Supporting Change in Teacher Practice: Examining Shifts of Teachers' Professional Development Preferences and Needs for Technology Integration

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Studies have shown that when K-12 school districts implement a new technology initiative, it is not always accompanied by effective teacher professional development (PD). Many teachers have indicated that effective technology PD experiences should incorporate their individual PD needs. The authors surveyed technology-using K-12 teachers at two points (2009 and 2015) to examine what they perceived as useful technology PD with regard to content and format. Specifically, since technology changes quickly, we sought to examine whether there were any changes to what teachers perceived as useful content and format for technology PD. Over 6 years, more teachers reported that personalized technology PD tended to be more effective. Although some things remained consistent regarding content (e.g., utilizing Web 2.0 resources continued to be preferred PD content by teachers in both years), other content preferences changed (e.g., mobile applications and pedagogical-focused knowledge and skills). Regarding PD format, the authors found that in 2015 more teachers perceived online and face-to-face workshops, personal learning networks, and conferences as useful. Finally, teacher-led PD and in-class support were suggested as useful by more teachers in 2015. Thus, more personalized, sustained, and situated PD is needed to effectively support K-12 teacher technology integration.

The fast-changing nature and prevalence of technology in society has had a substantial impact on many professional fields, such as journalism and medicine. Likewise, changes in technology have also impacted K-12 education and how teachers and students learn. Digital literacy has become an essential skill stakeholders have demanded be incorporated in K-12 education (U.S. Department of Education [U.S. DOE], 2016).

Technology has been deemed essential for potential benefits to student learning as well as for preparing students for an increasingly digital society (Project Tomorrow, 2017). For instance, studies done by Powell and Mason (2013) and Shin, Sutherland, Norris, and Soloway (2012) have shown that using technology to support students' learning processes can lead to improved learning outcomes. With the increase of technology initiatives in K-12 education, stakeholders expect teachers to integrate technology effectively and prepare students with essential digital literacy skills for their future careers (U.S. DOE, 2016).

Nevertheless, teachers' ineffective technology integration in classrooms has continually been identified as a critical unresolved issue (OECD, 2015; U.S. DOE, 2014). Despite recent increases in teacher technology use, it is often not utilized to its fullest potential to support teaching and learning (Smolin & Lawless, 2011; U.S. DOE, 2016). Several reports have shown that teachers primarily use technology to support administrative purposes as opposed to instructional purposes that leverage students' learning processes and outcomes (Hanover Research Council, 2014; Project Tomorrow, 2008). This ineffective technology integration could be due, in part, to ineffective teacher professional development (PD; Duran, Brunvand, Ellsworth, & Sendag, 2012; Lawless & Pellegrino, 2007; Project Tomorrow, 2013).

Effective teacher PD should help teachers adopt and integrate technology to change their teaching practices and further support student learning (Lawless & Pellegrino, 2007). In order to establish effective teacher PD, the content and formats that make PD programs effective to address teachers' professional learning needs must be identified (Cosmah & Saine, 2013; Ertmer & Ottenbreit-Leftwich, 2010; Lawless & Pellegrino, 2007).

Even though features of effective PD for technology integration have been identified in research studies (e.g., O'Hara, Pritchard, Huang, & Pella, 2013; Smolin & Lawless, 2011), teachers continue to report technology PD as not effective to support their use of technology in classrooms (Bill & Melinda Gates Foundation, 2014; U.S. DOE, 2016). If teachers do not think a PD is useful and supportive to address their professional learning needs, they are less likely to implement the technology integration ideas into their practices (Lawless & Pellegrino, 2007; Potter & Rockinson-Szapkiw, 2012). However, teachers have different needs and prefer different kinds of PD support (Martin, Miyashiro & Baird, 2015), keeping in mind that their available technology resources, such as digital devices, learning management systems, online curriculum, and technology-related policies, are constantly changing. Therefore, giving teachers choice and more options in PD, in terms of both content (what teachers learn during PD) and format (how PD is delivered), is more likely to support teachers' use of technology in classrooms effectively.

Since technology continues to change rapidly, teacher educators need to understand how teachers' preferences for both content and format change over time. In this study, we examined teachers' preferences for technology PD content and format over a period of technology change (2009-2015). By identifying shifts in teachers' PD preferences and needs for technology integration PD, stakeholders may recognize the importance of continually requesting teachers to identify areas of need and preference. Using this information, stakeholders could provide effective PD by directly addressing teachers' needs and providing support for teachers' technology integration practices.

What Makes Teacher Technology PD Effective?

Researchers have identified characteristics of effective teacher PD for technology integration. Effective technology PD should be sustained, incorporate authentic experiences situated within school contexts, and offer various levels of support.

Technology PD Should Be Sustained

Studies have shown that teachers perceive long-term and sustained technology PD support as being effective, as opposed to single, standalone PD trainings (Gerard, Varma, Corliss & Linn, 2011; Kopcha, 2012; Walkers, Recker, Robertshaw, Osen, & Leary, 2011). The Center for Public Education (2013) argued that PD programs as one-time interventions with short durations are unlikely to yield significant effects on changes in teachers' practices (Duran et al., 2012; Smolin & Lawless, 2011) and students' learning outcomes (Lawless & Pellegrino, 2007).

Some studies have shown positive effects of sustained technology PD on teachers' technology competencies. Duran and colleagues (2012) examined the impact of sustained participation in PD on K-12 teachers' use of Wikis in their classrooms. They found that teachers' sustained participation in PD had a significant impact on their technology integration skills, confidence, and practices. In addition, the teachers reported valuing the ongoing and follow-up support provided by the PD facilitators. Teachers should be given sufficient time and opportunities to implement what they have learned from PD with follow-up support for implementation into practice (Wells, 2007).

Situated in Authentic Experiences

Researchers have argued that teacher PD should include authentic PD activities and learning environments (Kopcha, 2012; O'Hara et al., 2013). Authentic learning experiences usually include hands-on practice and pedagogy-focused learning content and are situated in school contexts. Studies have shown that when teachers engage in authentic PD experiences, their knowledge and skills, as well as their teaching practices have been more likely to change (Gulamhussein, 2013), particularly for technology integration.

