Technology-based professional development in adapted physical education

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Introduction

Technology-based professional development (PD) is an umbrella term encompassing the variety of ways technology (e.g., eLearning technologies, social media networks [SMNs], augmented/virtual reality, video, mobile applications) can be utilized to improve the professional knowledge, competence, skill, and effectiveness of teachers. The purpose of this chapter is to explore technology-based PD as an emerging research topic in the field of adapted physical education (APE). But, before I delve into the current research on technology-based PD, and contemplate future trends, it is worthwhile to consider the factors that led to its emergence as a critical and fertile research area in the field of APE.

Necessity is the mother of invention. A substantial body of work reports on the challenges faced by physical educators to instruct students with disabilities in their classes. A US Governmental Accountability Office (2010) report specifically linked the challenge of successfully educating students with disabilities in general physical education classes to the inadequate preparation of physical educators to do so. Research involving physical education teachers attests to this lack of training and feelings of unpreparedness (Anunah & Hodge, 2005; Chandler & Greene, 1995; Hardin, 2005; Hodge, 1998; Kowalski & Rizzo, 1996; Lienert, Sherrill, & Myers, 2001; Rekaa, Hanisch, & Ytterhus, 2018). This situation is unsurprising when one considers that pre-service physical education teachers are typically receiving just one course devoted to APE (Piletic & Davis, 2008). Overall, there exists a consensus that many physical education teachers lack the competencies necessary to effectively teach students with disabilities. Furthermore, the competencies necessary to teach students with disabilities are constantly evolving; physical educators are expected to remain current on the newest knowledge, including topics such as technology-integration and evidence-based instructional strategies. The lack of adequate pre-service education in the field of APE, and the need for continuous professional development to allow teachers to remain abreast of emerging knowledge in the field, results in a need for educational reform.

PD—an experience that improves teachers’ knowledge, informs pedagogy, and contributes to personal and professional growth (Cohen, McLaughlin, & Talbert, 1993)—has been
identified as a link between the implementation of educational reform and its ultimate success (DeMonte, 2013). Researchers in the field of APE have long understood the need for a focus on PD. This has generally focused on traditional PD; typically, this PD consists of face-to-face, expert-led PD delivered via workshops, conferences, and classroom-based coursework (Feiman-Nemser, 2001). APE research on traditional PD has generally focused on improving self-efficacy and has demonstrated limited success (Haegele, Hodge, Gutierres Filho, & Gonçalves de Rezende, 2018; Taliaferro & Harris, 2014). In addition to the inconclusive impact of traditional PD, researchers are also increasingly aware of its limitations, including constraints related to cost, time, location and availability (Armour & Yelling, 2007; Elliott, 2017).

It was from this milieu—one of unprepared teachers, ever-evolving competency requirements, and inadequate methods of PD—that teacher educators and researchers have turned to technology-based PD solutions. The aim of this chapter is to provide a broad overview of technology-based PD in APE. With research on this topic currently in its infancy in the field of APE, I will also delve into the topic of technology-based PD in other disciplines so as to inform future research related to APE. Four major areas related to research in technology-based PD in APE will be discussed, including (a) theoretical frameworks underpinning technology-based PD research, (b) research related to formal online PD (OPD) in APE, (c) research on informal online communities and networks as a source of teacher PD, and (d) current trends and issues pertaining to technology-based PD.

Theoretical/conceptual frameworks underpinning technology-based PD research

“There is nothing so practical as a good theory” (Lewin, 1951, p. 169).

Researchers have long worked to understand and improve the competencies of physical educators to teach students with disabilities. Theories of learning have often guided this research and practice; researchers are aware that as well as knowing what works, it is essential that we also know why it works (Chibucos, Leite, & Weis, 2005). The utilization of a detailed theoretical underpinning allows research results to be better understood and replicated in research and in practice. With the shift in PD delivery from offline to online, we are required to revisit and review prominent theories of learning and question their conceptual relevance and applicability to technology-based PD. Researchers of technology-based PD have not always adhered to this recommendation, however; the absence of theoretical frameworks underpinning PD programs remains a critical weakness of existing research on the topic.

