pretest, posttest, and maintenance probe for each of the three topics. Learners who viewed CAPs significantly outperformed students in the text-only condition at posttest and maintenance for the LD, autism, and PBIS experiments. The effect sizes at posttest and maintenance for the three experiments, respectively, were d = 1.09, .81 (LD); d = 1.21, 1.33 (autism); and d = .98, .97 (PBIS).

The research group (Kennedy, Newton, Haines, Walther-Thomas, & Kellems, 2012) completed a mixed methods study of CAPs' impact on teacher candidate learning and satisfaction in a summer section of the introductory special education course. Researchers sought participant input on users' satisfaction with CAPs as daily learning tools and measured impact on performance during three case studies and the final exam. The qualitative feedback from users led to significant upgrades in CAPs' adherence to Mayer's (2008) instructional design principles and overall quality. See https://vimeo.com/14444176 for a sample CAP on the characteristics of students with LD from the early days. Then, see https://vimeo.com/72439473 for an upgrade.

Kennedy and colleagues (2012) continued this line of research with a replication study of CAPs' impact on teacher candidate capacity to learn content related to the characteristics of students with LD and autism. In this project, teacher candidates from two universities were randomly assigned to one of three conditions. In Condition 1, the participants watched a CAP and then read a practitioner-friendly chapter (i.e., Pre-CAP condition). In Condition 2, participants read the chapter and then watched the CAP (i.e., Re-CAP condition). Students in

Participants in Condition 3 only read. Students in the Pre- and Re-CAP groups significantly outperformed the students in the text-only condition at posttest and maintenance (*d* = .94, .94), but the students' scores were not significantly different. Thus, researchers concluded that CAPs could function as advance organizers or reviews when used as part of a learning sequence.

Finally, Hart and More (2013) created a CAP on characteristics of students with autism and randomly assigned 79 teacher candidates to either watch the CAP or read a practitioner-friendly article of the same content. Participants in the CAP condition significantly outperformed their peers in the text-only condition at posttest (*d* = .81). In summary, there is strong evidence to suggest that teacher candidates can use CAPs to learn the content necessary to become special education teachers. Therefore, improving knowledge of the characteristics of certain disability categories does not automatically transfer to the skill needed to implement evidence-based practices (EBPs) while teaching children with disabilities.

Impact of CAPs on teacher candidate knowledge and application of skill. Given the aforementioned open question of whether CAPs can impact teacher candidate application of instructional skill, Kennedy and colleagues (2012) pursued a branch line of research related to CAPs. To illustrate, Kennedy, Driver, Pullen, Ely, and Cole (2013) randomly assigned 148 teacher candidates at one university to watch a CAP on phonological awareness (see https://vimeo.com/40105175) or read a practitioner-friendly article containing the same content. The dependent measure included items that measured participant knowledge and application of skill within the teacher education environment. Participants in the CAP group learned significantly more content and displayed significantly higher levels of skill application, including the ability to select appropriate EBPs for use while teaching phonological awareness practices and identifying the number of phonemes within words at posttest (*d* = .86) and maintenance (*d* = .97).

Ely and colleagues (Ely, Pullen, Kennedy, Hirsch, & Williams, 2014; Ely, Pullen, Kennedy, & Williams, in press) completed a pilot study and follow-up experiment investigating the impact of CAPs on teacher candidates' and in-service teachers' knowledge of an evidence-based vocabulary intervention and ability to demonstrate steps of the strategy during a teaching exercise. In a pilot study (Ely et al., in press) using a single-subject design, three general education teachers made improvements on a number of intervention elements implemented during teaching per a checklist of EBPs associated with an evidence-based vocabulary intervention (Pullen, Tuckwill, Knoald, Maynard, & Coyne, 2010) following a viewing of a CAP and modeling video (see https://vimeo.com/29955974). In a follow-up experiment (Ely et al., in press), 49 teacher candidates were randomly assigned to watch the same CAP and modeling video as the pilot study or read a practitioner-oriented article containing the same content. First, participants completed a knowledge test, and the participants in the CAP condition significantly outperformed peers in the text-only condition (*d* = .72). Then, all participants taught a sample lesson using the intensified vocabulary instruction (IVI) strategy (Pullen et al., 2010). A fidelity checklist containing the steps of the IVI strategy was used to measure implementation and quality. Participants in the CAP-plus-video condition implemented significantly more practices (*d* = 1.14) than the text-only group implemented. The researchers in these studies have preliminarily shown that pairing CAPs with modeling videos may assist teacher candidates in gaining the knowledge and skills needed to implement EBPs. More research in this area is needed to understand properties of the modeling videos, the dosage needed to change practice, and the extent to which newly developed skills transfer to the classroom while teaching live students or to evolving simulated environments.

Finally, Kennedy and colleagues (2014) taught 40 teacher candidates production steps involved in producing CAPs for students (Kennedy, Deshler, & Lloyd, 2013; Kennedy, Thomas, Meyer, Alves, & Lloyd, 2013). Following a round of feedback, participants were able to produce CAPs that adhered to Mayer's (2008) instructional design principles and EBPs for vocabulary instruction. Participants reported overall satisfaction with the process, and most agreed that they would use CAPs in their future teaching careers.

Practical use of content acquisition podcasts. Although the aforementioned studies were mostly conducted in laboratory-like settings for the purpose of maintaining experimental control, teacher educators can use CAPs to flip their classrooms by way of providing students with high-quality instruction outside of class to accompany assigned readings and other assignments. Pre-service teachers can also use CAPs for review before exams and as resources while writing lesson plans and completing other course assignments.

An array of resources related to both the creation and use of CAPS are available online. Resources to create CAPs are available at http://people.virginia.edu/~mjk3p/, https://vimeo.com/24179998 (Part 1), and https://vimeo.com/24182724 (Part 2). CAPs about characteristics of students with LD (see https://vimeo.com/72439473), autism (see https://vimeo.com/72518420), and PBIS (see https://vimeo.com/14630006) are available for review and use by all readers. In addition, www.SPEDIntro.com is a freely available site containing dozens of CAPs on various topics of interest for special education teacher educators, researchers, administrators, and teachers.

According to The Collaboration for Effective Educator Development, Accountability, and Reform (CEEDAR) Center guidelines, CAPs are an emerging EBP. The important question for readers of this IC is as follows: How may CAPs be appropriate for use in pre-service teacher education? Kennedy and colleagues (2012) have shown the use of CAPs using a practical approach during typical course instruction. To further elaborate, each week, Kennedy assigns students one or more CAP to review along with their other required readings or activities. CAPs are often framed as resources made available for those looking for a fast summary of the key content likely to be prioritized during lectures, on assignments and assessments, and for use while teaching. Kennedy stresses that questions on the midterm and final exam are largely drawn right from the CAPs; therefore, students should use CAPs as study tools. In addition, pre-service teacher candidates are invited to bookmark www.SPEDIntro.com as a resource for use in other courses, during practicum experiences, and while teaching. This library of resources will continue to expand with more CAPs and, in the near future, with modeling videos. The vision is to create an online repository of high-quality, evidence-based learning materials that pre- and in-service teachers can reference as frequently as they reference the IRIS modules (see http://iris.peabody.vanderbilt.edu) for online content.

Video Case Studies

Case Studies Defined

Case studies are stories of real classroom-, student-, or school-based environments used in an instructional format to help pre- and in-service teachers apply new knowledge within a scaffolded yet authentic environment. Stories about teaching can be short or long, can be based upon information about real students and classroom events, or can be realistic with a focus on salient features of school-based problems. Cases can include information to address authentic problems that are under consideration or can require learners to conduct activities that lead to the resolution of problems. Case studies of educational scenarios typically portray dilemma-laden, complex, and dynamic challenges that teachers face in daily classroom decision making and provide practice for and models of expert teaching and EBPs to improve student outcomes. Case-based instruction supports the development of new domain knowledge and the understanding of the processes and procedures of implementation. It also helps teachers learn to identify the environmental cues that indicate the conditions under which applying the new knowledge and skills will attain the desired outcomes (Schrader et al., 2003). Within the case study format for learning, teacher education researchers and practitioners have investigated the use of emerging technologies to deliver and engage pre- and in-service teachers. Video has been a logical and powerful medium for delivering case studies.

Research on video case study emerges in the literature under various terms, including *video models*, *anchored instruction*, and *problem-based learning*. References to technology include delivery systems such as *computer-based instruction*, *multimedia*, and *hypermedia*, along with video alone. The commonality across labels and studies of the video case study method is the overlap and convergence of underlying learning theory supporting technology implementation.