Hands-On. As one example of authentic learning PD experiences, O'Hara et al. (2013) provided 16 teachers a technology PD program with demonstrations of experts using technology in language teaching strategies, technology-enhanced curriculum design, and instructional practices. The teachers also had opportunities to share, discuss, and reflect on their teaching practices with other teachers and experts after applying what they learned from the PD in their classrooms. The teachers indicated that the hands-on activities encouraged them to change their technology integration practices.

In another longitudinal teacher PD study, Mouza (2011) found that teachers' technology competencies were built through hands-on experiences where they designed and implemented technology-enhanced instruction during their technology PD sessions. She found that teachers not only developed technology integration knowledge, but positively changed their technology integration practices and attitudes. To make PD effective and support teacher change in technology integration practices, teachers should be provided with time as well as opportunities to play with and learn about newly introduced technology (Potter & Rockinson-Szapkiw, 2012).

Pedagogically Focused. Other researchers have emphasized the importance of focusing on pedagogical aspects of technology integration during PD sessions (Ertmer &

Ottenbreit-Leftwich, 2013; Hew & Brush, 2007; Inan, Lowther, Ross, & Strahl, 2010; Liu, 2013). For instance, Liu (2013) set up a technology PD in an elementary school in Taiwan and found that teachers perceived the PD effective because they learned how to teach with certain technology tools in their classrooms along with various instructional strategies. The study results showed that when technology PD was pedagogically focused, teachers shifted their technology teaching practices from teacher centered to student centered. Also, scholars have stressed the importance of teaching teachers how to use technology in pedagogical ways in their specific content areas along with instructional strategies linked to their teaching practices (Ertmer & Ottenbreit-Leftwich, 2013; Hew & Brush, 2007; Lowther, Strahl, Inan & Ross, 2008).

Situated. Situating technology PD in a school's context makes teachers' PD experiences more authentic and effective (Kopcha, 2012). Studies investigating teachers' technology integration practices have suggested that when PD was situated in local schools and classrooms, teachers' individual needs for technology use were more likely to be addressed and thus, more likely to impact their teaching practices (Hennessy & London, 2013; Vrasidas, 2015). When technology PD is offered in their own school contexts, teachers have access to currently available technology resources and are familiar with their instructional environments. Teachers are better able to visualize how technology can be used with their own resources when the PD is situated in their school contexts (Kopcha, 2012; Mouza, 2011).

Various Levels of Support

To support the best practices of sustained technology PD with authentic experiences, various levels of support need to be provided to teachers. Ongoing PD support can be categorized in three different levels: personalized support, peer and community support, and system support.

Personalized Support. Researchers have specified that to motivate teachers to participate in PD programs, the content should be personalized and based on teachers' individual learning needs (An & Reigeluth, 2012; Cosmah & Saine, 2013; Kopcha, 2012; O'Hara et al., 2013). Personalization can be executed through the content provided and how PD is delivered. To improve the effectiveness of teachers' technology integration, Hixon and Buckenmeyer (2009) urged that PD designers identify which PD approaches are appropriate for teachers at different stages of their development of technology integration and personalize PD for their specific needs (e.g., modeling for novice teachers).

One method for personalizing technology PD has been through a mentorship or a coaching model (An & Reigeluth, 2012; Beglau et al., 2011; Kopcha, 2012). In these models, the coach and mentor have typically been teachers skilled in technology integration. They work individually with teachers to provide support through curriculum planning, observations, reflection, demonstrations, and in-class troubleshooting (Borko, Jacobs, Eiteljorg, & Pittman, 2008; Gulamhussein, 2013).

Community Support. The next level of technology PD support has come from learning communities. A learning community is usually a form of PD that consists of a small group of teachers having regular meetings to share experiences and expertise for improving teaching skills and student learning performance (Newmann & Wehlage, 1995).

Technology learning communities can exist within or outside the local school context, onsite, or in online environments. Blitz (2013) and Borko and colleagues (2008) recommended joining online learning communities as an effective PD structure for

teachers to receive community support. Teachers can self-select from many online learning communities that focus on different content and meet at different times (Curwood, 2011). Many teachers have also reported that the value of online learning communities comes from the interaction with other teachers or professionals to foster their growth with technology integration (Gerard et al., 2011; O'Hara et al., 2013; Potter & Rockinson-Szakiw, 2012).

When learning communities are formed within the school context for teacher technology PD, Kopcha (2012) recommended that a teacher leader or technology expert guide activities to make PD more effective. He further suggested that prior to establishing a community of practice, PD developers should have well-prepared activities and support to help teachers change their beliefs and attitudes toward technology. Because teachers tend to show less motivation and interaction in online learning environments, Blitz (2013) recommended that effective online or hybrid PD formats should utilize experienced facilitators moderating group interaction and collaboration. Overall, building professional learning communities as a form of technology PD can provide a space for teachers' active participation and continuous personalized support.

System Support. Researchers have also recommended system support for effective technology PD (O'Hara et al., 2013; Somekh, 2008). System support focuses on the resources available at the administrative, school, and district level to support technology integration (such as technology resources, infrastructure, technology-related policies, and school culture).

Hanover Research Council (2014) stated that when teachers have limited access to technology resources, they are more likely to discontinue technology use and less likely to have a meaningful change in their teaching pedagogies. Ertmer and Ottenbreit-Leftwich (2010) suggested that effective PD needs to evolve from a shared vision of best practices with technology integration. This vision should be built by both administration and teachers.

In addition to a shared vision, administrations need to provide sufficient technology resources and supportive infrastructure, as well as help establish a school culture and environment where innovations and experiments with technology use are encouraged (Ertmer & Ottenbreit-Leftwich, 2010; Somekh, 2008).

O'Hara et al. (2013) argued that the alignment with district visions and goals was critical to making a technology PD program effective. When district visions and goals are aligned with PD content, that PD content could better support teachers' teaching performance evaluated by schools.