Researchers seeking to evaluate and refine the use of technology-based PD to advance the field of APE should be aware of the lack of theoretically sound research on PD in general, and seek to address this void in their work. To assist in this endeavor, the purpose of this section is to examine theoretical frameworks that may guide the use of technology-based PD related to APE. With a dearth of research on the topic in the field of APE, I delve into the wider body of work on theories of learning, and examine examples of theoretically sound technology-based PD research. Specifically, in this chapter, I will examine three prominent theories that may guide the implementation and evaluation of PD in APE; constructivism, andragogy, and theories of multimedia learning. Wenger’s model of Communities of Practice (CoP) is also discussed, as it is a popular and highly relevant theory for informal PD, and highlights how models of instruction derived from multiple theories are often required to underpin complex instruction and teaching processes. Other theories with
implications for technology-based PD, not discussed in this chapter, include the traditional learning theories of behaviorism (Skinner, 1976) and cognitivism (Ertmer & Newby, 2008), and newer theories based on networked contexts, such as heutagogy (Phelps, Hase, & Ellis, 2005) and connectivism (Siemens, 2005).

**Constructivism**

Constructivists believe in the philosophy and scientific position that “knowledge arises through a process of active construction” (Mascolo & Fischer, 2005, p. 49), or that learners *build* knowledge rather than *receive* knowledge (Berg-Sorensen, Holtuh, & Lippert-Rasmussen, 2010). Instructors guided by this theory strive to provide learners with opportunities to construct meaning through active mental effort and social interaction; it is then that learning and development occurs (Altman, 2009). Constructivist approaches to learning have long shaped instruction, and research on instruction, including the development and research of PD for physical educators (Patton, Parker, & Pratt, 2013). Traditional PD built upon constructivist principles employs strategies such as mentoring, engagement in communities of practice, or self-directed learning (Little & Curry, 2008). With a shift now towards OPD, the challenge is to adapt the constructivist principles for a new environment. One popular means of doing so is by the establishment of authentic learning environments, in which learners collaboratively engage in challenging experiences based on realistic settings and contexts (Keengwe, 2019). To aid researchers of OPD in APE, readers may contemplate how they can integrate eight design principles put forth by Salmon (2002) that provide a framework for the development of constructivist OPD.

1. Provide authentic contexts that reflect the way knowledge will be used in real life.
2. Provide opportunities for social negotiation and mediation.
3. Focus on content and skills that are relevant for the learner.
4. Present content and skills within the framework of the learner’s previous knowledge.
5. Make assessment informative, serving to enhance future learning.
6. Learners should be self-regulatory and self-mediated.
7. Serve as guides and facilitators of learning.
8. Provide for, and encourage, multiple perspectives and representations of content.

For a more in-depth explanation of the above principles, see Keengwe (2019). A constructivist framework has yet to be applied to OPD in the area of APE. However, researchers may look to the literature base on OPD and online instruction in general for several examples of how the principles, outlined above, can be reflected in the pedagogy and content of online courses (Chitanana, 2012; Gold, 2001; Huang, 2002; Salter, Richards, & Carey, 2004). For example, Chitanana (2012) examined how constructivist theory shaped the design and implementation of an OPD course focused on information, communication, and technology skills, as reflected by the interactions of 28 educators. Data showed the constructivist framework to be reflected throughout the OPD program, and noted the opportunities for collaborative knowledge building, reflection, and authentic tasks and experiences to be key elements contributing to the success of the program. Noteworthy in this study, and of relevance to future researchers of technology-based PD in APE, is the thorough description of how constructivism underpinned the OPD’s design. This strength is a rarity in research on this topic.
Andragogy

Andragogy is the art and science of helping adults to learn (Knowles, 1980). The popularity of andragogy in PD creation and implementation warrants its examination for underpinning OPD also. Andragogy does not meet the criteria to be classified as a theory, but, rather, is a model rooted in the theory of humanism (Elias & Merriam, 1995). Andragogy was suggested as a “system of concepts” by Knowles (Knowles, 1980, p. 8) but has also been referred to as a “theory, method, technique and set of assumptions” (Davenport & Davenport, 1985, p. 152). Andragogy proposes five assumptions for the adult learner, including that adults (a) have a preference for self-direction, (b) bring experience to the learning process, (c) have a readiness to learn based on a need to know basis, (d) exhibit a problem-centered approach to learning, and (e) have a high degree of internal motivation. Based on these assumptions, Knowles posits four principles that should be applied to adult learning experiences (Knowles, 1980). Although a substantial body of literature exists detailing how the andragogy principles can be applied to various fields of adult education, including teacher PD (Terehoff, 2002), there remains a scarcity of studies on the effect of andragogy-based instructional design programs. In one of few studies examining OPD related to APE for in-service physical educators, Healy, Block, and Kelly (2019) demonstrated how an asynchronous OPD course, built upon the tenets of andragogy, could result in significant learning for participants on the topic of peer tutoring. Table 25.1 outlines the four principles of andragogy, and how they were reflected in the OPD course “Peer tutoring in physical education” (Healy et al., 2019).