Video case study is interactive; it engages learners in activities and gives them control (Dieker et al., 2009). Video case study research may represent some of the earliest forays into "flipping the classroom" (PT3 Group at Vanderbilt, 2003), with learners engaging with the video case study outside of class and returning to class prepared to engage in an activity centered around the video case study. The asynchronous properties of video case study enable learners to revisit and review components of the case to check memory and confirm or refute impressions about new learning (Cognition & Technology Group at Vanderbilt, 1990). Video can make the covert overt. For example, in the work by Dieker and colleagues (2009), two teachers in the reading experiment reported that "from watching the video, they learned about nuances of the strategy that were not clear from either reading the book or participating in the training" (p. 188). This aha moment—when the video reveals to learners their misconceptions, misunderstandings, or gaps in knowledge that are impeding effective transfer—is one of the powers of video; the learners see all aspects of a practice and are not limited by their own comprehension of text or observations of the interpretations of the teacher educators.

Case Study Research Defined

In research and practice, video case studies often contain multimedia aspects and include additional instructional methods and components such as student data, examples of student work, and communication records between fictional or real teachers and parents. In studying video case studies, researchers have used instructional groupings that include individuals (Brunvand & Fishman, 2006-2007; Peng & Fitzgerald, 2006); pairs (Daniel, 1996; Herrington & Oliver, 1999); small groups (Barnett, 2006; Kurz & Batarello, 2004); large groups (D. H. Anderson, 2002); and groups varied by instructional purpose (L. M. Anderson & Bird, 1995; Ochoa, Kelly, Stuart, & Rogers-Adkinson, 2004; PT3 Group at Vanderbilt, 2003).

Instruction based upon video case study has included additional activities such as in-class discussion (Kurz & Batarelo, 2004; Ochoa et al., 2004; PT3 Group at Vanderbilt, 2003; Schrader et al., 2003); online discussion (Barnett, 2006; Beck, King, & Marshall, 2002; Kurz & Batarelo, 2004; PT3 Group at Vanderbilt, 2003); e-notetaking (Lambdin, Duffy, & Moore, 1997); lecture (Brunvand & Fishman, 2006-2007; Ochoa et al., 2004; PT3 Group at Vanderbilt, 2003); field experience (Beck et al., 2002; PT3 Group at Vanderbilt, 2003; Schrader et al., 2003); questions embedded in the computer-based environment (Daniel, 1996; Fitzgerald & Semrau, 1998; Koehler, 2002; PT3 Group at Vanderbilt, 2003) face-to-face questioning (Barnett, 2006; Kurz & Batarelo, 2004); readings (Ochoa et al., 2004; PT3 Group at Vanderbilt, 2003; Schrader et al., 2003); writing (L. M. Anderson & Bird, 1995; Hewitt, Pedretti, Bencze, Baillancourt, & Yoon, 2003; PT3 Group at Vanderbilt, 2003); and computer-based quizzes (Fitzgerald & Semrau, 1998; PT3 Group at Vanderbilt).

The use of video case studies is now a common practice in teacher education. However, in examining the literature, there is a lack of consensus about effectiveness because there is a high degree of variability across studies in (a) video case study features, structure, and delivery systems; (b) implementation procedures and duration; (c) the instructional purpose of the video; and (d) how teacher learning is measured. For example, in considering video features, Dieker and colleagues (2009) carefully designed explicit models of expert teaching while Riedel, Fitzgerald, Leven, and Toenshoff (2003) presented to learners the use of deliberately ill-structured problems. In a review of the literature on anchored instruction by Thomas and Rieth (2011), the duration of videos ranged from 1 to 30 min. J. Wang and Hartley (2003) were critical of the short duration of video case study instruction in the studies they reviewed, and they recommended lengthier immersion. They found that implementation duration ranged from one 50-min period (Brunvand & Fishman, 2006-2007) to a full semester (Fitzgerald & Semrau, 1998; PT3 Group at Vanderbilt, 2003; Schrader et al., 2003). However, courses that sustained lengthier immersions in video case studies introduced more confounds in interpreting research findings; in addition to the use of video case studies, they included instructional features such as field experience, journaling, and lecture, among others that influenced study results.

Fitzgerald and colleagues (2009), using a naturalistic design across five campuses and 10 instructors, found that education students, including pre- and in-service teachers in general and special education, learned best from their computer-based modules when the video case study was used for within-case learning and guided application of case knowledge and skills. Within-case learning related to accountability and time spent using the materials, and participants were "required to fully complete all embedded activities within the case and points were given toward their course grade for quality of work" (p. 16). Guided application referred to the built-in mediation and scaffolding within the computer-based environment in which "students were required to fully complete all embedded activities and then apply the information to simulated or real situations as transfer" (p. 16). In relating these findings to face-to-face implementations, the takeaways would be (a) time spent learning, (b) comprehensive engagement in activities related to the case, (c) accountability with feedback, and (d) transfer attempts with feedback.

Implications for Teacher Education

Research in this field provides some key features, such as length of time and embedded practices, but the range of use of videos should also be a factor in relation to adoption of video case studies. Ochoa and colleagues (2001, 2004) found case studies that were useful when learners participated in the special education referral process for English language learners. Other researchers have found that students engaged in applying the procedures of functional behavioral assessment when video case study materials supported instruction (D. H. Anderson, 2002; Schweder, Wissick, & Ayres, 2008; Thomas, 2008). Studies using video case studies to practice implementation of EBPs have also been effective for better understanding of early reading instruction (Dieker et al., 2009; Schrader et al., 2003); mathematics (Daniel, 1996; Dieker et al., 2009; Kurz & Batarelo, 2004; PT3 Group at Vanderbilt, 2003); and science learning (Abell, Bryan, & Anderson, 1998; L. M. Anderson & Bird, 1995; Dieker et al., 2009) as well as for engaging candidates in authentic reflection about teaching and learning (Etscheidt, Curran, & Sawyer, 2011; Hewitt et al., 2003). In one study (Beck et al., 2002), researchers taught students to create their own video case studies, collecting and editing video of mentor teachers providing instruction to exemplify effective teaching practices and showing evidence of teacher strategies, student thinking, and state standards.

Incorporation Into Practice

Video case studies offer affordances that make them useful in teacher education. Typical university-based teacher education classrooms are often highly decontextualized with auditorium-style seating with projectors and boards on which to write. Sharing video case studies of teachers, children, and classrooms provides a rich and dynamic context for understanding critical special education topics and brings all of the complexities of teaching and learning into teacher education classrooms. Video case studies can be used to create macro-context (Sherwood & Kinzer, 1989) environments within college classrooms that provide socially shared and co-constructed learning experiences between teacher educators, pre- and in-service teachers, and peers. Alternatively, video case studies can be computer based and presented as a practice field in which learners are exposed to multiple scenarios presented from many perspectives and are required to identify relevant information to solve a series of related problems while developing cognitive flexibility and scaffolding transfer (Fitzgerald et al., 2009). Further, some researchers have developed video case studies to provide explicit models of EBPs, enabling teacher learners to observe student outcomes in response to teacher practices and see exactly how to implement the practice with fidelity (D. H. Anderson, 2002; Dieker et al., 2009).

We have presented general principles that teacher educators must consider while using and creating video case studies, with further discussion of how to apply existing frameworks for video case study development and how to access existing video case study materials. In general, researchers suggest the following:

- Identify an explicit instructional purpose for the use of video case studies.

- Set explicit instructional objectives for intended learner outcomes.
- Select previously developed video case studies that were developed based on current learning theory.
- While developing video case studies, consider learning theory in its development.
- Choose and develop narrative video that is of sufficient duration, complexity, and explicitness to meet the instructional objectives.
- Ensure that video case study instruction is adequately mediated, either by the instructor or through the technology, to focus learner attention on the critical aspects of the cases.
- Employ multiple scenarios or cases as comparisons of parallel cases to enable the development of cognitive flexibility.
- Engage learners in sustained activity around the cases.
- Provide iterative feedback on skills performance and transfer attempts, enabling learners to revise their efforts based on feedback.

Design Frameworks

While developing video case studies, it is critical to consider three elements: (a) the content, (b) the context, and (c) the multimedia. Table 2 features design frameworks employed by researchers in video case studies.

Table 2

Design Frameworks

Video Models (Dieker et al., 2009)	Practice Fields (Barab & Duffy, 2000)	Anchored Instruction (Cognition and Technology Group at Vanderbilt, 1990)	Star Legacy Model (Bransford, n.d.)
1. Selection of EBPs • Review of research • Practice outline 2. Vignette script development • First draft • Script revisions • Storyboard development • Internal review 3. Video production • Video-shoot preparations • Video-shoot fidelity • During-shoot logging procedures • Editing process • Review of video products	1. Doing domain-related practices 2. Ownership of the inquiry 3. Coaching and modeling of thinking skills 4. Opportunities for reflection 5. Ill-structured dilemmas 6. Support learners rather than simplifying the dilemmas 7. Work is collaborative and social 8. The learning context is motivating	1. Video-based format 2. Narrative with realistic problems 3. Generative format • Students generate problems to solve 4. Embedded data design • Data to solve the problem is in the video 5. Problem complexity • Requires at least 14 steps to solve 6. Pairs of related cases • Illustrates analogical thinking 7. Links across the curriculum • Encourages knowledge integration	1. The Challenge • Presents an authentic problem 2. Generate Ideas • Learners articulate initial thoughts 3. Multiple Perspectives • Learners have access to different experts to gather information 4. Research & Revise • Learners conduct research and revise initial responses 5. Test Your Mettle • Learners engage in activities to test the depth of their new knowledge 6. Go Public • Formal assessment

Emerging Innovations

Research and practice using video case study continues, but one challenge is a lack of access due to individual development sites (e.g., Casenex at the University of Virginia, CTELL at the University of Connecticut) or discontinuation of the access after funding ceases (e.g., CASELINK at the University of California, Santa Barbara; Project MAINSTEP at The University of Texas at Austin). Developing and testing video case studies is expensive and requires substantial time and labor to develop quality products. To increase dissemination and provide open and continuous access, a web-based repository to warehouse these projects is necessary. Such a repository would enable other researchers and teacher educators to access and test materials across contexts, potentially building the evidence base for video case study.