However, with technology quickly changing, are teachers changing their preferences for PD content and format at the same rate? Considering teachers' technology integration processes, we would like to better understand how the pace of technology changes in education are aligned with the pace of change in teachers' technology PD preferences and needs. For instance, as more teachers become comfortable with technology, are they more willing to join online communities? As technology becomes updated and easier to use, are teachers changing their preferences for what and how they learn from their technology PD?

To find out whether teachers' technology PD needs can be effectively addressed in the latest PD programs, we investigated the changes in teachers' technology PD needs and perceptions of effective PD programs over a 6-year time span. The results inform better support of teachers' technology integration practices.

Methods

The purpose of this study was to examine K-12 technology-using teachers' perceptions and needs of PD for technology integration before and after 6 years' time. We used a cross-sectional study design (as described by Cohen, Manion & Morrison, 2011) with a two-phase survey that relied on a questionnaire and follow-up semistructured interviews (Creswell, 2002) in each phase. Phase 1 was completed in 2009, and Phase 2 was completed in 2015.

With the collected quantitative and qualitative data, we examined whether shifts had or had not occurred regarding teachers' perceived useful PD formats and content for technology integration. We examined both questionnaire responses and follow-up interview data collected in both study phases to address the following two research questions:

1. What are the content and formats of technology PD that K-12 teachers perceived useful for their technology integration practices?
2. What shifts have or have not occurred regarding teachers' perceived useful PD and their PD needs for technology integration in a 6-year span of time?

Participants

The participants in the two phases were recruited via e-mail lists from the International Society for Technology in Education (ISTE) and its affiliates who share a vision of supporting K-12 teachers' use of technology. Therefore, the participants we recruited were K-12 teachers who were interested in knowing more about technology integration or were already integrating technology to some extent.

Respondents to the questionnaires were self-identified technology-using teachers, mainly between third and 12th grade, across all subject areas, with a wide range of experiences teaching and teaching with technology. Over half the participants (60% in 2009 and 67% in 2015) had more than 10 years of teaching experience in K-12 settings. In each study phase, a question was integrated in the questionnaire asking about participants' willingness to participate in a follow-up interview. All interview participants were voluntary, were interviewed based on their availability, and were spread across different states and school districts across the country.

Phase 1. In 2009, of the 426 teachers who initiated the questionnaire, 245 teachers were selected because they completed all questions (including the open-ended question related to their previous technology-related PD experiences). Among the 108 teachers who volunteered to participate in the follow-up interviews in 2009, 28 teachers were purposefully selected and interviewed, representing a range of subject areas and grade levels.

Phase 2. The respondents to the questionnaire for Phase 2 were recruited through the same process and lists as Phase 1, but were not necessarily the same individuals. However, their responses represent teachers' perceptions from the same educational technology organizations. In 2015, of the 384 teachers that initiated the questionnaire, 175 completed it. Among the 175 teachers, 71 indicated being willing to participate in a follow-up interview, and 16 were purposely selected (representing a range of subject areas and grade levels) to be interviewed in fall 2015. Three of the 16 interviewees were also interview participants from Phase 1.

Data Sources

This study examined both questionnaire and follow-up interview data collected in 2009 (Phase 1) and 2015 (Phase 2).

Questionnaire. In the 2009 questionnaire, the questions related to technology PD were part of a larger study (Ottenbreit-Leftwich et al., 2012). The questionnaire consisted of 23 open- and closed-ended questions in an online format. For the purposes of this study, we analyzed responses to one open-ended question from the questionnaire: "Did you ever participate in a useful technology PD activity/project as a teacher? If so, please briefly describe that experience." Teacher responses ranged from specific technology interests (e.g., Web 2.0 resources) to specific format requests (e.g., workshops, conferences).

When constructing the 2015 questionnaire, we intended to understand what had changed since 2009. We wanted to know more details on specific PD content and formats that teachers continued to perceive as useful. The result was a 2015 questionnaire that contained four main questions, one close-ended and three open-ended, asking about teachers' previous technology PD experiences and specifically what PD content and formats they found useful for their technology integration practice. These questions were built from the coded responses from Phase 1. The 2015 questionnaire can be found in Appendix A.

The numbers of participants and responses in both 2009 and 2015 questionnaires are presented in Table 1. Vague or blank responses were coded as "N/A" and excluded from the total valid responses for counts and percentages of teachers' perceptions of useful PD. Some of the responses specifically mentioned format, but were vague on the content or vice versa.

Table 1
Participants With Valid Responses in 2009 and 2015 Questionnaires

Category	2009 Questionnaire	2015 Questionnaire
Total Participants	245	175
Valid responses coded for PD format	216 (88%)	167 (95%)
Valid responses coded for PD content	146 (60%)	146 (83%)

Interviews. The responses to the questionnaire were supplemented by follow-up interviews in both 2009 and 2015 with selected elementary and secondary teachers. The semistructured interviews were conducted with an intentional sample of teachers that spanned grade levels and subject areas, each of whom had previously completed the 2009 or 2015 questionnaire. Interviews in both phases included open-ended questions asking interviewees what PD experiences were most useful and important for them as professionals, as well as asking for descriptions of their ideal technology PD content and format.

Since the majority of teachers participating in the 2015 interviews had more than 6 years of teaching experiences in K-12, we also asked teachers' perspectives and reasoning on

shifts in technology PD and teachers' PD needs identified by the questionnaires. Therefore, one open-ended question was added in the 2015 interview (see Appendix B) asking teachers to describe why they thought changes in teachers' perceived useful PD formats and content had or had not shifted when provided with a table of the 2009 and 2015 questionnaire findings.

Data Collection

The Phase 1 questionnaire was distributed in 2009 to the electronic mailing lists of over 60 educational technology organizations, including ISTE, its state affiliates, and its special interest groups. Respondents to the 2009 questionnaire who agreed to participate in the follow-up interview were contacted via email to set up an interview time. All interviews were conducted over the phone or online. The same approach was used for the 2015 Phase 2 interviewees.

Data Analysis

This study primarily contained qualitative data from the open-ended questions in questionnaires and interviews from the two survey phases. To answer the research questions, a content analysis (Patton, 2002) was utilized for the Phase 1 and Phase 2 data sets, both the questionnaires and the follow-up interviews.