Further demonstrating the utility of andragogy as a theoretical framework for OPD in the field of APE, Sato and colleagues (Sato & Haegele, 2018; Sato, Haegele, & Foot, 2017b) examined the perspective of in-service physical educators who participated in two OPD courses, “Introduction to APE” and “Practicum in APE”; each course consisted of 45 contact hours. Overall, data, collected from journal reflections, assignments, and face-to-face interviews, revealed that the physical education teachers believed the OPD course to be beneficial, and served to help them develop their lessons and teaching strategies, and make academic adjustments to different teaching settings. Importantly, similar to Healy et al. (2019) and Sato, Haegele, and Foot (2017a) provide in-depth information on how the andragogical principles were reflected in the course design.

In addition to the andragogical principles being applied to APE courses for in-service physical educators (Healy et al., 2019; Sato & Haegele, 2018; Sato et al., 2017a, 2017b), researchers may also turn to research on adult education in other fields to inform future technology-based PD in APE. For example, andragogy has underpinned research focusing on the development of library staff competencies related to technology (Quinney, Smith, & Galbraith, 2013); teachers’ technological integration (Glazer, Hannafin, Polly, & Rich, 2009); and nursing education (Norrie & Dalby, 2007). Although andragogy has been recommended for underpinning teacher development, and there is emerging evidence to support this claim, common methodological weaknesses permeate the literature on the topic, including a lack of experimental designed studies and a failure to adequately detail how andragogy underpinned the program under study. Future researchers of technology-based PD in APE would do well to overcome these limitations.

Theories of multimedia learning

Whereas theories and philosophies such as constructivism and andragogy are useful for providing a structure to learning activities within OPD, creating technology-based OPD often
Knowles’ principles and their application to online professional development

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<th>Knowles Principles</th>
<th>Example of an application to the OPD program “Peer tutoring in physical education”</th>
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| 1. Adults need to be involved in the planning and evaluation of their instruction. | • When beginning the course, learners were encouraged to choose a student in one of their classes that they felt would benefit from a peer tutor.  
• Throughout the course, teachers were directed to design and implement a peer tutoring program for the chosen student.  
• After watching each course podcast, learners were prompted to reflect and report on how the course lessons related to their class.  
• In each of the four sections of the course, participants completed an application activity; this involved the learners taking the course lessons and applying it to their classroom. |
| 2. Adults require experience to learn. | • Teachers were provided with an evidence-based strategy to overcome a challenge that they identified in their physical education class.  
• The course was designed so that each section had a practical lesson that could be applied directly to the teacher’s class. This allowed teachers to see the immediate relevance of the course to their teaching. |
| 3. Adults are most interested in learning content that has immediate relevance and impact to their job or personal life. | • At the beginning of the course, teachers identified a student who presents a challenge to teach in physical education; a student who may benefit from peer tutoring.  
• Throughout the course, teachers were reminded that they should choose from the array of strategies offered depending on their unique situation. |
| 4. Adult learning should be problem-centered rather than content-oriented. | |

*Note: OPD = Online professional development*
also requires a method of transferring information, and this, too, should be theoretically sound. Most often, this requires the presentation of information in an asynchronous manner that often involves the learner receiving information via text, audio, images, and/or videos. Mayer’s (2009) cognitive theory of multimedia learning (CTML) is a popular theory for guiding research in this area. CTML suggests three elements that must be considered in the design of technology-based instructional material. First, instructors must seek to reduce extraneous processing, or cognitive processing that does not support the instructional goal and is attributable to confusing instructional design. Second, instructors must manage essential processing, or cognitive processing needed to mentally represent the incoming material and that is attributable to the complexity of the material. Finally, Mayer suggests that instruction should foster generative processing, or cognitive processing, aimed at making sense of the incoming material, including organizing it and integrating it with prior knowledge (Mayer, 2009). Mayer provides ten principles outlining how the above requirements can be achieved in the design process (see Table 25.2). Kennedy and colleagues (2011, 2012, 2014) demonstrate how these principles can provide the basis for the creation of “enhanced podcasts” that can transfer knowledge to pre-service and in-service teachers in the field of special education. Furthermore, Healy and colleagues (Healy et al., 2019) have replicated the use of enhanced podcasts based on Mayer’s principles with in-service physical education teachers. Overall, CTML and its associated design principles offer researchers of technology-based PD in APE a theoretically sound design process. The growing body of research demonstrating its success within OPD is encouraging, and it is recommended as a basis for asynchronous information delivery.

