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Teacher preparation programs must be systematic in the way they teach content and pedagogy while providing preservice teachers the tools they need to both be successful and want to stay in the field. Reports such as the National Council for Accreditation of Teacher Education (NCATE, 2010) Blue Ribbon Panel report call for teacher preparation programs to use technology to support preservice teacher development of best practice. However, research indicates that there is a disconnect between what is expected of preservice teachers and the way they are taught, especially in the area of technology (Barak, 2017). In an effort to guide teacher preparation programs in their efforts, the authors use the components of the Joyce and Showers (1980) model of professional development (i.e., study of theory and best practice, observation of best practice, one-on-one coaching, and group coaching) to create a guiding framework of how teacher preparation programs can systematically infuse technology throughout their programs to support preservice teachers' knowledge and skill acquisition in early, mid, and late candidacy. Examples of technology and supporting research are provided and aligned with Joyce and Showers' (1980) model.

Keywords: teacher preparation, technology, preservice teachers

Teacher shortages and the inability to hire qualified teachers at current wages have affected districts for years (Sutcher, Darling-Hammond, & Carver-Thomas, 2016). In their report, Sutcher et al. (2016) estimated that by the year 2020, 300,000 new general and special education teachers will need to be hired in order to meet the educational needs of students. Given this information, major changes must occur in order for the field of education to supply more teachers to meet this demand. Since teacher shortages are driven by four main factors, two of which include a decline in

enrollment in teacher preparation programs and increasing teacher attrition (Sutcher et al., 2016), responsibility falls on teacher preparation programs to carefully design programs that will not only teach content and pedagogy, but also provide preservice teachers with the tools needed to both be successful and want to stay in the field.

Although teacher attrition occurs for various reasons (e.g., leaving the teaching profession, transferring to other teaching and educational positions; Billingsley, 2004), research indicates that teacher preparation plays a major factor. Preservice teachers who attend teacher preparation programs where they have more comprehensive experiences report feeling more prepared to teach in their perspective fields (Kee, 2012). For the purposes of this paper, the authors focus on issues specifically related to special education teacher preparation; the subsequent sections address the research of effective preparation in special education.

Effective teacher preparation programs in special education

Researchers have identified program features that impact preservice teachers' learning and their influence of student outcomes within their first year of teaching (e.g., Brownell, Ross, Colón, & McCallum, 2005; Grossman et al., 2009). In 2005, Brownell and colleagues identified critical features of effective special education teacher preparation programs. These include (a) having a coherent program vision, (b) conscious blending of knowledge, theory, pedagogy, and practice, (c) carefully crafted field experiences, (e) using standards for teaching, (f) programmatic focus on meeting the needs of a diverse student population, (g) and fostering collaboration. Similarly, Grossman et al. (2009) noted that key program features should include (a) blending coursework and clinical practice, (b) active pedagogy, (c) focus on the work of first-year teaching, (d) opportunities to observe best practice, and (e) immediate feedback. Taken together, these researchers determined that programs that created a cohesive focus on what first-year teachers need to know to effectively teach K-12 students (e.g., content and pedagogical knowledge, ability to work with diverse student population, and collaborate with colleagues and parents) and provided opportunities for preservice teachers to actively engage in learning (e.g., coursework linked to field experiences) with scaffolded supports (e.g. feedback) yielded graduates that reported feeling better prepared to teach during their first years and were more likely to stay in the field over time.

As noted above, effective special education teacher preparation programs allow for active engagement in learning, which is essential for students acquisition and appropriation of effective teaching practices (e.g., Brownell et al, 2005). Grossman and colleagues (2009) further identified active engagement in terms of interactive practices as a critical component of professional education programs. Examples of interactive practices include the use of role-playing, videos, and case studies in coursework to facilitate the development of knowledge and skills. Barak (2017) also identified instructional technology as a way to actively engage preservice teachers in learning. Although not specific to special education, these opportunities for active engagement facilitate preservice teachers acquisition of key components necessary to learn and transfer knowledge to practice.