An inductive approach of content analysis (White & Marsh, 2006) was initialized by reading through the 2009 questionnaire and interview responses by one of the authors. By identifying key words and sentences that corresponded to the research questions, an initial coding scheme was established with several codes (e.g., conferences and workshops) and categories (e.g., online, face-to-face, blended PD format). After the 2015 questionnaire data were collected, all the data were reviewed again by two of the authors.

The initial 2009 coding scheme was revised and finalized to accommodate for additional themes identified in 2015. With the finalized coding scheme, two researchers individually coded all questionnaire data again and went through each coded item to reach consensus (as recommended in Saldana, 2015). We calculated the frequency of each code under the categories with regard to teachers' perceptions of useful content and formats based on their PD experiences. We used relative frequencies (i.e., proportions) and rankings to examine changes in the frequency distributions of teachers' perceived useful PD formats and content between 2009 and 2015 to identify whether shifts had or had not occurred. For instance, we identified face-to-face workshops as persistently perceived useful over 6 years because it was the top response for perceived useful PD format in both years, even though the number changed from 41% ($n = 89$) to 72% ($n = 120$).

For the interview data, two of the authors individually analyzed all the interview data of two study phases and documented potential themes corresponding to research questions with quotes from transcriptions in a spreadsheet. The themes were categorized by effective and ineffective formats and content, as well as teachers' reasoning on the shift of technology PD over 6 years. Finally, in a meeting the two authors compared and discussed the notes and potential themes they documented, deciding how each interview quote aligned with each theme, until consensus was reached.

To achieve rigor for the data analysis process and improve the trustworthiness of the findings of this research, we used triangulation of data sources (Merriam, 2009) and triangulating analysts (Patton, 2002). We analyzed teachers' responses in questionnaires and follow-up interviews and compared our coded items and themes to ensure we reached

consensus on capturing teachers' perceptions and PD needs accurately. When there was an inconsistency with codes and themes, we discussed it until we reached consensus before moving to the next response.

Limitations

Since the questionnaire was distributed to voluntary organizations with members who possessed some motivation to join an educational technology professional organization, there may be some inherent bias toward more-motivated technology-using teachers. Recruiting the same number of teachers from the same group of participants across two research phases separated by 6 years was also challenging. Moreover, many teachers self-identified their grade levels as being across both elementary and secondary. Therefore, we reported the findings of K-12 teachers, in general, instead of differentiating perceptions and needs of teachers by different grade levels. Despite these limitations, efforts were made to sample a wide range of teachers across subject areas and grade levels in both the questionnaire and the interviews to minimize errors or bias.

Almost all participants were recruited through their educational technology organizations in both study phases, and only those who were current K-12 technology-using teachers were included in the study. This approach helped address perceptions and needs of teachers based on their technology PD experiences in practice. Yet, since the technology PD K-12 teachers received may have varied between districts, the findings of teachers' perceptions in this study were not meant to be generalized to the broader K-12 technology-using teacher population regarding effective technology PD.

Results and Discussion – PD Content

The data were collected in two study phases (2009, 2015). We established themes regarding PD formats and content teachers perceived useful in each phase. Then we compared results between the phases to identity if shifts occurred over the 6-year period. Table 2 lists the effective technology PD formats and content that persisted and shifted as perceived by teachers.

Table 2
Persisted and Shifted Teacher Perceptions of Useful Technology PD Content and Format

Teachers' perceived useful PD content	
Persisted	Shifted
Web 2.0 instructional resources	More variety of mobile applications
Differentiated and personalized	More pedagogy-focused knowledge and skills
Teachers' perceived useful PD format	
Persisted	Shifted
Face-to-face workshops	Online PD (workshops and professional learning networks)
Face-to-face conferences	Teacher-led PD
	In-class PD support

PD Content Persistently Perceived Useful by Teachers

Web 2.0 Instructional Resources. In both 2009 and 2015, Web 2.0 resources were reported as one of the top five useful technology PD content perceived by teachers (see Table 3). In 2009, one elementary teacher explained that PD content needed to focus on Web 2.0 technologies because of a wide variety of available resources: "There are tons out there on the Internet. Anything you want is out there." Another teacher in a 2015 interview pointed out that "getting students engaged, you really need Web 2.0 [resources]." Over a 6-year time span, teachers consistently saw the value of Web 2.0 resources and recognized the possibilities of integrating those resources into their teaching practices.

Table 3
Top Five Teachers' Perceived Useful Technology PD Content in Questionnaires

Phase 1 (in 2009)	Number of Teachers	Phase 2 (in 2015)	Number of Teachers
Technological Knowledge and Skills		Technological Knowledge and Skills	
Interactive whiteboards	28 (19%)	General Web 2.0 resources	41 (28%)
Web design and development	23 (16%)	Mobile applications (apps)	35 (24%)
Learning management systems	23 (16%)	Content specific resources	30 (21%)
General Web 2.0 resources	22 (15%)	Learning management systems	25 (17%)
Production resources	15 (10%)	-	
-		Pedagogical knowledge and skills	
-		Instructional approaches & strategies with technology	25 (17%)

Note. The total number of questionnaire respondents in 2009 was 245; 60% of teachers (*n* = 146) responded with clear responses for PD content. The total number of questionnaire respondents in 2015 was 175; 83% of teachers (*n* = 146) responded with clear responses for PD content.

Typically, Web 2.0 resources are easy to use and/or can be freely accessed on most devices (Solomon & Schrum, 2014). Web 2.0 resources address common barriers associated with teachers' use of technology such as a lack of availability of technology resources (Hew & Brush, 2007; Pittman & Gaines, 2015) and a lack of time for technology PD (Hechter & Vermette, 2013). The accessibility and variety of Web 2.0 resources may reduce those barriers to technology use (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). Because Web 2.0 resources contain flexibility and variety, focusing on this as PD

content may be easier to accommodate for a wide range of subject areas, thus providing relevant PD content to teachers with different learning needs.