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<th>Table 25.2 Mayer’s principles (Mayer, 2011)</th>
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<td>1. <strong>Coherence principle.</strong> People learn better when extraneous words, pictures, and sounds are excluded rather than included.</td>
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<td>2. <strong>Redundancy principle.</strong> People learn better from animation and narration than from animation, narration, and on-screen text.</td>
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<td>3. <strong>Signaling principle.</strong> People learn better when the words include cues about the organization of the presentation.</td>
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<td>4. <strong>Spatial contiguity principle.</strong> People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.</td>
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<td>5. <strong>Temporal contiguity principle.</strong> Learners must have the corresponding words and pictures in working memory simultaneously so as they can make connections between them.</td>
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<td>6. <strong>Segmenting principle.</strong> People learn better when a multimedia lesson is presented in learner-paced segments rather than as a continuous unit.</td>
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<td>7. <strong>Pre-training principle.</strong> People learn better from a multimedia lesson when they know the names and characteristics of the main concepts.</td>
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<td>8. <strong>Modality principle.</strong> People learn better from pictures and narration than from pictures and on-screen text.</td>
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<td>9. <strong>Personalization principle.</strong> People learn better when the words are in conversational style rather than formal style.</td>
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<td>10. <strong>Multimedia principle.</strong> Learners learn better when they receive a verbal and visual representation of the same material; a cognitive process of integration of the material can then occur.</td>
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Communities of practice

Wenger’s Communities of Practice (CoP) (Wenger, 1999) model is one of the most common frameworks through which to understand and evaluate OPD. Most commonly, this has involved informal OPD (Macià & García, 2016). Wenger, Trayner, and de Laat (2011) define CoP as a “learning partnership among people who find it useful to learn from, and with, each other about a particular domain. They use each other’s experience of practice as a learning resource” (p. 9). Characteristics of a CoP include (a) a domain, the knowledge that brings the community together; (b) the community, the people for whom the domain is relevant and the nature of the interaction among the people; and (c) the practice, the knowledge, methods, tools, stories, cases, and documents, which members share and develop together within their community to solve challenges facing the community (Wenger, 1999).

Researchers of informal OPD have previously used this framework to examine concepts such as the nature of online communities, and how knowledge sharing occurs in online environments (Booth, 2012; Crane & Yoong, 2009; Duncan-Howell, 2010). For example, Booth (2012) examined the common practices that support and encourage knowledge sharing within online learning communities for K-12 educators. Using a multiple-case study design, two online communities for teachers were examined. Based on interviews with moderators, community members, and community documentations, the authors reported that knowledge sharing and trust were cultivated and sustained within the community. This was ascribed to the community having a clear purpose and common identity, multiple opportunities for social learning, the active involvement of an experienced and credible moderator, and modeling and enforcement of appropriate online behavior. In the field of APE, various online communities exist where practitioners and researchers meet, interact, and share knowledge, experiences, and frustrations; however, research remains to be conducted on their impact on physical educators. As Booth (2012) notes, we cannot expect productive interactions to occur spontaneously. In APE, researchers should examine what communities are effective, and what characteristics make them so. Wenger’s CoP theory may provide the framework necessary to guide this examination.

In summary, sound education relies on sound learning theory (Haythornthwaite & Andrews, 2011). The above theories are examples that may be used to guide technology-based PD in APE. Applying a theoretical lens to the design and evaluation of technology-based PD will allow us to conceptualize how learning and teaching interactions, facilitated by technology, will affect outcomes. Researchers interested in technology-based PD should seek to not merely state the theoretical construct that underlies the PD, but clearly detail how an underlying theory guides the design, implementation, and evaluation of the PD.

A review of current scholarship: formal OPD and informal OPD

Formal OPD

Online PD has been touted as having the potential to address shortcomings in teacher competence related to the learning of students with disabilities in physical education (Healy et al., 2017). This is unsurprising, as the literature suggests OPD provides a plethora of benefits for the teacher and the teacher-educator, including allowing the learning experience to be made available to teachers at their convenience, the ability for learners to access experts and resources otherwise unavailable, and for the learning experience to be scalable to more people and places than in-person PD (Dede, Ketelhut, Whitehouse, Breit, & McCloskey,
Prior to exploring the research on the topic of OPD, it is worthwhile to remind the reader of the vastness of this topic. Foremost, OPD is professional development, and therefore may vary in its pedagogical design, participants, duration, and purpose. The addition of online further confounds this topic: OPD can vary widely. It can be synchronous (online learning that occurs in real time) or asynchronous (online learning that occurs at different times for different participants). It can also be online or hybrid (a combination of in-person, face-to-face instruction coupled with online learning) and can employ an array of online tools. Extrapolating from the research, therefore, requires close consideration of the OPD design under study. For the purpose of this section, I will maintain a broad definition of OPD, only stipulating that this is a discussion of formal OPD—that is, PD that occurs online that may be mandated, and generally has a fixed duration, curriculum, instructional strategy, and anticipated outcomes (Dede, Eisenkraft, Frumin, & Hartley, 2016).