Despite what is known about effective teacher preparation, recent research

(Barak, 2017) indicates that there is a disconnect between what is expected of preservice teachers and the way they are taught, especially in the area of technology. In her study, Barak (2017) found that preservice teachers are expected to use innovative technology in their teaching, but they are not exposed to this technology during their teacher preparation programs. As a result, upon graduation, many teachers lack the motivation, experience, resources, or expertise to use instructional technology during their teaching (Barak, 2017). Therefore, the purpose of this manuscript was to create a guiding framework for teacher preparation programs to use as they systematically infuse technology throughout their programs to support preservice teachers' knowledge and skill acquisition in early, mid, and late candidacy. The authors use existing research that has been proven effective for teacher preparation to distinguish ways to support preservice teacher development through the use of technology. In the following sections, the authors discuss the use of technology in teacher preparation programs and how technology can be used to support preservice teacher development throughout teacher candidacy.

Technology in teacher preparation

Technology in teacher preparation can be viewed as concentric circles (see Figure 1). Concentric circles are circles that share the same center. In this case, one circle represents the technology preservice teachers must learn to use in schools and a second circle represents how preparation programs and teacher educators use technology to support preservice teacher development. The shared center circle represents teaching and learning with technology. Each circle is described in more detail below.

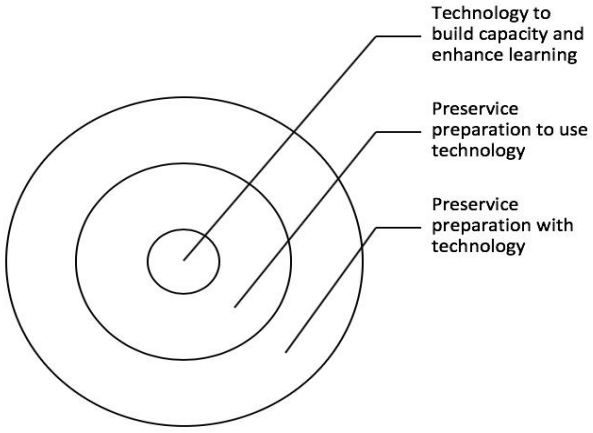

Figure 1. Technology in teacher preparation viewed as concentric circles.

Using this visual of concentric circles, in the outer circle programs are tasked with preparing preservice teachers to incorporate rapidly changing technology into their instruction in meaningful ways (U.S. Department of Education, 2016). For

example, the Council for Accreditation of Educator Preparation (CAEP) standard 1.5 requires that "Providers ensure that candidates model and apply technology standards as they design, implement and assess learning experiences to engage students and improve learning; and enrich professional practice" (CAEP, 2015). Additionally, the Council for Exceptional Children (CEC) and the Collaboration for Effective Educator Development, Accountability and Reform (CEEDAR) centers' High Leverage Practices (HLP) also address the importance of including instructional technology to improve education outcomes (i.e., HLP13, HLP18, and HLP19; McLeskey et al., 2017).

Moving closer to the center, in the next circle teacher educators must also use instructional technology in ways that transform preservice teachers' ability to learn and apply content and pedagogical knowledge (Schmidt-Crawford, Lindstrom, & Thompson, 2018). For instance, in 2010 the National Council for Accreditation of Teacher Education (NCATE, 2010) provided a report of the Blue Ribbon Panel on Clinical Preparation and Partnerships design principle #8 for improved preparation notes that technology applications should,

... foster high-impact preparation: State-of-the-art technologies should be employed by preparation programs to promote enhanced productivity, greater efficiencies, and collaboration through learning communities. Technology should also be an important tool to share best practices across partnerships, and to facilitate on-going professional learning (p 6).

More recently, striving to increase both the accountability and effectiveness of teacher preparation programs, the CEEDAR Center developed the Innovation Configuration *Use of technology in the preparation of preservice teachers* (Dieker et al., 2014). Researchers at the CEEDAR Center have developed several Innovation Configurations (IC), which are used to identify and describe the components of a practice or innovation—in this case, technology. Dieker and colleagues (2014) designed the technology IC to support teacher preparation program providers' use of evidence-based research and the use of technologies. The researchers specifically address six broad categories of technology, which include podcasts, video case studies, online delivery of content, technology-based support, supervision and feedback, and virtual learning or simulation experiences.