Differentiated and Personalized PD Content. In both study phases, many teachers expressed a need for personalized PD, learning about specific technology tools that were relevant to their skill-level and classroom. Technology PD content needs to be differentiated because there is

> ...a wide range of technology comfortability and knowledge among teachers...some need to know how to create a course in iTunes U, others either already have one or are such beginners in technology, that it would not be useful for them. (Interview, 2009)

In the 2015 interviews, five teachers mentioned that the least useful PD content was the one-size-fits-all approach: "They [the school districts] never tried to find out at what level their staff was in educational technologies." Other teachers emphasized that PD content needs to accommodate for teachers' needs, interests, and levels by providing choices to teachers, as opposed to having fixed learning programs focusing on learning district-selected technology tools.

Teachers in the 2015 interviews confirmed that they were provided with more technology PD opportunities compared to 2009. Although the quantity of technology PD experiences seemed to increase over 6 years, teachers in both 2009 and 2015 described that differentiation was absent from their previous technology PD experiences.

A few teachers in 2015 reported that they were still being offered one-size-fits-all PD and irrelevant PD content for technology integration in their school districts. When designing technology PD, knowing teachers' existing technology-related knowledge and skills, as well as their instructional needs, should be the first step of technology PD design. Some researchers have recommended involving teachers in the PD design and decision-making processes surrounding the creation of technology PD programs to better address individual needs (Rybakova & Witte, 2016; Tondeur, Pareja Roblin, van Braak, Voogt, & Prestridge, 2017).

Other trending informal PD (e.g., EdCamps) and online PD (e.g., Professional Learning Networks) have been suggested to provide a variety of learning content where teachers can self-select appropriate PD based on their interests, levels, and needs (Carpenter & Linton, 2016; Trust, Krutka, & Carpenter, 2016). When teachers are provided the autonomy to select their PD content, they report being more motivated and engaged in technology PD activities (Rybakova & Witte, 2016).

Shifts in PD Content Perceived Useful by Teachers

More Variety of PD for Mobile Applications. Over a 6-year period, teachers' reported needs regarding PD content shifted to needing a greater variety of sessions on mobile applications. In the 2009 questionnaire, only two teachers reported learning about mobile applications during technology PD as useful. In the 2015 questionnaire, it was the second most preferred PD content by teachers ($n = 35$, 24%; see Table 3). Teachers in 2015 interviews indicated having this PD need because they were given mobile devices and were asked to use them in their school districts: "We had gotten class sets of iPads. So, during one of our preps, we'd go to a session where [PD facilitators] would introduce new apps or different things that you could do with the iPads. That was really helpful." In addition, one teacher explained that learning a variety of mobile apps was useful because of "new

applications and ways to deliver information…make it more exciting and interactive with students." The results showed that teachers' perceived useful PD content shifted toward learning more about a variety of mobile applications over 6 years.

The shift of teachers' needs focusing on mobile apps might be due to increasing adoption rates of 1:1 or bring-your-own-device (BYOD) initiatives in school districts that make technology resources more accessible to teachers. A nationwide survey of 2,431 school districts (Project Tomorrow, 2013) identified mobile devices in K-12 education as a growing trend.

Despite the rapidly changing technology hardware and software in our society, we found that teachers' change in needs and preferences of PD content for technology integration was mainly based on the technology resources available in their schools. PD designers should consider what PD content can best support and align with school technology plans and policies by utilizing available technology resources when they develop technology PD for teachers.

More Pedagogically Focused Knowledge and Skills for Technology Integration. There was an increasing desire by teachers to go beyond learning how to use technology tools in order to gain pedagogy-related knowledge on how to integrate these tools in their curriculum. The percentage of teachers having this PD preference increased from 1% ($n = 2$) to 17% ($n = 25$) on the questionnaire responses over 6 years.

Teachers in the 2015 questionnaire reported valuing PD content that focused on using instructional approaches with technology (e.g., "project-based learning, student-centered instruction and flipped classrooms") to teach specific learning content in their curricula. One teacher explained in an interview that "learning how to use technology without learning about pedagogy is worthless. Teachers should learn about content and pedagogy first, then technology. They go hand in hand" (Interview, 2015).

More teachers in 2015 wanted to learn not only about how to operate technology tools, but how to use them for teaching and learning purposes. This finding connects to the importance of the integration of content, pedagogy, and technology in teachers' technology integration practices (Angeli & Valanides, 2009; Ertmer & Ottenbreit-Leftwich, 2013). In a study on technology-oriented PD enactments, Walkers and colleagues (2011) found that teachers valued both technology-focused and pedagogy-focused PD activities.

Mishra and Koehler (2006) also stated that by learning technology while simultaneously designing technology-enhanced lessons for their classrooms, teachers were able to learn both pedagogical and technical knowledge. Teachers tend to have more uses of technology if they can see the pedagogical value (Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010).

Results and Discussion – PD Format

Teachers' PD experiences were classified as one of three categories of PD formats – face-to-face, online, and blended PD. Under each of these three categories, various PD delivery approaches emerged from the data (e.g., workshops and degrees). The top five useful PD formats and the most important PD features in 2009 and 2015 are presented in Table 4.

Table 4
Top Five Useful Technology PD Formats and Features Perceived by Teachers

Teachers' Perceived Useful PD Formats	Phase 1 (In 2009) No. of Teachers	Teachers' Perceived Useful PD Formats	Phase 2 (In 2015) No. of Teachers
Face-to-face		Face-to-face	
Workshops	89 (41%)	Workshops	120 (72%)
Non-degree programs	60 (28%)	Conferences	91 (54%)
Conferences	40 (16%)	Summer PD	80 (48%)
Degree programs	19 (9%)	Online	
Summer PD	12 (6%)	Online workshop	113 (68%)
		Personal learning networks	102 (61%)
Features		Features	
Hands-on opportunities	23 (11%)	In-class support	52 (31%)
		Hands-on opportunities	42 (25%)

Face-to-Face Workshops. Over the 6-year period, teachers reported face-to-face workshops as a useful technology PD delivery approach. Face-to-face workshops were deemed as useful because of the (a) sustained support and (b) hands-on practice opportunities.PD Formats Persistently Perceived Useful

Teachers in both years requested sustained face-to-face PD workshops for supporting their technology use. In other words, face-to-face workshops could be segmented and delivered over a continuous period of time. An elementary school teacher in 2015 explained, "Break it up over – a few seminar trainings, couple of hours, every month or a couple of weeks, depending on how it would best work out in the community." Teachers went on to describe that useful PD should also follow up with teachers: "Come back a couple of weeks later and ask 'where do you need help?'" To make face-to-face PD workshops successful, teachers should be provided with learning opportunities and support in a sustained manner.