From the onset, it appears OPD as a means to improve the skills of physical educators in the field of APE is an avenue of research and practice with much promise. However, research examining OPD’s utility, in the field of APE, is in its infancy. The previously mentioned study by Healy and colleagues (2019) involved 44 physical educators in a randomized control trial that sought to determine the effectiveness of an asynchronous OPD course, built upon andragogy theory and Mayer’s principles, to provide physical educators with increased knowledge about, and motivation to implement, a peer-tutoring program. Results revealed that participation in the OPD course contributed to a significant increase in knowledge related to peer tutoring for physical educators who participated in the OPD course compared to the waitlist control group. Furthermore, participation in the OPD course resulted in over 70% ($n = 15$) of teachers reporting that they applied lessons learned from the course to their classes. Although the results suggest OPD has potential for addressing the lack of knowledge among physical education teachers about evidence-based APE practices, the lack of an objective assessment of the teachers’ application of the strategies learned to their classroom, and the absence of a measure of the impact on students, limits the inferences that can be made about OPD’s ultimate goal: student learning. Such limitations were also evident in research by Sato and colleagues (2017b), who examined the perspective of in-service physical educators who participated in two OPD courses. A descriptive–qualitative methodology using an explanatory case study design, utilizing data collected from journal reflections, assignments, and face-to-face interviews, revealed teachers to have an overall positive and meaningful experience of the OPD courses. Several findings emerged which led to recommendations for future OPD development in the field of APE. These included the need for OPD instructors to provide thorough, regular, and timely feedback and for them to be sensitive and responsive to learners’ needs (e.g., flexibility to time schedules and interests) (Sato et al., 2017b). The limited research on formal OPD in APE suggests OPD has potential for bridging the APE knowledge gap for physical educators in an environment with the flexibility, versatility, and scalability that they require. This area remains fertile ground for future research, with a particular emphasis on OPD’s effect on student learning being especially warranted.

With a paucity of research on OPD in the field of APE, we may turn to the literature on OPD for teacher development in other subject areas to guide and inform research on the topic. First, we should look to a number of studies that exemplify quality research designs in this area. For example, researchers should seek to employ experimental designs to examine OPD, as was done by Masters and colleagues (2010) in their study of an OPD program’s effect on the knowledge and instructional practices of fourth grade English language teachers. Research on the effect of OPD in APE should also consider study designs that compare
OPD versus more traditional methods of PD, such as that by Powell and colleagues (2010) who present us with an example where they compared the effect of on-site, face-to-face PD versus remote-coaching OPD on teachers’ use of evidence-based literacy instruction and student learning. Future research on OPD in APE should also contemplate the contentious issues of OPD evaluation. The literature on OPD reveals a variety of methodologies employed to assess the effect of OPD, including teacher knowledge tests (Masters et al., 2010); teacher observation, including video recordings (Powell et al., 2010); teacher and student satisfaction assessment (Fisher et al., 2010); self-reported frequency of desirable instructional practices (Masters, 2010); and student learning tests (Fisher et al., 2010).

Second, the research base provides several characteristics of effective OPD that should inform future research on OPD in APE. Desimone and Garet’s (2015) discussion of evidence-based practices in OPD summarizes five key features that make PD effective. They propose that OPD should include: (1) content focus, learning activities that are focused on subject matter content and how students learn; (2) active learning opportunities, in which learners engage in active learning activities, such as observations of fellow teachers, interaction with other learners, and interaction with student work; (3) coherence, the OPD’s aims, content, and learning activities should be coherent with the teachers’ school curriculum, prior knowledge and beliefs, school and district policies, and their teaching needs; (4) sustained duration, OPD should involve at least 20 hours of contact time, and be provided ongoing throughout the school year; and (5) collective participation, where programs involve groups of teachers with common grades, subject-areas, and PD needs. To conclude, despite a scarcity of research on OPD in APE, the evidence is mounting for the effect of OPD on teachers of other subject areas. This should be encouraging to researchers in APE, and prompt them to replicate exemplary features of study and OPD design, and overcome the shortcomings, as are highlighted above.