Finally, the core of these two circles is the same- to build capacity and enhance student learning. In order for teacher preparation programs to effectively address the use of instructional technology for developing effective teachers, program developers must consider ways to systematically infuse technology into their programs. As a result, teacher preparation programs should be using technology to support their teachers, expect them to use technology in their learning, and be providing sufficient examples of its use that preservice teachers can use in their future classrooms to enhance student learning (Barak, 2017).

Systematically using technology in teacher preparation programs

While the technology tools discussed above (e.g., podcasts) can support preservice teachers and serve as models of K-12 instructional practice, providing a guiding framework for teacher preparation programs to use, may support program developers as they attempt to systematically embed technological

supports for effective instruction. To create a guiding framework, the authors used the professional development literature. Joyce and Showers (1980) note that in order for teachers to learn new content and transfer that knowledge into practice, in-service teacher training (e.g., job-embedded professional development) should include the study of theory and best practice, observation of best practice, one-on-one coaching, and group coaching. Although originally described for in-service teachers, the professional development model created by Joyce and Showers (1980) may help teacher preparation programs facilitate preservice teacher's content and pedagogical knowledge.

The authors saw a parallel application of the professional development model developed by Joyce and Showers to preservice teachers within teacher preparation programs and concluded that this model could be used as a guiding framework for intentional integration of technological supports throughout preservice teacher development. Examples of the components of professional development, across the three stages of teacher preparation programs, are presented in Table 1.

Table 1
Technology Embedded Support for Preservice Teachers

Continuum Component (Joyce & Showers, 1980)	Technology	Research	Candidacy Development			
			Early	Mid	Late	Not Specified
Theory and Best Practice	Digital Material	Barak, 2017				NS*
	Podcasts	Evans, 2008	UG*#			
		Carvalho & Aguiar, 2009	UG*		G	
		Kennedy, Hart, & Kellems, 2011	UG*	UG*	UG*	
	Online Modules	Sayeski, Hamilton-Jones, & Oh, 2015				UG* G
	Online Courses	Barnett, 2006				NS*
	Online Discussion Forums	Hibbard, Bellera, & Vermette, 2010				G*
Observation of Best Practice	Video Case Studies	Dieker et al., 2009				UG* G
		Beck, King, & Marshall, 2002	NS*			

	Digital Teacher Observation	Brunvand & Fishman, 2007			NS*
One on One Coaching	eCoaching	Rock et al., 2009			G* G
		Rock et al., 2014			G*+ G +
		Coogle et al., 2015		UG*	
		Coogle et al., 2016			UG *+
	Guided Video Analysis	Nagro et al., 2017		UG*	
Group Coaching	Simulation	Dawson et al., 2017	*Alt. Route		
		Ely et al., 2018			UG*

Note. *Initial Licensure, +Recent graduates. #Outside of education, UG= Undergraduate, G=Graduate, NS=Graduate or Undergraduate Status Not Specified.

A guiding framework for supporting preservice teacher development: Early, mid, and late candidacy

While there has been a call for greater use of instructional technology in teacher preparation, implementing technology for the sake of using technology will not suffice (U.S. Department of Education, 2016). Therefore, teacher preparation programs can benefit from being intentional about infusing technology through their perspective programs. When following the Joyce and Showers professional development model, it becomes apparent that certain features may be more prominent during different stages of pre-service teacher development. For example, preservice teachers typically spend four to five semesters (i.e., two to two and a half years) earning their teaching degree. During the first semester, a preservice teacher will most likely conduct more observations in the field than a final semester preservice teacher due to limited pedagogical and content knowledge. Accordingly, when systematically infusing instructional technology to support preservice teacher development by following Joyce and Showers' model, those who develop teacher preparation programs must not only consider the research but must also consider the preservice teachers' stage of candidacy.