When teachers reported face-to-face workshops as a useful PD delivery approach, many highlighted the importance of embedding hands-on opportunities in workshops (see Table 4). One teacher in 2009 described how critical hands-on practice time was to the success of technology PD workshops: "Many PD classes focus on bells and whistles, and if a teacher does not have the time to apply and play with what they learn, nothing transfers." Many teachers in 2015 expressed the same idea that being able to "play around [with technology] on their own" in face-to-face workshops was perceived as critical.

The 2015 results suggested that teachers' needs of having hands-on opportunities in face-to-face PD workshops increased from 11% ($n = 23$) to 25% ($n = 42$). This might be because of an increase in accessible resources and a change of policies and expectations for teacher

technology integration in school districts. Along with rapid-changing technology and initiatives, teachers have consistently reported a need for developing related knowledge and skills (U.S. DOE, 2016). Teachers in our study described the importance of seeing an instructor demonstrate the technology they were expected to integrate in their classrooms and trying it themselves in face-to-face workshops.

Researchers have indicated that showing teachers different ways and strategies of using technology with examples (Borko et al., 2008) with authentic PD learning experiences (Hixon & Buckenmeyer, 2009; Mouza, 2011; O'Hara et al., 2013) can effectively support teachers' technology use in practice. Moreover, situating technology PD in local school contexts allow teachers to learn about technology hardware and software available to them, as well as to fulfill instructional goals of the initiatives in their specific districts (Kopcha, 2012; Mouza, 2011).

A long-term PD package of face-to-face workshops provided by local schools might be an option to make PD more useful for teachers. A PD workshop package should embed sufficient play and trial time of technology use during workshops and regular check-in and problem-solving time with teachers after workshops.

Face-to-Face Conferences. Attending conferences was another face-to-face PD delivery approach that was persistently perceived useful by teachers in 2009 (n = 40, 16%) and 2015 (n = 91, 54%) questionnaire responses (see Table 4). An increase of perceived usefulness of attending conferences was also recognized in teacher interviews from 2009 to 2015. In the questionnaires from the two study phases, teachers described attending conferences as useful because they "got exposed to a variety of content and strategies" to integrate into their curriculum and had the "flexibilities and choices" to directly address their individual interests and needs.

In both 2009 and 2015 interviews, teachers described appreciating the opportunities to network and interact with other teachers and technology experts at conferences. A secondary English teacher described the value of attending conferences in the 2015 interview:

> When I first started going to conferences, mainly it was exposure to seeing what's out there and what people are doing that you don't see in your own building …. It was the opportunity to have dialogue with these people.

According to teachers' perceptions of attending conferences for their PD, the features that make technology conferences useful included the varieties of topics, efficient learning experiences, and plenty of networking opportunities. Although teachers did not attend conferences as frequently as workshops, they seemed to be more excited and inspired to learn about technology integration because of those face-to-face conference features. In 2009, teachers reported attending annual large-scale national and statewide conferences (e.g., ISTE), while in 2015, more teachers reported having useful PD experiences at small-scale conferences held by school districts. By offering more local technology conferences, more teachers may be able to attend without the limitations of attending national conferences (e.g., funding from schools or schedule conflicts).

Since 2010, Edcamps have been a fast-growing delivery approach of teacher PD (e.g., Carpenter & Linton, 2016; Swanson et al., 2014). Edcamps are a voluntary-based, participant-driven PD delivery approach that has similar features to conferences but without predetermined sessions. Carpenter (2016) employed two phases of a survey with 95 teachers to examine their reasons and experiences of attending Edcamps. Teachers

described being motivated by the PD design and valued this delivery approach of PD due to opportunities to collaborate, discuss, and network with other motivated teachers (Carpenter, 2016; Carpenter & Linton, 2016).

Less than 5% of teachers in our study suggested Edcamps as a useful PD format for technology integration, however, possibly due to teachers' lack of exposure to technology PD via an Edcamp delivery approach. Compared to face-to-face conferences, some teachers, especially first-timers, may be overwhelmed by the spontaneous-structured sessions and discussions (Carpenter, 2016; Carpenter & Linton, 2016).

Shift in PD Formats Perceived Useful

Online PD. Between 2009 and 2015, a shift occurred in teachers' described preference for online PD format. Less than 5% of teachers in the 2009 questionnaire reported online delivery approaches as useful. In 2009, teachers said that online workshop PD experiences were provided by companies as trainings for specific technology tools. Two 2009 teachers described useful technology PD experiences using professional learning networks (PLNs; Wikispaces and Ning) in their questionnaire responses. However, in 2015, more than 60% of teachers reported in the questionnaire that participating in online workshops (68%) and online PLNs (61%) were useful online PD delivery approaches to support their use of technology.

Teachers reported favoring online PD because of its flexible access (e.g., "Teachers can complete the online modules and practice at their own pace"), variability, (e.g., "join different Twitter chats and get ideas about technology integration from different groups of people"), and interactivity (e.g., "PLNs have been really powerful once I realized there are people from other places I can learn from"). Teachers reports about online PLNs in this study echo the findings of Trust's (2012) study. She reviewed teachers' online activities on three PLN platforms (Edmodo, Classroom 2.0, and Educator's PLN) and found these PLNs allowed teachers to enlist support, share knowledge, and brainstorm with others about new approaches.