Informal online communities and networks

In contrast to formal PD, informal teacher learning (or informal PD) is typically teacher-driven and voluntary, with the duration, content, and desired outcomes dependent upon the teachers’ preferences (Dede et al., 2016). Similar to formal PD, informal PD is also shifting to an online environment. Informal idea sharing between teachers, which previously occurred in school corridors, staff rooms, and during downtime at formal conferences, is now occurring within online SMNs; SMNs are web-based platforms that facilitate the sharing of information, ideas, interests, and other forms of expression via virtual communities and networks. Informal learning through SMNs is now part of daily life for teachers (Haythornwaite, 2009). This offers teachers, including those providing physical education services to students with disabilities, a new avenue through which to improve their teaching effectiveness. To harness the full potential of SMNs to contribute to the ability of physical educators to teach students with disabilities, we must first understand teachers’ current use of these networks and the impact that participation within these communities and networks have on teaching.

Thus far, research on this topic in the field of APE is absent. Research in the field of general physical education teacher development does, however, suggest that SMNs have great promise as a setting for informal OPD. The extant literature suggests physical educators view SMNs favorably, and believe SMNs provide convenient opportunities to connect, collaborate, and exchange information with others in similar professional circumstances (Goodyear, Casey, & Kirk, 2014; Krause, Franks, & Lynch, 2017). For example, Goodyear and
colleagues (2014) examined the communication between physical educators on Twitter and reported SMNs to be effective platforms to refine teachers’ practice by allowing them to receive critical feedback, collaborate with others, and innovate within a virtual group. We can also look outside the field of physical education to the broader field of teacher education. Macià and García’s (2016) review of informal online communities and networks as a source of teacher development provides us with a synthesis of the current body of work that may guide future research related to APE. The review of literature presents the main characteristics of online communities and networks used by teachers for informal PD; the communities and networks studied varied to a great degree including heterogeneity in sample size (from fewer than ten to thousands); topic (ranging from singular thematic focus to generic foci); practice/purposes (from sharing experiences, knowledge, and skills, to peer support); and platforms (ranging from forums to private messaging). The review also provides us with an overview of the research on the processes that foster participation in the communities and networks. Trust is identified as a key construct that influences community participation. Trust can be fostered when participation is based around work-related problems, when peers in the community are perceived as competent, and a sufficient level of digital literacy (Macià & García, 2016).

Other research foci within the literature on the topic of informal PD include the nature of the dialogue that occurs within the online communities and barriers to participation. Despite the frequent assertion that informal OPD has a positive impact on the development of teachers, research has yet to establish this link. As Macià and García (2016) explain, studying the impact of informal online interactions on teaching practices and student learning would require costly and time-consuming approaches. Nevertheless, research must extend beyond understanding the nature of informal OPD participation, to an examination of how such participation affects practice. Future researchers with an interest in informal OPD in APE would be well served to keep this in mind.

**Current trends and issues**

Technology may have the potential to revolutionize PD in the field of APE. Coupled with effective pedagogical design, and relevant content and goals—factors of PD that will always remain fundamental to effective PD—technology may offer the chance to make PD more scalable, cost-effective, flexible, and tailored than ever before. However, in this nascent field, the true scope of technology for APE-based PD has yet to be understood. To inform researchers with an interest in the area, an understanding of emerging technologies and trends in the use of technology for PD is needed. For further reading on the topic, I direct the reader to the New Media Consortiums Horizons reports (Johnson et al., 2016) and textbooks dedicated to this topic (Dede et al., 2016). These resources provide excellent overviews of current trends in technology within education, including PD. Three topics receiving increased attention within the literature and believed to be central to the future of technology for PD are (a) a move towards hybrid learning environments, (b) gamification for teacher development, and (c) technology-based individualized learning experiences.

**A move towards hybrid learning environments**

The sweeping wave of enthusiasm for online learning has left few sectors unaffected. Most commonly, this online learning comes in the form of massive open online courses (MOOCs), or similar style instructivist online courses. The instructor has simply moved
from lecture podium to online; the pedagogical style remains largely teacher centered. Numerous OPD courses for teachers now exist, yet the success of these efforts remains unclear. While the MOOC-style course is beneficial in its scalability and cost-effectiveness, it is largely constrained as a medium for knowledge delivery for the teacher. Many of the core features of effective PD—including active learning, applicability to other school initiatives, and collective participation of teachers from the same school or district (Desimone & Garet, 2015)—are often absent in instructivist, MOOC-like, OPD courses.