Improving access to available video case studies through search engine optimization (SEO) is critical for disseminating information and providing teacher educators with easy access to content. Future research and technology development may mimic commercial and social media by implementing behavior analytics that match users (e.g., teacher educators and their students) to video case studies based on needs and interests. Video case study should continue to evolve along with technology innovations. For example, video case study interactivity may become more simulation based (e.g., Google Glass, Wii), learners and technology will directly interact, and the learners' actions will drive the technology response. Currently, TLE TeachLivE™ housed at the University of Central Florida employs avatars (i.e., virtual representations of humans) in a mixed reality teaching experience; for video case study, as technology advances, it may become possible for learners to participate in more immersive video and simulated experiences, testing and revising actions and reactions. Future researchers should continue to propose and test design frameworks and define critical features of video case study.

Most measures used in video case studies are researcher developed; quantitative measures have psychometric weaknesses, and the majority of measures focus on constructs specific to the individual-study and teacher-education contexts rather than being broadly generalized. In general, qualitative investigations have revealed findings that provide foundational structural considerations for the field of teacher education (Fitzgerald et al., 2009; Thomas & Rieth, 2011). Findings for video case study research is an emerging EBP based on CEEDAR Center standards, and further and future research should be conducted and considered by teacher educators.

Despite this word of caution, a substantial body of research on video case studies aggregated over a period of more than 30 years reveals that on objective measures of knowledge, learners exposed to video case studies did at least as well as learners in other conditions, and in many cases, they did better (Fitzgerald et al., 2009; Thomas & Rieth, 2011). The findings regarding skill development and transfer are less clear, primarily due to challenges in measurement (Bransford, Derry, Berliner, Hammerness, & Beckett, 2005).

Online Delivery of Content

Interactive Online Practices

The dramatic increase in K-12 online education for all students, including those in traditionally underserved populations, necessitates an analysis of the ways in which educators plan and implement instruction. It may come as a surprise that distance education, including online education, has existed for decades (Cavanaugh, Gilan, Kromrey, Hess, & Blomeyer, 2004). The term *online education* is defined as an educational program in which students learn at least partially through the online delivery of content and instruction with some element of student control over time, place, path, and pace. Some online programs may be supervised in a brick-and-mortar location; however, content is still delivered online. Online education can be divided into two distinct types: (a) completely online and (b) blended instruction. In blended instruction, students are taught through a combination of online instructional delivery and face-to-face experiences. The Center of Online Learning and Students with Disabilities (COLSD) has identified field-based and government policies addressing online education (Basham, Smith, Greer, & Marino, 2013). For example, nearly every state has some form of state-led initiatives in online education, and 31 of these states have statewide, full-time online schools (Watson, Murin, Vashaw, Gemin, & Rapp 2012). According to Watson and colleagues (2012), professionals in various states have seen huge growth rates in online student enrollments over the past 4 years, with some states serving more than 35,000 students in full-time online schools.

Summary of Existing Research

The research in online learning in teacher preparation is not as rich as the past model of distance learning. Overall, the majority of the researchers have focused on pre-service teachers' thoughts, perceptions, and basic opinions on the use of online environments. The literature is not yet anchored in how online preparation does or does not impact teacher practice or, more important, classroom-based student learning. Several researchers (Canter, Voytecki, & Rodríguez, 2007; Chiero, Tracz, Marshall, Torgerson, & Beare, 2012; Mercer, 2004; Sebastian, Egan, & Mayhew, 2009) have shared findings on how to design, develop, and use tools in online environments, but these findings currently fall short in the comparison or transference of online learning to teacher practice and student outcomes.

Related to distance learning, two major studies by Ludlow and Brannan (1999, 2010) provided a summary of the research in teacher education specifically targeted in special education. The literature summary reflected perceptions, opinions, case studies, and general overviews but provided limited evidence on teacher performance and change in practice. Despite the lack of clear evidence, three themes emerged from the literature for consideration in teacher education: (a) ensure that outcomes align with online course content; (b) include tools such as videos, podcasts, and other materials that assist teachers in understanding current and emerging trends in the field; and (c) stay abreast of emerging innovations to integrate into courses as the field rapidly changes.

Chiero and colleagues (2012), along with O'Brien, Hartshorne, Beattie, & Jordan (2011), conducted studies on pre-service teachers in online courses. O'Brien and colleagues specifically worked with special education teachers, and Chiero and colleagues (2012) looked at both general and special education teachers, comparing K-12 school-based internships and online teacher preparation with a large group of 3,709 supervisors and 12,571 first-year teachers. Each completed a 110-item survey, and the findings showed that both teachers and their supervisors found online delivery to be as effective, if not more effective, than the traditional face-to-face instruction received in teacher preparation programs.

O'Brien and colleagues (2011) also compared online to face-to-face instruction and looked at hybrid or blended courses through a short questionnaire and semi-structured interviews of 159 teachers. They found teachers in all three groups, based upon the type of course delivery, identified no difference in their abilities to handle their jobs as new teachers. These findings are similar to other perception types of studies (McDonnel, Jameson, Riesen, Polychronis, Crockett, & Brown, 2011; Skylar, 2009) revealing that online instruction can produce parallel results to face-to-face or blended learning environments. We share this statement with caution due to the perception-based nature of this work with limited validation in transference of these findings related to teacher performance and student learning.

A considerable number of empirical studies focusing on comparing media use in online learning also exist, but media comparisons may not account for the complex relationships that must occur for mastery of learning of pre-service teachers between content, pedagogy, and technology. New media for online learning are typically compared in research studies to traditional face-to-face instruction to determine whether the new media is more, less, or similarly effective relative to traditional instruction, yet the overall learning outcomes or transference to practice are rare in the current research literature on pre-service teacher education.

In Clark's (1983) seminal work comparing distance education and face-to-face instruction, he stated that media are "mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition" (p. 457). Several researchers (Kozma, 1994; Morrison, 1994; Tennyson, 1994; Ullmer, 1994) rebutted Clark's (1983, 1994) position, contending that both media and methods are part of the instructional design. Both arguments contain valid points. As Clark (1983, 1994) noted, media, instruction, and curriculum are frequently confounded, and disentangling these concepts aligned to what students do and do not learn and transfer to practice is difficult at best. Further, if instruction and curriculum are equal in terms of effective delivery, then media comparisons become trivial. Media certainly can hinder the delivery of instruction and thereby impact student learning outcomes (Kozma, 1994).

Findings from the 2002-03 and 2004-05 National Center for Education Statistics (NCES) surveys suggest that technology-based distance education has established its presence in the nation's schools (Zandberg & Lewis, 2008). Rapid technological developments and widespread availability of Internet access have made online education increasingly accessible (Zandberg & Lewis, 2008). Between 2003 and 2005, the overall estimated number of student enrollments increased 60% from 317,070 to 506,950 (Zandberg & Lewis, 2008). The following section of this IC contains current research related to the use of online learning practices as a means to support online teaching.

Early meta-analyses of distance education have found it to be equivalent to face-to-face instruction; several reviewers have suggested that this pattern may change with advancements in technology. Researchers argue that online learning as practiced in the 21st century may outperform earlier forms of distance education in terms of effects on learning (Zhao, Lei, Yan, Lai, & Tan, 2005). Means, Toyama, Murphy, Bakia, and Jones (2010) conducted a recent meta-analysis by the U.S. Department of Education that buttressed the prior meta-analysis, finding no statistical differences between online and face-to-face instruction. The researchers from the meta-analysis developed a conceptual framework with four categories that emerged from the research (see Table 3) that should be found in strong online instructional delivery. The first two categories (i.e., content and instructional design) are found in any instructional environment, including online environments, and have dominated the face-to-face versus distance education landscape.

The area with the most research for online instruction is the interactivity construct. Interactivity is an area in which instructors have several options for increasing learning experiences for students. From a theoretical construct, interactivity is built upon the theories of Engagement Theory, promoting (a) working collaboratively, (b) project-based learning, and (c) having an authentic focus (Kearsley, 1997; Shneiderman, 1994, 1998). This theory suggests that even in an online environment, for authentic and transferable learning to occur, students must engage as active versus passive learners.