In this manuscript, an early candidate preservice teacher was defined as an individual taking the introductory courses required for their teacher preparation program. A mid-candidate preservice teacher was defined as an individual admitted to a teacher preparation program but has not yet completed their student teaching. A late candidate preservice

teacher was defined as an individual in their final semester, including student teaching but prior to graduation. Finally, graduate students who were not seeking initial licensure were also defined as a late candidate. In the following section, the authors present recent research on instructional technology use throughout preservice teacher stages of development and align the instructional technology used with Joyce and Showers' model for knowledge and skill acquisition (see Table 1).

Study of theory and best practice. Joyce and Showers (1980) describe the study of theory and best practice as the presentation of a skill or instructional technique. In traditional coursework, theory and best practice are often presented through readings, lectures, and course discussions. There are several technological supports that can also be used to develop preservice teachers understanding of theory and best practice throughout their preparation. For example, Table 1 draws attention to how digital material, podcasts, modules, and alternative collaborative forums can be utilized to enhance learning experiences.

Technology affords teacher preparation programs the opportunity to provide easily accessible, low-cost options for expensive textbooks and other print material critical to distributing the information preservice teachers need to gain new content knowledge. Beyond the accessibility and mere convenience of the technology options for developing an understanding of theory and best practice, is the effectiveness of such efforts (i.e., Barak, 2017; Carvalho & Aguiar, 2009; Kennedy, Hart, & Kellems, 2011). For example, podcasts (Carvalho & Aguiar, 2009; Kennedy et al., 2011), online collaborative forums (Hibbard, Bellera, & Vermette, 2010), and online professional development (Sayeski, Hamilton-Jones, & Oh, 2015) have yielded positive outcomes for preservice teachers.

Podcasts. A podcast is an audio file of a topic that can be downloaded (Dieker et al., 2014). Podcasts provide an alternative means of presenting information, and research has shown its promising potential for improving student knowledge (Evans, 2008). Evans found that through giving learners the opportunity to be more actively engaged in course material through podcasts, as compared to more passive approaches such as textbooks and lectures, students provided a better interpretation of the material. Kennedy and colleagues (2011) addressed the efficiency of podcasts in their 2011 research and noted that, "Enhanced podcasts designed using Mayer's CTML [cognitive theory of multimedia learning] and accompanying research-based design principles may be a promising intervention for preparing and delivering course content that may otherwise go uncovered by teacher educators dealing with non-negotiable limitations on instructional time" (p. 100). Additionally, podcasts can be successfully used by instructors to describe assignments in combination with other presentations of information to preservice teachers. Finally, as preservice teachers make meaning of the information gathered in their preparation programs, podcasts can be used to provide feedback on performance allowing for appropriate revisions to the students understanding of course content (Carvalho & Aguiar, 2009).

Online discussion forums. While podcasts provide a multitude of ways for individuals to receive information and to disseminate their knowledge, online

discussion forums can provide an interactive environment for scholarly dialogue surrounding the content presented. Hibbard and colleagues (2010) concluded that online discussion forums could yield a multitude of student responses, ranging from summaries to discussions integrating current practices. They also emphasized the importance of structuring the discussion boards with guiding questions or discussion starters and noted the importance of sharing the specific requirements of each forum. By providing structure in the online discussions, teacher educators can help their preservice teachers hone in on the theory and skills that will support instructional effectiveness.

Online courses and modules. Online courses and modules provide opportunities for preservice teachers to engage with theory and knowledge through multiple technological supports integrated into one place and have the potential for positive outcomes in the development of preservice teachers understanding and application of course material. For example, Barnett (2006) found that through systematically implementing an Inquiry Learning Forum (ILF), while utilizing teaching videos and holding discussions, preservice teachers can improve their understanding of complex content. Additionally, statistically significant gains in learning have been found in the utilization of the IRIS Center's STAR Legacy modules (Sayeski et al., 2015). Specifically, the use of IRIS modules in flipped classrooms have been found to be more effective than classrooms that utilize IRIS independently with no direct connection discussed in class (Sayeski et al., 2015). Together, these two studies highlight the importance of including interactive practices with technology, such as discussions (Grossman et al., 2009), in preservice teacher acquisition of knowledge and skills.