In 2015 interviews, many teachers indicated that the large shift in teachers' preferences for online PD formats could be due to the increased number of online PD options being offered: "The flexibility of time, place, options and variety of workshops that just exist online currently [2015], which is a huge difference from what we had in 2009." This increase in the availability of online PD for technology integration has been documented by others (e.g., Ching & Hursh, 2014; Keil et al., 2016). Therefore, the accessibility and availability of technology resources may be an influential reason for teachers' change in technology PD preferences and needs.

Teacher-Led PD. Teachers in 2009 did not mention their experiences and perceptions of teacher-led PD. However, in 2015 teachers' interviews, teacher-led PD activities were commonly reported as useful. Teachers in 2015 described the usefulness of teacher-led PD: "The best experience was going to PD sessions led by other teachers where they shared what they were doing in the classrooms."

In particular, teachers highlighted the importance of sharing their ideas with other teachers in the district and how this facilitated a culture of technology integration. Teachers in 2015 also reported that PD facilitated by teachers from the same school district was more valuable because those teachers were "in the trenches," understanding their peers' teaching practices, situated contexts, technology resources, and school culture. One elementary teacher stated, "Teachers will listen more to other teachers rather than a curriculum

developer or administrator saying, 'You should do this.'" By seeing other teachers demonstrate the use of technology within similar contexts, teachers may feel that implementing those ideas into their own classrooms is more feasible (Kopcha, 2012; O'Hara et al., 2013).

In-Class PD Support. Over a 6-year period, teachers that perceived in-class PD support as useful increased from 1% ($n = 1$) to 31% ($n = 52$). Teachers in 2015 were more specific in their requests of needing follow-up, in-person, and situated PD support, focusing on just-in-time support in their classrooms to better support their integration of technology into their practices. From the perspectives of teachers in our study, situated PD support could include troubleshooting technical issues, providing instructional feedback and strategies, or modeling technology use by an experienced teacher or a technology expert.

Specifically, many teachers perceived in-class coaching as the most useful PD support, because it provided an opportunity to "have someone come into your classroom to show you with your students how to integrate technology" (Questionnaire, 2015). One teacher shared an example of effective in-class support provided by a technology coach in her school: "He will come into the classrooms on days that we are going to try out new technology and be our co-teacher to help us troubleshoot" (Interview, 2015).

More teachers in 2015 reported that when they received immediate PD support in their classrooms, they were able to learn more about pedagogical uses of the technology. Overall, teachers perceived PD support as being useful, particularly when it was continuous and within specific classroom contexts to solve teachers' unique technology integration problems. Researchers have suggested similar concepts for PD support in classrooms, such as utilizing mentorship (An & Reigeluth, 2012; Kopcha, 2012) and coaching models (Hanover Research Council, 2014) to address teachers' individual needs for technology integration in their classrooms.

Having experienced technology-using teachers model integration practices (Borko et al., 2008; Gulamhussein, 2013) could be another option for teachers' in-class PD support after technology PD sessions. To make situated technology PD useful for teachers, Daly and Conway (2015) suggested that support from the teacher PD community would be beneficial when teachers are in a school culture where they have a shared vision of technology integration with support and guidance by administrators and feel comfortable learning with their peers.

Why Teachers' PD Perceptions and Needs Persisted and Shifted

According to teachers in the 2015 interviews, increasing technology support and changing technology policies may be the reasons to explain teachers' persisted and shifted PD preferences and needs for technology integration. Teachers indicated that over the past 6 years, more technology resources and technology PD support had become available in their school districts, so more teachers are willing to try to use technology and know what they need in terms of support. "Six years ago, teachers were isolated. Technology integration wasn't a widespread thing. Teachers didn't have adequate resources and didn't really think they're going to use technology in classrooms," explained a fifth-grade teacher. Teachers reported, however, that school conditions, such as budgets and support for technology PD, still varied among districts which may influence the changing pace of teachers' technology PD needs.

In addition, teachers in the 2015 interviews suggested that shifts were due to expectations and implicit pressure from schools and stakeholders, along with the implementation of

technology policies and initiatives (e.g., "Teachers are provided technology, so they are expected to apply it"). Peer pressure may be another reason because "when they [teachers] saw other teachers using technology, they felt they needed to catch up so they don't get left behind." Teachers' explanations indicated that the shift of teachers' perceptions on useful PD and their technology PD needs may have been triggered by the changes at the school and district level, including technology infrastructure and resources, budgets for technology PD, technology integration agendas, and decisions made by administrators.

Implications for Teacher PD for Technology Integration

Implications for Technology PD Practices

Overall, the results of this study showed that teachers continue to need technology PD that is personalized, sustained, and situated. Teachers stated that more PD for technology integration has been provided in their districts compared to 6 years ago. Nevertheless, many still described a need for having more technology PD opportunities that can address their individual needs in their classroom practice. The results indicated that teacher technology PD should incorporate flexibility and variety into formats and content to better address a wide range of teachers' PD preferences and needs.

These results suggesting more personalized, sustained, and situated PD align with recent tech PD plans and reports. For example, the 2016 National Educational Technology Plan highlighted the importance of providing ongoing PD support for teachers and providing more opportunities and choices in PD (U.S. DOE, 2016). One way to address these types of changes would be through revising and revaluating technology PD policies at the school and district levels in order to allocate sufficient PD time and resources and, thereby, establish a PD culture more aligned with these ideals (NSD Technology Plan Update Committee, 2014; Project Tomorrow, 2017). Meanwhile, statewide policies associated with PD for technology integration (e.g., Virginia Department of Education, 2016) also could be created to support recognition of a great range of useful PD experiences.

To provide useful technology for teachers in practice, PD designers need to consider the teacher, school, and system levels. Researchers suggest that awareness at the school and district level for teacher agency and teachers' capacity for directing their professional growth in PD should be elevated to provide teachers more effective PD experiences (Calvert, 2016; Tondeur et al., 2017). Moreover, schools and administrators should support the flexibility of PD by allowing teachers autonomy in choosing their PD content and formats (Rybakova & Witte, 2016). Instead of being subject to specific, mandated, districtwide PD, teachers should receive credit for informal learning opportunities (such as online PLNs or Twitter Chats; Twining, Raffaghelli, Albion, & Knezek, 2013).