In the emerging research on interactivity in online environments, there is some evidence suggesting that better learning outcomes occur when students receive an element of control over the online content with which they engage. However, the few study findings are mixed with respect to the relative effectiveness of interactivity. Five studies (Cavus, Uzonboylu, & Ibrahim, 2007; Dinov, Sanchez, & Christou, 2008; Gao & Lehman, 2003; Vasquez III & Slocum, 2012; Zhang, 2005) provided preliminary evidence supporting the hypothesis that conditions in which learners have more control of their learning increase engagement, which produces larger gains than instructor-directed (i.e., passive) conditions do. For example, Zhang (2005) reported on two studies comparing expository learning with active learning, both of which found statistically positive results in favor of active learning. Zhang manipulated the functionality of an online course to create two conditions. For the control group, students viewed videos and other instruction via the Internet in a specified order and in their entirety (i.e., students could not fast-forward, and rewinding was not allowed). The experimental group could randomly access materials and watch videos in any sequence, rewinding and fast-forwarding through the content. Zhang found a statistically significant positive effect in favor of learner control (i.e., interactivity) versus passive Internet functionality.

Researchers in the online learning literature have also explored the effects of learner reflection. In several studies, researchers (Bixler, 2008; Chang, 2007; Chung, Chung, & Severance, 1999; Cook, Dupras, Thompson, & Pankratz, 2005; Crippen & Earl, 2007; Nelson, 2007; Saito & Miwa, 2007; Shen, Lee, & Tsai, 2007; Szabo & Schwartz, 2011; K. H. Wang, Wang, Wang, & Huang, 2006) examined the degree to which promoting aspects of learner reflection in a web-based environment improved learning outcomes. These researchers found that a tool or feature prompting students to reflect on their learning was effective in improving outcomes. For example, Szabo and Schwartz (2011), in a study of 93 pre-service teachers in an educational studies course, found online course discussions increased critical thinking measured using Bloom's Taxonomy. Overall, the available research evidence suggests that promoting self-reflection, self-regulation, and self-monitoring leads to more positive online learning outcomes. Features such as prompts for reflection, self-explanation, and self-monitoring strategies have shown promise for improving online learning outcomes.

In addition to the interactivity construct, the usability construct has received recent attention. The usability construct focuses on the user interface experience of online classes. There are two main areas in which research has guided practice in the user interface. This construct has limited research but has reached a level of acceptance as a standard in the field. Simply stated, if online environments are too difficult to access or understand, teachers will not implement or learn. An example of a usability construct is the emerging acceptance of Universal Design for Learning (UDL), which is used to create online environments. UDL is a framework for the design and implementation of instructional materials that meet the needs of all students by proactively circumventing curriculum barriers (Rappolt-Schlichtmann, Daley, & Rose, 2012). The framework is organized as a series of principles including multiple means of representation, action and expression, and engagement. Guidelines and subsequent checkpoints further delineate each principle. The UDL guidelines provide a helpful mechanism for analyzing curricular materials and identifying areas that can be augmented for online instruction. For example, if the curriculum presents information using only one modality (e.g., reading the textbook), an online platform can provide multiple means of representations. Although a full discussion of UDL is beyond the scope of this IC, interested readers can learn more at http://www.udlcenter.org/aboutudl/udlguidelines.

Finally, Means and colleagues (2010) provided three considerations in relation to online learning that should be situated in either synchronous or asynchronous learning: (a) expository instruction in which technology delivers the learning, (b) active learning in which learners use technology to build their own learning, and (c) interactive learning in which learners interact with others via technology to create and shape knowledge. Despite the lack of research to support these three components, Means and colleagues recommended that these components be considered to shape online learning environments.

Table 3

Evidence-Based Practices in Online Learning Conceptual Framework

Research Category	Features	Examples
Content Area	Subject-area contingent, domain specific	• Reading, math, science, art
Instructional Design	Taxonomy based (e.g., Bloom's Taxonomy, Structure of Observed Learning Outcomes [SOLO])	• Direct instruction or inquiry-based instruction • Motivation: ARCS (Attention, Relevance, Confidence, Satisfaction) Model or Behavioral Model
Interactivity	1. Feedback 2. Connection type	• Email/voice • Synchronous chats • Grading • Opportunity for reflection of learning • Blogs • Social media
Usability	1. Universal Design for Learning (UDL) framework 2. Accessibility	• Multiple methods of presentation • Multiple methods of expression • Multiple methods of engagement • All content accessible for people with exceptionalities

Teacher Education and Online Education

The preparation of teachers in the educational uses of technology appears to be a key component in almost every improvement plan for education and educational reform programs (Davis & Falba, 2002; Dawson, Pringle, & Lott Adams, 2003; International Society for Technology in Education [ISTE], 2002; National Council for Accreditation of Teacher Education [NCATE], 1997; Thompson, Schmidt, & Davis, 2003). In spite of the many efforts that researchers and educators have invested over the years in preparing teachers in the educational uses of technology, teachers still lack the skills and knowledge to successfully teach with technology (Basham et al., 2013; Rodrigues, 2003; Vasquez III & Straub, 2012). There appears to be a growing debate in relation to the professional learning needs of teacher educators who work in online environments. Several studies have revealed a common fear among teacher educators that a lack of technical skills would be a barrier to creating an effective online course (Mills, Yanes, & Casebeer, 2009; Paulus et al., 2010). Others, however, warn of the danger of prioritizing technological skill development above pedagogical competencies such as instructional design, facilitation, and assessment skills (Bawane & Spector, 2009; Salmon, 2009; Wilson, 2004). Indeed, discussion surrounding the pedagogical approaches in the online environment reveal a diversity of views in relation to whether teaching online requires a different skill set (Bawane & Spector, 2009; Ni & Aust, 2008; Wray, Lowenthal, Bates, & Stevens, 2008). There seems agreement, however, that student expectations are similar in both spaces—students desire meaningful learning and assessment strategies; effective facilitation; prompt and constructive feedback; a vibrant community of learners; and experienced, enthusiastic, and knowledgeable teaching staff (Rovai & Downey, 2010; Salmon, 2009).

Therefore, rich online environments for pre-service teacher education, like face-to-face environments, should include strong content and design features. However, the two remaining categories—interactivity and usability—need particular attention in online environments. These two areas also have the least amount of research to make specific recommendations beyond consideration in online course design and delivery.

There are legal and ethical UDL requirements to make accessible all online content associated with the user interface experience. Unfortunately, several learning tools exist for which few accessibility and accessible alternatives are possible (e.g., embedded video, synchronous online lectures). A text transcript for the audio portion of an instructional video is one example of how to make content more accessible. Instructional designers must be cognizant of the methods they choose to provide content to all students. Simple accommodations exist to increase the accessibility of online content. A list of each standard is available at www.w3c.org, and trainings, articles, and videos to assist instructors are available at www.webaim.org.

Effective usability and interactivity in any learning environment includes the creation of a positive learning environment by cultivating self-efficacy, providing meaningful and active engagement, and promoting inclusivity. Instructors of online learning programs must do the following:

- Ensure that communication between faculty members and students is constant and effective and includes email; web-based conferencing (e.g., webinars); blog postings; online discussions; and phone contacts. Instructors should use FaceTime and Skype for students who need a personal approach.
- Provide cooperative learning opportunities to facilitate critical thinking, brainstorming and problem solving, study groups, and the use of dyads and peer assessment activities that exist in many online learning environments.
- Provide experiential and active learning activities, utilizing Bloom's Taxonomy and the Engagement Theory to activate areas of the brain responsible for higher order thinking and active learning that address the construction of knowledge through analysis, synthesis, and evaluation. These more engaging and higher order activities require pre-service teachers to make decisions, conduct experiments, and explore ways to solve real-world problems, case studies, and scenarios to promote higher levels of achievement of knowledge and potential transference of learning.

- Give punctual feedback regarding students' posts within blogs and through email, assignment postings, or other methods agreed upon by teachers and students. Instructors should structure opportunities for practice and establish peer tutoring when necessary.
- Express high expectations of students by continually motivating, commending success, and providing stimulating activities to support active learning.
- Embrace cultural diversity and different learning styles by incorporating Gardner's theory of Multiple Intelligences (MI) to address varied learning styles and engaging students' academic strengths. Provide differentiated instruction and personally channel into all students' needs in order to reach all learners and develop them to their fullest potentials.
- Discuss and define course policies, teacher expectations, and plagiarism early in the course. Differentiate intentional and non-intentional plagiarism. Implement contractual documentation if necessary.
- Ensure accommodation of learners who need special assistance and assistive technologies (AT).

Impact of online education on teacher candidate learning. Despite the emergence of literature in the teacher education sector, many components of online education remain unexplored. Researchers (Georgina & Olson, 2008; Tao & Rosa Yeh, 2008; Wray et al., 2008; Vasquez III & Straub, 2012) have noted that there is scant literature on the experiences and beliefs of education faculty members on their readiness and preparation for online teaching or their beliefs in relation to the appropriateness of online education for pre-service teachers. This is despite the significant growth in this sector, which mirrors the wider phenomenon, and the potential for technology to significantly alter the actual practices and processes of learning and teaching.