Observation of best practice. Joyce and Showers (1980) describe the observation of best practice as modeling and demonstration of a skill or strategy "either through a live demonstration with children or adults, or through television, film, or other media" (p. 382). Observation of best practice involves helping teachers increase instructional effectiveness (e.g., Hendry & Oliver, 2012) and has an impact on awareness, knowledge, and mastery of theory and skills (Joyce & Showers, 1980). The use of technology in observing best practice has been demonstrated through video case studies (Dieker et al., 2009) and teacher observations (Beck, King, & Marshall, 2002; Brunvand & Fishman, 2007).

Digital teacher observations and video case studies. Digital observations of best practice can be conducted through live web-based streaming or pre-recorded online video models. Dieker and colleagues (2009) used exemplary teachers as models in their research on video modeling of evidence-based practices. While findings were preliminary in nature, preservice teachers who viewed the videos showed improvement in their understanding of the practices viewed as evidenced by the change in pre-post test scores. Additionally, the gains in posttest scores were higher for the video condition than for those who only read about the strategy.

There have been some concerns noted with video observation of best practice. For example, while Dieker and colleagues (2009) observed gains in preservice teacher knowledge, the authors also noted that some of the more novice preservice teachers felt they could not model what they observed. Moreover,

similar to the concerns noted in Barnett's 2006 research, Dieker and colleagues (2009) also found that preservice teachers enjoyed watching the teacher models but were uncertain about what they should gather from the videos. To overcome this uncertainty and facilitate the understanding of the inquiry process expected when watching the video, Barnett (2006) highlighted the importance including the teacher from the video in class discussion when possible.

Beck and colleagues (2002) employed the use of self-created video case studies as they explored the impact of technology-supported practice in observation (TSPO) over 10 weeks. For these case studies, students videoed their supervising teacher and themselves in placement and completed a video analysis. Students who engaged in the video case studies performed significantly better on tests examining teaching ideas in language arts, math, and science when compared to their peers in the regular classroom observation condition. Furthermore, related to the findings from Barnett (2006) and Dieker et al. (2009), Beck and colleagues (2002) noted that providing a specific lens to prompt reflection helped students to see video recordings through various points of view (e.g., teacher strategies, student learning, standards-based instruction, classroom interactions). In addition to using various lenses to create meaningful dialogue and reflection, research has suggested what preservice teachers notice and learn are significantly impacted when given scaffolds such as on-screen text prompts and integrated commentary from teachers (Brunvand & Fishman, 2007).

One-on-one coaching. Coaching, or opportunities to practice with feedback, has a statistically significant impact on the transfer of skills (see Joyce & Showers, 2002). Like traditional elbow or side by side coaching, the technology-enabled variation, (e.g., *e*Coaching or bug-in-ear), allows a coach to provide immediate feedback to a teacher during classroom instruction (e.g., Rock et al., 2012; Scheeler et al., 2012). The difference, however, is that the coach's feedback is delivered electronically to the teacher through onsite or online bug in ear technology, a Bluetooth handless earpiece, a web camera or mobile device, and a platform for observing- such as Skype, Zoom, or Webex. In both forms of coaching, the purpose remains the same: the coach provides a teacher or co-teachers with individualized support, helps a teacher or co-teachers gain better understanding of how classroom teaching impacts student performance, increases awareness of classroom practices, and enhances comprehension of how classroom practices influence the school environment (e.g., Rock et al., 2009).

eCoaching. Rock and colleagues (2009) not only found *advanced online bug-in-ear* (BIE) coaching to be practical and efficient, they found increases in the frequency of teacher praise and use of effective instructional practices. Rock and colleagues (2009) also examined the impact of *e*Coaching on student outcomes and found an increase in student on-task behavior for the teachers being coached. Additionally, a follow-up study (Rock et al., 2014) found that as time went on teachers had a more positive attitude towards advanced online BIE technology.