Since effective technology PD should be long term to make an impact on teachers' teaching practices and student learning (Gerard et al., 2011; Lawless & Pellegrino, 2007), the educational system, schools, and teachers need to have a shared vision of PD plans to continually support teacher change in technology integration practice (Twining et al., 2013).

Implications for Technology PD Research

The main purpose of this study was to examine technology PD content and formats teachers perceived useful in 2009 and 2015, documenting whether shifts occurred. Understanding teachers' current preferences and needs and how they change

over time can inform PD designers and facilitators, as well as K-12 stakeholders, to better address teachers' individual needs and improve technology PD.

According to the participants in the study, K-12 teachers' shift of PD perceptions and needs for technology integration over a 6-year period may be due to the changes in K-12 education contexts, including technology infrastructure, resources, policies, and expectations. Teachers' PD learning experiences and needs within current educational environments should be continually investigated for shifts to provide context-based recommendations for teacher technology PD.

In addition, researchers must examine the effectiveness of teacher PD for technology integration and provide evidence from study results. Lawless and Pellegrino (2007) suggested that not only the PD program should be examined, but also teachers' change of technology use in teaching practice and students' learning outcomes. Thus, as one of the ways to determine if teachers' needs are addressed in technology PD, more research studies should examine how teachers learn from different PD approaches and how they transfer what they learn into their teaching practices, as well as the impact on students' learning outcomes.

Conclusion

Based on the changes of teachers' PD needs and preferences found in this study, technology PD seems to have shifted over a 6-year time span to better support teachers' classroom technology integration. However, there is still a need for improvement. Echoing the literature, the findings of this study suggest that teachers have perceived personalized (Trust et al., 2016), situated, and sustained PD (Kopcha, 2012; Mouza, 2011) effective to help them learn and integrate technology in classrooms. Yet, some teachers continue to request more effective PD in their school districts to better address their existing PD needs.

As teachers' perceptions and needs shift, technology PD should take changes into account at different levels of support, from individual teacher to school system, when designing and delivery technology PD (Twining et al., 2013). Finally, teachers could be held accountable for self-selected personalized PD opportunities and receive credit for participating in any form of technology-related PD. This strategy would allow teachers to focus on the content and format they find useful for improving their own practices.

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Appendix A
2015 Questionnaire Questions for K-12 teachers

Q1. How often do you participate in Professional Development (PD) for technology integration?

(e.g., workshops, conferences, webinars, graduate degrees, etc.)

- Never
- Once or twice a semester
- Once or twice a month
- Once or twice a week
- More than twice a week
- Other

Q2. Please list the topics of technology-related PD you have attended in the past year.

(e.g., How to Use SMARTBoard, Use of Web 2.0 Tools, Teacher Website Design, etc. If you did not attend any technology-related PD in the past year, please type "None.")

Q3. What are technology-related PD formats that you found effective for supporting your technology integration practice? Please select all that apply.

- None
- Summer classes/activities
- Workshops
- Online workshops/webinars/webcasts
- Conferences
- Personal Learning Networks (i.e., Facebook group, Twitter, LinkedIn, Pinterest, etc.)
- Degree programs
- In-class coaching
- Non-degree programs/courses/certificates
- Other:

Q3.1. Based on your response to the previous question, please describe your effective PD experience(s) for technology integration. (If you select None in previous question, please type "None.")

Q4. What technology-related PD topics do you perceive as effective for your technology integration practice? Please explain why. (e.g., using SMARTBoards, creating teacher websites/blogs, subject-focused tools such as Geometer Sketchpad, etc.)

Q5. Do you have any additional comments or suggestions for current technology integration PD designers and facilitators? (This is an optional question.)

Appendix B
2015 Interview Questions for K-12 Teachers

K-12 Teacher Professional Development for Technology Integration - Interview Questions

General/Background Information

- Grade level & subject area:
- Years of teaching:
- On a scale of 1 to 5, where 1 being very uncomfortable and 5 being very comfortable, how comfortable are you with technology integration in your classroom?

Technology Integration

- What technology resources do you have for teaching in your school? Compared to 5 or 6 years ago, is there a big change in terms of available technology resources in your school?
- In general, how do you usually integrate technology in teaching and learning?
- What barriers or challenges have you encountered in your technology integration practice?

Professional Development

- What is the most useful technology integration PD experience?
- What is the least useful technology integration PD experience?
- Can you recall or picture yourself what technology-related PD looks like 5 or 6 years ago?
- If you were asked to set up an ideal professional development for teachers in your school on technology integration, how would you set it up and what would that look like in terms of format and content?
- Table 1 and Table 2 below show the changes from 2009 to 2015 in the percentages of teachers' preferences for PD formats, content, and features. Why do you think there has been such a big change?

Table 1
Changes of K-12 Teachers' Technology-Related PD Format Preferences (Questionnaire Responses)

PD Formats		Number of Teachers, 2009	Number of Teachers, 2015
Face-to-face	Workshops	89 (35%)	120 (69%)
	Conferences	40 (16%)	91 (52%)
	Summer PD	12 (5%)	80 (46%)
Online	Workshops	9 (4%)	113 (65%)
	Social networking sites	3 (1%)	102 (58%)
Features	Flexible time/Allowed more time	8 (3%)	36 (21%)
	Opportunities for hands on practice	23 (9%)	42 (24%)
	Just-in-time/in-class support	1 (0%)	52 (30%)
	Grow from being a technology leader	41 (16%)	7 (4%)

Table 2
Changes of K-12 Teachers' Technology-Related PD Content Preferences (Questionnaire Responses)

PD Content		Number of Teachers, 2009	Number of Teachers, 2015
Technological knowledge and skills	Applications (mobile apps)	2 (1%)	35 (20%)
	Content specific resources	12 (5%)	30 (17%)
	General Web 2.0	22 (9%)	41 (23%)
Pedagogical knowledge and skills	Instructional theories/approaches	2 (1%)	25 (14%)
Features	Applicability of learning content	19 (7%)	40 (23%)