Leaders recommend that pre-service teachers receive appropriate amounts of time to acquire the pedagogical and technical skills and then practice and operate within online classroom environments. They also recommend providing support for the development of the pedagogical and technical skill development for those new to online teaching as well as the adoption of a belief that quality teaching can occur in an online environment. Undoubtedly, the intrinsic rewards of teaching in an online environment may look and feel different from the face-to-face environment, but as Angeli, Valanides, and Bonk (2003) noted, it is possible and satisfying.

Online education has become a force for a major shift in K-12 education. District leaders, teachers, teacher educators, and educational leaders should quickly move to purposefully shape the skills of pre- and in-service teachers to impact learning environments that make use of online and blended practices. Additional specific efforts include (a) understanding that technology use is only one part of sound pedagogical design, (b) developing pre- and in-service teacher skills for designing and applying instructional design that makes use of technology as well as pedagogical strategies to achieve desired goals and objectives, and (c) working with technology developers to build a research base of online tools and EBPs for practitioners to use.

Emerging Innovations

Technology simply does not afford the necessary modality to present visual stimuli nor the interactive capabilities to provide the necessary discriminated feedback on student responses. This same level of specificity for preparing teachers is as much dependent on the modality of the media used as on the content presented within the media. For example, with a computer conferencing system that can afford real-time, two-way audio and video, reading instruction or sharing examples of best practice in reading instruction is much less hindered by the technology. If media can hinder instruction during face-to-face instruction, in contrast, there may be ways that media can afford pedagogical opportunities not available in face-to-face instruction. The ways in which media may enhance or hinder instruction are often subtle; therefore, new forms of technology used to deliver instruction in teacher education should be empirically validated in order to make claims of effectiveness.

An increasing body of evidence suggests that online learning can promote the engagement and achievement of students; however, a large research base is lacking to make any firm causal statements. As we continue to increase our knowledge base, new practices will be added. For example, Traxler (2007) suggested that mobile devices play an increasing role in online education environments for PD, training, conferences, seminars, and presentation of lessons. Personal and private communication devices are compact, user friendly, convenient, and easily available to serve as progressive collaborative tools. The integration of technology, simulation, gaming, and social media through online courses may allow instructors to disseminate research-based instructional and learning strategies that facilitate learning and classroom management in their classroom experiences.

Serious educational games are becoming available resources to provide teachers with the means to create curricular materials (Marino, Basham, & Beecher, 2011). In fact, the National Research Council (NRC; 2011) reported that an increasing body of evidence suggests that educational video games have the potential to promote critical attributes. However, it remains unclear whether this enthusiasm has empirical support to increase academic skills. Similarly, social media (e.g., Facebook, Twitter, Google Docs, blogs) may be used to improve teaching and learning in educational institutions through discussions, chats, group activities, and videos of lessons. Scholarship of teaching and learning works toward improvement in student learning. The integration of social media into the curriculum allows educators to increase practices of scholarly teaching. Research continues to evolve related to the social media that can offer the best practices to attain desired outcomes for educational institutions.

The quality of instruction should continually improve as teachers effectively use the existing technology and a mindset focusing on the future uses of technology without jeopardizing the integrity of the content. Instruction must be available to all students, including students with disabilities, and AT must be available for students who need help with visual and audio elements for completing courses; these services must be readily accessible with clear directions for obtaining them. Unfortunately, technology changes much faster compared to the efficacy of research and the publication of emerging innovations.

Supervision and Feedback

Supervision and Feedback Defined

Supervision is typically provided via a master teacher or administrator in the field who oversees performance and provides specific feedback. Feedback is information given to teacher candidates so that they can compare their performance to pre-determined standards. The technological component of supervision and feedback included in this section refers to how these two components can be delivered to make a positive impact on teacher performance.

Overall, opportunities for pre-service teachers to learn to teach are greatly enhanced through supervision and feedback. Scheeler (2008) identified feedback as a vital component in helping pre-service teachers transfer the skills learned in preparation programs to real-world classrooms of practice. Although researchers have established the importance of supervision and feedback during field experiences (Cornelius & Nagro, 2014; Feiman-Nemser, 2001), many teachers report receiving too little too late in their teacher education programs (Buck, Morsink, Griffin, Hines, & Lenk, 1992). When pre-service teachers receive insufficient supervision and feedback, they are in danger of incorrectly performing newly learned skills or not performing them at all (Scheeler, 2008). In the digital age, technology-enabled supervision and feedback, referred to henceforth as eCoaching, offers teacher educators a 21st century system for providing more pre-service teachers with more opportunities more often to learn to teach with supervision and feedback.

Drawing on seminal definitions of clinical supervision in psychotherapy and clinical services (Gallant & Thyer, 1989; Hess, 1980), Rock and colleagues (2014) defined eCoaching as "a relationship in which one or more persons' effective teaching skills are intentionally and potentially enhanced through online interactions with another person" (p. 2). Because eCoaching is web based, the coaches or supervisors' on-site presence is not required. Consequently, traditional barriers, such as time and distance, are eliminated (Rock, Gregg, Gable, & Zigmond, 2009; Rock, Zigmond, Gregg, & Gable, 2011).

Summary of Existing Research

While designing and delivering a technology-enabled approach to supervision and feedback, such as eCoaching, teacher educators should also consider lessons learned through the bug-in-ear (BIE) literature. The findings reported by BIE researchers establish a series of useful, evidence-based guidelines that are applicable while providing in-ear feedback online. To illustrate, Herold, Ramirez, and Newkirk (1971) reported that teacher educators should field test the BIE three or four times to minimize pre-service teachers' anxieties and promote enthusiastic use.

To increase pre-service teachers' mastery of specific teaching techniques, such as completion of three-term contingency trials, teacher educators should opt to provide BIE feedback during instruction rather than after the fact during a post-conference environment (Scheeler & Lee, 2002). Farrell and Chandler (2008) indicated that teacher educators should not delay BIE use until student teaching. Instead, they should consider adopting BIE use in early field experiences, not only to promote faster progression and achievement of teaching competencies, but also to decrease pre-service teachers' feelings of frustration. Scheeler, Bruno, Grubb, and Seavey (2009) indicated that teacher educators should guide pre-service teachers in developing and implementing specific generalization plans to aid their ongoing application of improved teaching skills initially developed through BIE supervision and feedback. Giebelhaus and Cruz (1994) underscored the need for teacher educators to engage in longer-term, rather than shorter-term, BIE use with pre-service teachers to achieve lasting improvements.

Scheeler's (2008) research findings confirmed that teacher educators should provide four types of feedback (i.e., instructive, corrective, encouraging, and questioning) using a series of predetermined keywords or phrases. Finally, Scheeler and Lee (2002) confirmed that although pre-service teachers easily adjust to wearing and using the BIE device, teacher educators should provide pre-service teachers with reassurance, especially in the beginning when feelings of awkwardness abound.

These findings confirm that the specific knowledge, skills, and dispositions that eCoaching targets are the ones that remain in use over time. Thus, teacher educators should look to the current literature and prevailing professional standards to determine which knowledge, skills, and dispositions are the most important for pre-service teachers to achieve through eCoaching. Without question, teacher educators should include evidence-based approaches to classroom and behavior management in eCoaching activities, not only to reduce the gap between research and practice, but also to strengthen beginning teacher preparation (Freeman, Simonsen, Briere, & MacSuga-Gage, 2013).

Rock and colleagues (2014) used a mixed-methods sequential explanatory strategy to investigate the longer-term effects of eCoaching with BIE. Quantitative data on five dependent variables were extracted from 14 participants' electronically archived video files at three points in time—Spring 1 (i.e., baseline, which was the first semester of enrollment without virtual coaching feedback); Spring 2 (i.e., 1 year later with virtual coaching feedback); and Spring 3 (i.e., 2 years later, after exiting the program without virtual coaching feedback). Interviews with participants about their ongoing participation in eCoaching yielded qualitative data. Quantitative analysis, using repeated measures ANOVA, confirmed initial improvements in participants' teaching practices, and pre-K-12 student engagement withstood the test of time.

Effect sizes were large for four of the five dependent variables that were statistically significant, ranging from > .25 to .75. Power was > .80 for the dependent variables that had a statistically significant trend, whether linear or quadratic. The average values for student engagement indicated a linear trend from 75 to 96 to 99. Mean differences were statistically significant [F (2,12) = 13.88, p = .001], with an effect size of .70 and power of .99. The specific test of linear trend was also statistically significant [F (1,13) = 17.95, p = .001], with an effect size of .58 and power of .97. Finally, qualitative findings indicated, as time went on, that participants harbored more positive orientations toward one-on-one eCoaching with BIE.

Findings suggest that teacher educators should consider adopting longer-term, rather than shorter-term, approaches to online in-ear coaching. Regular eCoaching for 2 years yielded lasting changes in teacher practices and their pre-K-12 students' engagement. Also, teacher educators should advise pre-service teachers that ongoing involvement in eCoaching may lead to more positive attitudes about it.