Coogle, Rahn, and Ottley (2015) studied preservice teachers in early childhood's use of communication strategies (activity-based intervention approach) with BIE coaching support. They found that BIE enhanced preservice

teachers' use of communication strategies with small groups and their data suggested that the preservice teachers were maintaining the implementation of skills without feedback. However, while preservice teachers in 2015 were able to generalize their skills, further research results in 2016 found generalization to be inconclusive (Coogle, Rahn, Ottley, & Storrie, 2016). Overall, research indicates eCoaching is an effective method that can be used to support preservice teachers with one-on-one support.

Guided video analysis of candidate instruction. Guided video analysis is a process in analyzing videos with guidance utilizing self-evaluation (rubrics) and feedback (Nagro, deBettencourt, Rosenberg, Carran, & Weiss, 2017). Using a quasi-experimental study, Nagro and colleagues (2017) compared both reflective ability and self-reports of teaching ability of preservice teachers who received coaching (i.e., feedback) on their video-taped lessons and reflections to those who did not receive coaching. While both groups reported an increase in teaching ability after completing their video analysis, those who received coaching on both their reflections and instruction demonstrated the highest level of growth and confidence at the end of their student teaching experience. This study showcases the potential impact coaching feedback via email on improving candidate practices.

Group coaching. Group coaching focuses members attention to goal setting, awareness building, and accountability (Britton, 2013). In other words, group coaching brings preservice teachers together to identify and solve problems of practice more effectively. Professional learning communities (PLCs) can be used for group coaching, where teachers and coaches work together to find, share, and develop practices that enhance their effectiveness and benefit K-12 student learning (Hord, 1997). Common PLC group coaching approaches include Critical Friends Groups (CFG's) and Grand or Instructional Rounds. All of these approaches can be technology-enabled through methods such as virtual realities and simulations (Dawson & Lignugaris/Kraft, 2017; Ely, Alves, Dolenc, Sebolt, & Walton, 2018).

Simulations. Virtual classrooms can be used for PLCs and CFG by providing a safe environment for observing and discussing instruction. Virtual classroom simulations allow for full immersion into a teaching environment but with the support of peers and professors. These simulations also provide opportunities for immediate feedback and reflection that trigger change in the moment. The coaching provided during simulations differ from that received in one-on-one coaching, BIE or traditional, because the feedback can be both provided and internalized the group. In 2017, Dawson and Lignugaris/Kraft studied the impact of TeachLive, a virtual classroom, on pre-service special educators' delivery of specific praise, praise around, and error correction. With repeated practice and structured feedback in the group setting using TeachLive they found increases in all areas. Additionally, Dawson and colleagues (2018) found that preservice teachers were able to generalize these skills to the classroom environment. In summary, the results of the aforementioned studies provide supporting evidence that technology can be integrated with Joyce and Showers (1980) model of professional development. As a result, program developers can use this guiding model to support preservice teachers.

Conclusion

In this article, by using Joyce and Showers' (1980) model of professional development, the authors provided a guiding framework for integrating technology in teacher preparation programs to support preservice teachers' knowledge and skill acquisition. Although not comprehensive, authors have identified relevant literature (see Table 1) and organized it within the four components of the Joyce and Showers (1980) model. By creating this guiding framework, program developers can begin to have discussions about how, when, and where to infuse technology throughout their programs to support preservice teachers' development. For example, when preservice teachers (early, mid, or late candidacy) are learning new content (i.e., study of theory and best practice), information can be provided using technology such as podcasts, in addition to lectures and course readings. The overall goal is to model and use this technology during preservice teacher development so when they graduate, preservice teachers will not only feel confident in their knowledge, skills, and ability to teach, but also in their capacity to use technology in their future classrooms. When teacher preparation programs systematically integrate effective program features (Brownell et al., 2005) and infuse technology throughout, the field of education could potentially see a change from the long history of teachers' reports of feeling unprepared after completing their preparation programs (Buck et al., 1992) to a new history of preservice teachers' feeling prepared to step foot into the dynamic field of education.

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