The limitations of MOOC-style courses is leading teacher-educators to experiment with hybrid learning environments; these courses involve a combination of in-person, face-to-face instruction coupled with online learning. These environments capitalize on the strengths of both the online and face-to-face environments. Implementation of hybrid teacher development courses are ongoing and emerging research suggests they can hold great value (Curtis & Swenson, 2003; Motteram, 2006; Oliver, Herrington, & Reeves, 2006). For example, Owston, Sinclair, and Wideman (2008) reported on the effectiveness of two one-year hybrid OPD programs for middle school mathematics and science/technology teachers. Teachers engaged in four face-to-face sessions and three eight-week online sessions over the course of a year. Positive effects were reported for teacher attitudes, content knowledge, and their motivation to transform their classroom practice. The effects on students were mixed: whereas students viewed science/technology more favorably after the program, their attitudes towards mathematics became less favorable. The authors noted that the hybrid nature of the OPD reduced the number of face-to-face sessions, and the online portion of the OPD allowed for the teachers to receive ongoing feedback from their peers and expert program facilitators as the teachers applied the OPD’s lesson to their classrooms. Based on the amassing evidence demonstrating the potential of hybrid methods of OPD, those responsibility for the provision of PD to physical educators in the field of APE, and researchers of the topic, should seek to experiment with this emerging trend in PD delivery.

**Gamification for teacher development**

The New Media Consortiums Horizons reports (Johnson et al., 2016) also cites the use of gamification, including virtual simulations, as an emerging trend in education, and its merits for teacher education are receiving increased attention in the literature (Dede et al., 2016). The use of virtual simulations overcomes a challenge that faces providers of PD: the need to engage teachers to actively participate in a task that is often mandated. Furthermore, simulations may help overcome the challenge of making PD relevant and practical. For example, simulated teaching environments, such as SimSchool, Quest2teach, and TeachLivE, allow teachers (pre-service and in-service) to rehearse teaching strategies in a virtual, simulated classroom (Dede et al., 2016). For example, Garland and colleagues (2012) examined how individualized clinical coaching within a virtual reality learning modality (TLE TeachLivE virtual classroom laboratory) affected pre-service teachers’ fidelity of implementation of discrete trial (DDT) teaching when working with a student with autism spectrum disorder. Using a multiple baseline cross participants design, six 15-minute intervention sessions were shown to improve participants’ (n = 4) DDT accuracy on average from 37% to 87%. Such results should inspire researchers in APE to refine and test virtual environments for overcoming challenges in the area of teacher education and development. For example, one challenge teacher educators’ face in APE is how to prepare physical educators with the knowledge and skills to educate students who have unique and rare disabilities. Online simulations may hold promise for providing them with the opportunity to observe and practice the necessary pedagogical strategies to appropriately educate these students.
Technology-based individualized learning experiences

The ability for teachers to self-direct and individualize their learning experiences for their professional needs echoes the principles of accepted learning theories. Traditional PD is limited in its ability to achieve this individualization. Now, with the emergence of technology, learners can enjoy highly tailored learning experiences; technology provides teachers with endless opportunities regarding what, how, with whom, and from whom learning occurs. Mobile and personal technologies, in particular, are driving this individualization of learning revolution (Dede et al., 2016), with teachers having instant access to learning via Skype, YouTube, podcasts, and online communities.

One challenge grappled with by providers of PD is how this learning can be tracked and rewarded; what will be the currency of technology-based PD (Bowen & Thomas, 2014)? Jovanovic and Devedzic (2015) suggest the use of digital badges may bear utility for overcoming this challenge. Digital badges are web-enabled “tokens of accomplishment” that document learning and achievement (O’Byrne, Schenke, Willis, & Hickey, 2015), a feature commonly used for tracking progress in video games. Although yet unproven in research, this technology could offer a novel method of motivating, scaffolding, recognizing, and credentialing learning. For example, teachers could gain digital badges for completing PD courses, attending education workshops, or engaging in online communities of practice. Perhaps researchers of PD in APE can be among the first to demonstrate the utility of this emerging technology.

Possible implications for research and practice

As previously stated, technology-based PD is already commonplace in teacher education, including APE teacher education. Universities and physical education-related organizations and webpages offer courses to in-service physical education teachers focused on teaching students with disabilities. However, the impact of these courses on teacher behavior and student learning remains understudied. This section briefly summarizes the implications that can be drawn from the extant literature on the topic, specifically related to (a) OPD design for practitioners and researchers, (b) research design, and (c) the application of new technologies to overcome unique challenges in the field of APE.