Most recently, Ploessl and Rock (2014) used a single case (i.e., A-B-A-B) withdrawal design to investigate the effects of eCoaching delivered through online BIE technology on co-teachers as they planned and carried out co-teaching. Participants included three co-teaching dyads (*n* = 6), each comprised of one general and one special educator.

Visual inspection of graphed data along with quantitative analysis (i.e., percentage of non-overlapping data [PND]) confirmed that *e*Coaching with BIE increased participants' use of varied co-teaching models and student-specific accommodations. Semi-structured interviews provided a measure of social validity. Observers used time-sampling measures to document student engagement during baseline and intervention conditions. Results indicated that all teachers increased use of varied co-teaching models and student-specific accommodations. Praise continued at a high rate while redirection of student behavior decreased over the length of the study. K-12 student engagement (i.e., on-task behavior) was high and steady and remained higher than 90%.

Researchers have indicated that teacher educators should consider eCoaching not only with special education pre-service teachers, but also with their general education counterparts during co-teaching planning and instruction. Moreover, teacher educators should consider extending eCoaching use from early, mid, and late field experiences to include induction support.

Other than the aforementioned studies that Rock conducted, only one other published account (see Scheeler, McKinnon, & Stout, 2012) of online BIE use has appeared in the peer-reviewed professional literature. In that study, Scheeler and colleagues (2012) used the eCoaching system developed by Rock, Gregg, Thead, and colleagues (2009) to provide immediate BIE feedback to five pre-service teachers during practicum. Results from a single-subject-across-participants design confirmed that four of the five participants maintained improvements in teaching during a brief maintenance phase. For teacher educators, the findings from this study are instructive because others were able to replicate and use Rock, Gregg, Thead, and colleagues' off-the-shelf technology to provide online feedback to pre-service teachers during instruction. Thus, university faculty who possess basic technology skills and expertise can effectively use online technology to provide immediate feedback and supervision to pre-service teachers from a distance. Teacher educators should also note that although the evidence base for traditional onsite BIE use has been established, especially with regard to short-term improvements, the research supporting long-term changes and technology-enabled supervision and feedback (i.e., eCoaching) is emerging.

Incorporation Into Practice

First and foremost, teacher educators should be intentional while incorporating eCoaching into the pre-service teacher education curriculum. In essence, teacher educators should carefully examine the existing curriculum and determine when and how to carry out eCoaching sessions during clinical field experiences. Because Ericsson, Krampe, and Tesch-Romer (1993) posited that in order for deliberate practice to be successful, individuals engaging in it must be motivated and willing to exert effort to improve their performance, teacher educators should devote time and effort to creating a culture of improvement or what Dweck (2006) referred to as a growth mindset within the teacher education program. Together, teacher educators and pre-service teachers should actively focus eCoaching activities on the explicit goal of exceeding current abilities and improving performance (Bhugra, 2008).

Second, teacher educators should design eCoaching around the skill levels of pre-service teachers. Ericsson and colleagues (1993) and Bhugra (2008) cautioned that deliberate practice should begin at a low level and slowly increase. As such, it is important for teacher educators to note that one-on-one in-ear coaching alone will not suffice; rather, it must be provided alongside the study of theory and practice (i.e., course work), observations of live or recorded demonstrations, and opportunities for group coaching with peer feedback that are commensurate with pre-service teachers' current developmental levels.

Third, during eCoaching, teacher educators should provide pre-service teachers with immediate, informative feedback and knowledge about their performance. While doing so, teacher educators should strive to be the outside eyes and ears. As is the case with face-to-face supervision or coaching, teacher educators typically provide pre-service teachers with feedback before a lesson, during a lesson, and after a lesson (i.e., before, during, and after observation conferencing; Range, Duncan, & Hvidston, 2013). Without frequent high-quality, performance-based feedback from university faculty and mentor teachers, pre-service teachers' abilities to reflect on their learning, growth, and development greatly diminishes, thwarting motivation and dedication to future improvement.

Fourth, teacher educators should ensure sufficient repetition during eCoaching. Essentially, teacher educators should provide pre-service teachers with frequent opportunities to repeatedly perform the same or similar teaching tasks designed with their current pedagogical skills and content knowledge in mind. Repetitive performance activities, however, should not be mindless (Ericsson et al., 1993). By contrast, during repeated practice, teacher educators and pre-service teachers should actively strive for incremental improvement by closely monitoring performance, looking for clues, examining performance data, and asking questions that prompt reflection.

In the one-on-one variation of eCoaching, an online coach offers discreet in-ear feedback to a teacher during real-time instruction (see Rock, Gregg, Gable, et al., 2009; Rock et al., 2011). Relying on more than five decades of traditional BIE research (see Bowles & Nelson, 1976; Giebelhaus & Cruz, 1994; Herold et al., 1971; Kahan, 2002; Korner & Brown, 1952; Scheeler & Lee, 2002; Scheeler, McAfee, Ruhl, & Lee, 2006; Thomson, Holmberg, Baer, Hodges, & Moore, 1978; Van der Mars, 1988) and recent advances in mobile technology, Rock and colleagues, in 2009, revolutionized the device while keeping costs affordable.

The eCoaching-through-online-BIE technology system that Rock, Gregg, Thead, and colleagues (2009) pioneered consists of four components: (a) a Creative WebCam Live! Ultra-Wide Angle Web Camera™ ($61; Model No: VF0060); (b) a Plantronics P1-Voyager 510 Windsmart Bluetooth Headset™ ($41; Model No: 72270-61); (c) an IOGEAR Bluetooth 2.0 USB Adapter, Class 2™ ($34; Model No: GBU221); and (d) Skype™ (Free Version 6.14[351]). When combined, they form the technology-enabled platform for online in-ear coaching (i.e., eCoaching). Skype is a free Internet-based telephony—Voice over Internet Protocol (VoIP)—system that allows pre-service teachers to use desk or laptop computers or mobile devices (e.g., smartphone, tablet, iPhone, iPad) and a Bluetooth earpiece to receive real-time feedback and expert coaching from university professors or mentor teachers while delivering classroom instruction. The wide-angle webcam permits the eCoach to observe both the pre-service teacher and his or her K-12 students in the classroom and vice versa. If needed, a Bluetooth adapter can connect the computer with the Bluetooth headset so that the *e*Coach can offer online support from anywhere to the teacher working in the authentic context of a real classroom.

Since Rock, Gregg, Gable, and colleagues (2009) and Rock, Gregg, Thead, and colleagues (2009) unveiled their technology-enhanced system for supervision and feedback, other systems (e.g., Hagar, Baird, & Spriggs, 2012) have emerged, offering teacher educators a plethora of low- and high-cost options from which to consider. See Table 4 for the delineation of eCoaching technology options at various price points.

Table 4

eCoaching Technology Options

High Cost (Online)	Mid Cost (Onsite)	Low Cost (Online & Onsite)
Iris Connect http://www.irisconnect.co.uk/ $ = Contact Sales thereNow www.therenow.net $ = Contact Sales Polycom Online http://www.polycom.com $ = Contact Sales Cisco Collaborative Conferencing http://www.cisco.com/c/en/us/products/conferencing/index.html $ = Contact Sales Adobe Connect http://www.adobe.com/education/products/adobeconnect.edu.html?showEduReq=no $ = Contact Sales Tandberg Video Conferencing Systems http://www.ivci.com/videoconferencing-tandberg-video-conferencing-systems.html $ = Contact Sales Microsoft Lync http://office.microsoft.com/en-us/lync/ $ = Contact Sales	Williams Sound Personal FM System 350E http://www.williamssound.com $ = $677 Talk System (Talk Technologies) Traditional English as a Second Language translator system www.talktech.com $ = $945-$1,400	Online BIE Components • Existing PC or Mac platform; laptop or desktop computer • Bluetooth ear piece $ = $50.00 • Bluetooth adapter (if needed) $ = $19.00 • Webcam (exterior, wide angle capability if needed) $ = $45.00 • Skype or another video call or chat platform Free www.skype.com www.oovoo.com www.webex.com www.gotomeeting.com Total = $114-$137 Onsite Motorola Two-Way Radios (Model T4500) $ = $25 + Single Earbud Microphone System $ = $50 $ Total = $75 per unit + batteries http://www.buytwowayradios.com/products/motorola/motorola-t4500-2.aspx

Emerging Innovations

Once considered too futuristic for widespread use, prospects for technology-enhanced supervision and feedback (i.e., eCoaching) are brighter than ever. As has been the case in other disciplines, such as medicine and business (Franklin, Sexton, Lu, & Ma, 2007), integrating technology-enabled training into teacher education is no longer a luxury—it is a necessity. Preliminary research about eCoaching confirms that it is a powerful and affordable tool that allows teacher educators to provide pre-service teachers with more opportunities to effectively learn to teach.

Although purely speculative, when looking forward, three future uses for eCoaching seem likely. First, as the evidence base expands, adoption of eCoaching seems far more feasible on a widespread basis. At present across the United States, only one or two eCoaching labs exist in teacher education programs. In the not-too-distant future, it seems plausible that eCoaching labs will be commonplace, allowing university faculty from across disciplines to provide supervision and feedback to pre-service teachers in real time not only about pedagogy, but also about content. Second, it is easy to envision a time when eCoaching and other technology-enabled training approaches, such as virtual simulation, will routinely couple. As Elford, Carter, and Aronin (2013) described, this approach is currently taking place at a few United States universities (e.g., the University of Central Florida, the University of Kansas) where pre- and in-service teachers receive coaching through BIE while immersed in TLE TeachLivE™ classroom instruction with student avatars. Again, it seems feasible that this will become the norm rather than the exception in teacher education. Finally, expanding eCoaching to include supervision and feedback during simulated and real-world team decision making on problems of practice seems sensible, especially because Multi-Tiered System of Supports

(MTSS) and Response to Intervention (RtI) are essential components of effective service provision. No doubt, the possibilities for eCoaching are as endless and intriguing as they are important for the future of effective special education teacher education.

Teaching Simulations

Simulation Defined

Simulations using technology are tools that make situations and participants look like, feel like, and act like they would in real-life scenarios. Teaching simulations originally emerged as written case studies that pre-service teachers read in class, watched as video vignettes, or role played with classmates to learn a targeted skill or set of skills. Today, these simulations have incorporated technology in the forms of games, avatars, and fully immersive simulated environments. The evolution of simulations changed as technology emerged. Kamman, McCray, Brownell, Wang, and Ribuffo (2014) have provided further information about written case studies as pedagogical practices.

With the emergence of technologically based environments, such as games and web-based tools, the field of teacher education began to move to more fully immersive simulated environments. Immersive and technologically supported environments have long been present as an industry standard for practice in the military, aviation, and medicine, but the use and research of simulations in teacher education are just beginning to emerge (Clarke, 2013).

Simulated environments can be used to learn skills while studying participant behavior in a way that does not put real people (e.g., students) at risk and allows the person in the simulator (e.g., pre-service teacher) to repeatedly practice until he or she reaches a level of mastery or target. Technological simulations in teacher education can range from a low-tech online game to a more immersive environment like Sim School, Second Life (SL), or Active Worlds, in which teachers role play as avatars. Simulations can also provide fully immersive environments much like a flight simulator in which the teacher interacts in what appears to be a real environment of students, like TLE TeachLivE™. An interdisciplinary research and development team of education and computer science faculty (Dieker, Hynes, Hughes, & Smith, 2008) created the TLE TeachLivE™ environment in 2008. This lab is a mixed-reality, avatar-based simulation environment used to prepare pre-service teachers or retrain in-service teachers. Imagine walking into a room that looks like a middle school classroom with props, whiteboards, and, of course, children. This room is not a traditional classroom; it is a virtual setting, and the students in the classroom are avatars. The virtual students may act like typically developing or non-typically developing students, depending on the objectives of the experience. Participants can interact with students and review previous work, present new content, provide scaffolding or guided practice in a variety of content areas, and monitor students while they independently work. The TLE TeachLivE™ Lab provides teachers with opportunities to learn teaching skills and craft their practices without placing real students at risk during the learning process. Interactions that occur in virtual environments give learners the feeling of being in real environments and provide them with the ability to act on their thoughts, ideas, or experiences for self-directed learning (Cobb, 2007; Limniou, Roberts, & Papadopoulos, 2008). The potential experiences are relevant to the transfer of knowledge from one environment to the next and also from acquisition to application. TLE TeachLivE™ allows teachers to practice new skills, providing them with a higher concentration of training tasks in a period of time that is not usually possible in classrooms. Teachers receive immediate reviews of their performance in the simulator. If the performance is not at an acceptable level, teachers, with feedback from the After Action Review (AAR), can go through the simulation again. Teachers can practice the targeted skills in TLE

TeachLivE™ until the desired levels of competence are met. Thus, teachers return to their classrooms with new skills and the confidence that they can implement these skills.

A simulated experience does not need to involve technology, but for the purpose of this IC, simulations are those supported by technology. Indicated as an emerging EBP based on CEEDAR Center standards, the following research supports the potential for SL to increase the knowledge and practice of pre-service teachers. Although game-based environments have some level of discussion in the field, the level of research to show this as an EBP in the preparation of pre-service teachers has not yet been documented.

Research Related to Simulations

First-person immersive environment. Case study research of first-person immersive environments documents the need to embed the use of simulations in teacher education courses. First-person environments require that pre-service teachers move beyond simply playing games to becoming engaged in online environments, typically in the form of avatars. One of the most widely used online immersive environments is SL; Active Worlds is another common platform. The use of SL came about in the past decade (Linden Lab, 2003), and many universities have purchased virtual land or spaces to build simulated experiences in this environment; some use these virtual spaces within teacher education courses and experiences. First and foremost, researchers suggest that the more immersive environments be used, as well as embedded in courses, to ensure greater adoptions of these tools by pre-service teachers (Teo, 2011; F. Wang & Burton, 2013).

F. Wang and Burton (2013) conducted a meta-analysis of the research to date on SL and found 50 articles; however, only seven focused on teacher education. Most of these seven were case studies or reports on the use of SL for teachers to experience and understand the potential of virtual environments. Teo (2011) found in his study of nine pre-service teachers that teachers learned best when assignments were embedded into the course, and students could learn both content and pedagogical knowledge documented through interviews and journals to improve their practices. Teo required teachers in his course to create an avatar and profile picture, tour the library, create a book, stream audio, and visit another educational site. These teachers shared ideas about how they would use this tool in their future teaching, and they identified new methods they learned for using this tool for teaching history, science, and art. As Teo noted, the practices the teachers valued occurred because of their complete immersion in the program.

The use of SL appeared to have value during and following the course work, although enthusiasm for the environment did wane for the participants over time. Kim and Blankenship (2013) found that the use of SL helped teachers understand how to teach second-language learners and that two of the 12 teachers involved in the use of SL moved into the zone of proximal development (ZPD), which the authors said shows the mastery of the teachers' pedagogical content knowledge. The process for moving these two pre-service teachers forward involved immersion with two English as a Second Language (ESL) avatars over 6 weeks and debriefing sessions after the review of the SL sessions. This simulation activity embedded in a course and the safe environment in which to practice working with students who are English language learners seemed to provide an environment for growth. F. Wang and Burton (2013), in their work with pre-service teachers in immersive environments, realized that teacher educators involved in more futuristic technology taught the teachers to embrace this type of tool in their own classrooms. According to Prensky (2010) and Rosen (2010), beginning teachers in the 21st century should be less resistant to modern technologies, but, again, this is a theory without clear research to show levels of resistance. Devlin-Scherer and Sardone (2010), in their work with simulations and games in social studies for student learning, found that pre-service teachers did not have strong gaming experiences in all cases and gravitated toward games that were easy to implement and incorporate into their lesson plans. Cheong (2010) found that teacher practice over time in SL did change teachers' personal teaching efficacy (i.e., the belief that they could be effective) after practicing with their peers in SL increased. Dickey (2011) further supported this finding from qualitative analyses of teachers' use of SL and Active Worlds. Dickey suggested that exposure to these worlds can impact teacher acceptance of emerging practices, but no conclusive evidence was provided.

Fully immersive environments. The third type of environment that is on the horizon in teacher education and is already present in initial stages at some universities is the use of fully immersive environments that create a suspension of disbelief (Dede, 2009). The suspension of disbelief is that in these environments, if correctly created, teachers no longer feel like they are playing games or that avatars are representing them; they feel like they are interacting with avatars in real environments. These high-level simulators are typically costly and scenario based, which is why their adoption in teacher education is just emerging. Currently, the only known fully immersive simulator in teacher education is TLE TeachLivE™ (Dieker et al., 2014), although other immersive environments in education exist for student learning. Using the software concept of a sandbox, where pre-service teachers are free to play (Hayes, Straub, Dieker, Hughes, & Hynes, 2013) and teacher educators shape the experience, the TLE TeachLivE™ technology allows teacher educators and pre-service teachers to shape virtual classrooms to personalized learning experiences (Dieker, Straub, Hynes, Hughes, & Hardin, 2014).

To date, the research on TLE TeachLivE™ has come from dissertation research conducted at the University of Central Florida and from the first-year findings of a 3-year, large-scale research study funded by the Bill & Melinda Gates Foundation (http://www.gatesfoundation.org/). Three teacher education doctoral studies have discussed preparing teachers to use Discrete Trial Training (DTT) for students with autism (Vince-Garland, Vasquez III, & Pearl, 2012), investigating pre-service teacher perceptions about Latino males who are and are not labeled as emotionally disturbed (Lopez, 2013), and comparing differing methods of performance feedback for pre-service teachers (Rodriguez, 2011).