First, providers and researchers of OPD alike should look to the literature to ensure that the OPD program is evidence-based and theoretically sound. For example, several characteristics of OPD have been tested in rigorous randomized control trials (Desimone & Garet, 2015). Providers and researchers of OPD for APE should consider whether these evidence-based factors are reflected in their OPD courses. For example, it should be ensured that OPDs (a) have a clear content focus, (b) provide active learning opportunities, (c) are relatable to the learners’ context and work, (d) is of a suitable duration, and (e) involve collective participation (Desimone & Garet, 2015). Both researchers and practitioners should be aware of these elements of effective OPD that have empirical evidence supporting their usefulness.

Similarly, both practitioners and researchers of OPD in APE should consider the theoretical frameworks that have demonstrated utility for OPD creation, including theories related to the OPD structure (e.g., constructivism) and multimedia being used (e.g., CTML).

Second, there are implications, from the extant literature, related to study design for technology-based PD research in APE. A number of shortcomings of previous research should challenge researchers to advance their research agenda with increasing rigor. For example, research on technology-based PD must have clear research questions that go beyond program evaluation.
(e.g., teacher perceptions of the program). A specific research aim—ideally focused on student learning—should remain the focal point of research on technology-based PD. Furthermore, theoretical constructs with demonstrated utility for underpinning OPD should be used in the design, delivery, and study of OPD. These include traditional learning theories such as social constructivism and andragogy, and more digital-age theories, such as connectivism and heutagogy. For us in the field of APE to capitalize on technology-based PD, and utilize it to its full capacity, we must build and extend upon what the literature and theories tell us about learning in the digital age.

Finally, researchers and practitioners in the field of APE should not shy away from embracing the emerging technologies that have yet to be proven for teacher development, and research their merit for overcoming challenges related to PD for APE. Emerging technologies, such as virtual environments and augmented realities, may have untold applications for the field of APE. Similarly, there has been a call for the use of a variety of mobile applications in APE (Cummiskey, 2011; Krause & Taliaferro, 2015); the use of a variety of mobile applications for the support and development of physical educators in APE is an area ripe for research.

A summary of key points

1. Technology-based PD solutions in APE are warranted due to the lack of APE knowledge and skills among physical educators and the inadequacies of traditional PD modalities.
2. A range of theories and models exist that may (and should) underpin OPD in APE, including constructivism, andragogy, theories of multimedia learning, and Wenger’s model of Communities of Practice.
3. Formal OPD shows great promise for bridging the knowledge gap among physical educators related to APE; its benefits include allowing the learning experience to be made available to teachers at their convenience, the ability for learners to access experts and resources otherwise unavailable, and for the learning experience to be scalable to more people and places than traditional, in-person PD.
4. Informal teacher learning (or informal PD) is typically teacher driven and voluntary, with the duration, content, and desired outcomes dependent upon the teacher’s preferences; this type of PD is increasingly occurring in an online environment, including on SMNs.
5. Despite the popularity and pervasiveness of informal online communities related to APE, their effect on physical educators remains unstudied. Future research in this area can be guided by research on informal OPD in the broader field of physical education and general teacher development.
6. Hybrid courses are increasingly favored in teacher education and involve a combination of in-person, face-to-face instruction coupled with online learning. The impact of this modality of teacher education in the field of APE remains to be studied.
7. Providers and researchers of OPD for APE should ensure their courses are evidence-based and theoretically sound; for example, OPDs should: (a) have a clear content focus, (b) provide active learning opportunities, (c) be relatable to the learners’ context and work, (d) be of a suitable duration, and (e) involve collective participation.
8. Several weakness permeate the literature on OPD including a lack of focus on student learning, and a lack of a theoretically sound underpinning; research of technology-based PD in APE should work to overcome these limitations.
9. Researchers and practitioners in the field of APE should embrace the emerging technologies (e.g., virtual and augmented realities, digital badges, mobile applications) that have yet to be proven for teacher development, and research their merit for overcoming challenges related to PD in APE.

**Reflective questions**

1. What factors have led to the need for technology-based PD solution in the field of APE?
2. Contrast formal and informal PD, and explain how both can be fostered in an online environment.
3. Discuss the importance of applying a theoretical framework to the design and study of an OPD course in the field of APE.
4. Compare the advantages and disadvantages of the following PD modalities: traditional (face-to-face), online PD, and hybrid PD.
5. The lack of focus on student learning is a common weakness in the study of OPD; what are some ways in which this limitation can be overcome?
6. Various emergent technologies (e.g., virtual and augmented reality technologies) have yet to be studied in the field of technology-based PD in APE. Suggest one way you would envision one of these technologies being used to provide PD to physical educators in the field of APE.

**References**


Technology-based professional development