Just recently, Dieker, Hynes, Hughes, and Straub (2014) found from the first year of a large research study including the observation of more than 134 teachers randomly assigned to either an experimental or control group that TLE TeachLivE™ participants, after spending less than four 10-min sessions in the simulator, changed one critical teaching behavior. Using a pre-post, quasi-experimental control group design, the effective teaching strategies gained in the simulator transferred into the middle school mathematics teachers' classrooms (Dieker, Hynes, Hughes, & Straub, 2014), and the students in the teachers' classrooms also made academic gains as measured by a pre-post assessment of questions in algebra from the National Assessment of Educational Progress (NAEP). Teachers who were in the simulator were found to ask a higher percentage of describe/explain questions in their real classrooms than those who did not receive the treatment (Dieker, Hughes, Hynes, & Straub, 2014). In this study, both experimental and control groups received a high-quality lesson plan designed by the Mathematics Assessment Resource Service (MARS) aligned to the Common Core State Standards (CCSS) and a video explaining the benefits of the lessons. The student avatars received common error patterns gathered from the literature and from observing middle school students, and then teachers could ask questions of the students. These targeted behaviors—describe/explain questions and frequency of specific feedback—were observed in the treatment and control group teachers' classrooms pre-post, and one variable (i.e., wait time) was observed pre-post in the teachers' classrooms with no intervention in the simulator. A change did occur in the targeted behaviors with no change observed in wait time, which further supports the potential impact of the simulator on targeted behaviors.

Recommendation for Teacher Education

The use of simulators in teacher education should be embedded into clear course objectives, but simulators should be considered a tool to promote the teaching of and use of these emerging technologies with students in the classroom with the primary purpose of potentially increasing adoption of such tools. Although additional research is needed, teacher educators should ensure that while using fully immersive environments, they use Action Review Cycle (ARC; Institute of Defense Analyses, 1999), the same process that is an industry standard for the military and was used in the TLE TeachLivE™ research studies. The ARC cycle includes Before Action Review (i.e., setting the BAR); Action (i.e., time in the simulator is approximately 10 min); and AAR (or teacher reflection, as known in the field) with a minimum of four sessions to ensure that a targeted skill increases. The future of these environments, tied with personalized analytics and the ability to incorporate quantified data (New Media Consortium, 2014), such as giving coded feedback and measuring heart rate or blood pressure, will provide new opportunities to refine or even remediate practices of teachers interested in using this type of tool as part of their initial and ongoing development.

Emerging Innovations

The use of fully immersive simulations (e.g., fully automated robots) is emerging. For example, in Korea, a robot named Eng Key is serving as a co-teacher of English, and V2Go is allowing children who are chronically ill to attend class via a robot. Perhaps fully immersive environments can also coach teachers. We are still in uncharted territories with simulation, but program leaders should consider the future of robotics for taking remote coaching, feedback, and simulated environments to the next level. If the future of simulation continues to decrease in cost, as has been seen with Kinect, which allows for a fully embodied interface with gaming platforms, and Google Glass, which will allow for more blending of real and virtual worlds, teacher educators should prepare to embrace new tools while conducting research on the potential impact these tools will have on practice. Simulated environments are expected to progress much like online delivery did in the 1990s. Given that tablet use is an industry standard, fully immersive environments will come into play with the integration of personalized learning, quantifiable data, and virtual assistants to ensure that well-prepared teachers enter the classroom from day one. The ultimate goal of simulation is to help promote, retain, and, as needed, retool pre-service teachers as they enter the workforce to ensure that they make a strong and long-term impact on student learning.

Closing Thought

As technologies continue to emerge, the burden is on members of our community to not accept the latest and greatest programs and apps at face value; instead, we must opt to conduct experimental trials and ask other appropriate research questions that provide evidence of effectiveness given our goal of preparing future teachers for success while teaching students with disabilities.

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Appendix

Innovation Configuration for the Use of Technology in the Preparation of Pre-Service Teachers

Essential Components	Implementation Levels				
Instructions: Place an X under the appropriate variation implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0** There is no evidence that the component is included in the syllabus, or the syllabus only mentions the component.	**Level 1** Must contain at least one of the following: reading, test, lecture/ presentation, discussion, modeling/ demonstration, or quiz.	**Level 2** Must contain at least one item from Level 1, plus at least one of the following: observation, project/activity, case study, or lesson plan study.	**Level 3** Must contain at least one item from Level 1 as well as at least one item from Level 2, plus at least one of the following: tutoring, small group student teaching, or whole group internship.	**Rating** Rate each item as the number of the highest variation receiving an X under it.
1.0 Podcasts					
1.1 - Podcasts are incorporated into courses where appropriate and aligned with content. 1.2 - Podcasts contain key content likely to be prioritized during lecture, on assignments, in assessments, and in practice. 1.3 - Podcasts contain rich content of any length, on any topic, and including any number of instructional approaches. 1.4 - Podcast topics focus on critical skills that are in the teacher preparation program.					

Essential Components	Implementation Levels				
Instructions: Place an X under the appropriate variation implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0**	**Level 1**	**Level 2**	**Level 3**	**Rating**
	There is no evidence that the component is included in the syllabus, or the syllabus only mentions the component.	Must contain at least one of the following: reading, test, lecture/ presentation, discussion, modeling/ demonstration, or quiz.	Must contain at least one item from Level 1, plus at least one of the following: observation, project/activity, case study, or lesson plan study.	Must contain at least one item from Level 1 as well as at least one item from Level 2, plus at least one of the following: tutoring, small group student teaching, or whole group internship.	Rate each item as the number of the highest variation receiving an X under it.
2.0 Video Case Studies					
2.1 - Anchored in the content. 2.2 - If using for research, consider trade-off between the number of videos and the potential confounds. 2.3 - Consider three elements: (a) the content, (b) the context, and (c) the multimedia. 2.4 - Identify an explicit instructional purpose for the use of the video case study that, if possible, was previously developed based on current learning theory. 2.5 - Set explicit instructional objectives for intended learner outcomes. 2.6 - Choose/develop narrative video that is of sufficient duration, complexity, and					

Essential Components	Implementation Levels				
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2.0 Video Case Studies					
explicitness to meet the instructional objectives (typically less than 30 min). 2.7 -Instructor focuses teacher candidates on critical aspects of case. 2.8 - Employ multiple scenarios or cases as comparisons of parallel cases, which enables the development of cognitive flexibility. 2.9 - Provides opportunities for feedback, analysis, and revisions.					

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3.0 Online Delivery					
3.1 - Ensure that communication between faculty and students is continual and effective; consider use of email, web-based conferencing (e.g., webinar), blog postings, online discussions, phone contact, FaceTime, Skype, or Google Hangouts. 3.2 - Early in course, discuss and define course policies, teacher expectations, and plagiarism. 3.3 - Provide cooperative learning opportunities to facilitate critical thinking, brainstorming/problem solving, study groups, and the use of dyads and peer assessment activities. 3.4 - Provide experiential and active learning activities, utilizing Bloom's Taxonomy and the Theory of Engagement to activate areas of the brain					

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3.0 Online Delivery					
responsible for higher order thinking and active learning that address the construction of knowledge through analysis, synthesis, and evaluation. 3.5 - Ensure that structure and content require student to make decisions, conduct experiments, and explore ways to solve real-world problems, case studies, and scenarios that lead to transference of learning in practice. 3.6 - Give punctual feedback. 3.7 - Structure opportunities for practice and establish peer tutoring when necessary. 3.8 - Express high expectations by continually motivating, commending successes, and providing stimulating activities.					

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3.0 Online Delivery					
3.9 - Embrace cultural diversity and different learning styles by incorporating Gardner's theory of Multiple Intelligences (MI). 3.10 - Provide differentiated instruction by knowing students and learning how to best impact their learning in this environment. 3.11 - Ensure accommodation of learners needing special assistance and assistive technologies (AT).					

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4.0 Supervision and Feedback					
4.1 - Consider how to best integrate eCoaching into program. 4.2 - Use eCoaching with special education pre-service teachers and general education counterparts during co-teaching planning and instruction. 4.3 - Educators should consider extending eCoaching use from early, mid, and late field experiences to include induction support. 4.4 - Identify how to use eCoaching in early experiences. 4.5 - Differentiate how to use eCoaching in mid field experiences. 4.6 - Differentiate how to use eCoaching in late field experiences.					

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4.0 Supervision and Feedback					
4.7 - Consider how to use eCoaching in beginning induction to the field. 4.8 - Use inexpensive and validated tools for eCoaching.					

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5.0 Teaching Simulations					
5.1 - Tools are embedded with clear connections to course objectives. 5.2 - Fully immersive simulators ensure use of Action Review Cycle (ARC). 5.3 - A minimum of four 10-min sessions are used to focus on a targeted skill in teacher practice in an immersive simulator. 5.4 - Ways to investigate impact of online simulations are a part of the development as new environments emerge.					

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6.0 Emerging Innovations					
6.1 - Create a strategy for faculty to stay abreast of innovations and how these may be incorporated into the program as they are validated. 6.2 - Ensure exposure of pre-service teachers to emerging technology as a promising practice in preparation program.					