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Teachers' perceptions of the barriers to technology integration and practices with technology under situated professional development

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ABSTRACT

This case study examines 18 elementary school teachers' perceptions of the barriers to technology integration (access, vision, professional development, time, and beliefs) and instructional practices with technology after two years of situated professional development. Months after transitioning from mentoring to teacher-led communities of practice, teachers continued to report positive perceptions of several barriers and were observed engaging in desirable instructional practices. Interviews suggest that the situated professional development activities helped create an environment that supported teachers' decisions to integrate technology. Implications for teacher professional development and technology integration are discussed in conjunction with the strengths and limitations of the study.

1. Introduction

There is an apparent gap between the amount of technology available in today's classrooms and teachers' use of that technology for instructional purposes. In a recent study by the National Center for Educational Statistics (Gray, Thomas, & Lewis, 2010), less than half of the 3000 surveyed teachers reported using technology often during instructional time – it was used more frequently for administrative tasks such as grading and attendance. Others have similarly found that teachers more often use technology for non-instructional tasks such as communicating with peers and parents (Russell, Bebell, O'Dwyer, & O'Connor, 2003; Zhao, Pugh, Sheldon, & Byers, 2002) or preparing teaching materials (Cuban, Kirkpatrick, & Peck, 2001; Russell et al., 2003). This has led to well-placed criticism regarding the monies spent on technology in the schools (Cuban et al., 2001; Machin, McNally, & Silva, 2007; Oppenheimer, 2004).

One reason for this gap is that teachers face a number of barriers when integrating technology into their instruction. These are reviewed thoroughly in the literature (Ertmer, 1999; Hew & Brush, 2007) and are summarized briefly here:

- *Access.* Teachers can feel as if they lack access to technology even when it is available because it does not work properly (Clark, 2006; Lim & Khine, 2006; Zhao et al., 2002) or because it is not useful for teaching (Norris, Sullivan, Poirot, & Soloway, 2003).
- *Vision.* Teachers with a strong administrative vision for technology use are less likely to abandon their efforts to integrate technology when they encounter setbacks (Hayes, 2007; Park & Ertmer, 2008; Sugar & Kester, 2007).
- *Beliefs.* A teacher's beliefs about the usefulness of and difficulty associated with integrating technology influence whether they use technology for instruction (Inan & Lowther, 2010; Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010; Vannatta & Fordham, 2004).
- *Time.* Teachers have reported that technology requires more of their time to deal with student misbehavior when using technology (Bauer & Kenton, 2005; Lim & Khine, 2006; Wachira & Keengwe, 2010) or to plan for and learn to use it (Al-Senaidi, Lin, & Poirot, 2009; Clark, 2006; Lim & Khine, 2006).
- *Professional Development.* Training can be a barrier to technology integration when it lacks connection to actual classroom practice (e.g. stand-alone workshops) or focuses solely on technical skills (Bradshaw, 2002; Hinson, LaPrairie, & Heroman, 2006; Mouza, 2009; Wells, 2007).

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There is a clear connection between the degree to which teachers experience these barriers and their decision to use technology for instruction (Inan & Lowther, 2010; Mueller, Wood, Willoughby, Ross, & Specht, 2008; Norris et al., 2003). In a path model exploring laptop technology use among 379 teachers, Inan and Lowther (2010) found that professional development, technical and administrative support, and teacher beliefs played an influential role in whether teachers felt ready to use laptops in the classroom and, in turn, whether they actually did.

Situated professional development such as mentoring is a promising way to prepare teachers to negotiate the common barriers and improve their use of technology for instruction. Mentored teachers integrate technology more frequently over time than teachers who do not learn with a mentor (Lowther, Inan, Strahl, & Ross, 2008; Smith & Smith, 2004; Swan & Dixon, 2006; Zhao & Bryant, 2006). Lowther et al. (2008) conducted large-scale study of teachers' attitudes and practices with technology across 26 schools; mentored teachers were more confident with technology and more frequently employed student-centered uses of technology than non-mentored teachers. Zhao and Bryant (2006) similarly found that teachers who did not receive in-classroom support following workshop-style training were less likely to implement student-centered instructional practices with technology.

Mentored teachers also report positive attitudes and experiences with the common barriers to technology. Researchers have found that mentored teachers effectively resolve technology issues during their instruction with limited additional support (Boulay & Fulford, 2009; Franklin, Turner, Kariuki, & Duran, 2001; Sugar, 2005; Swan, Kratcoski, Mazzer, & Schenker, 2005), exhibit positive beliefs about using technology for instruction (Franklin et al., 2001; Levin & Wadmany, 2008), and have a clear vision for using technology in their teaching (Owston, 2006). This may explain why mentored teachers more frequently use technology for instructional purposes than non-mentored teachers. Equipping teachers with the skills and attitudes needed to negotiate the barriers is an important step toward improving their use of technology for learning (Earle, 2002; Kopcha, 2010; Tondeur, Valcke, & Van Braak, 2008; Wang & Reeves, 2003).

School leaders are less likely to employ mentoring as professional development, however, due to its high demand on school resources (Chuang, Thompson, & Schmidt, 2003; Gallagher, 2000) and lack of scalability (Polly, Mims, Shepherd, & Inan, 2010). Communities of practice may be a cost-effective alternative to mentoring that can improve teachers' use technology for instruction. Within a community, teachers meet regularly over time to establish goals for integrating technology into their teaching, share solutions to the problems they face, and receive support while integrating technology (Glazer, Hannafin, & Song, 2005; Hughes & Ooms, 2004). These activities offer teachers long-term support in the context of their classroom without heavy reliance on an outside expert (Brill & Walker, 2006; Glazer, Hannafin, Polly, & Rich, 2009).

There is limited evidence that teachers who participate in a community of practice experience positive changes in their attitudes and practices with technology (Cifuentes, Maxwell, & Bulu, 2011; Glazer & Hannafin, 2008; Hughes & Ooms, 2004). Glazer and Hannafin (2008) followed two technology leaders and nine additional teachers engaged in a community of practice over one school year. The majority of teachers improved their ability to plan and implement technology-infused lessons as a result of extensive modeling, one-on-one planning, and technical support from peers in the community. Hughes and Ooms (2004) similarly found that five teachers used technology for instruction more frequently at the end of a school year after meeting monthly as a community of practice to support their integration efforts.

1.1. *Purpose of the study*

The common barriers to technology integration are clearly identified and well established in the existing literature (see Ertmer, 1999, 2005; Hew & Brush, 2007). Despite this knowledge, teachers continue to report that they lack the time, resources, and training to use classroom technology for instructional purposes. This has led researchers to investigate situated professional development as an alternative to stand-alone workshop training for technology integration. Situated professional development has tremendous potential to promote long-term changes in teachers' attitudes toward and practices with technology in the classroom by providing individualized training and support in the context of the real classroom (Bradshaw, 2002; Ertmer, 2005; Kariuki, Franklin, & Duran, 2001; Sugar, 2005).

Unfortunately, existing studies of situated professional development suffer from a number of methodological issues. To begin, those studies are heavily criticized for their reliance on the self-reports of teachers, which are prone to exaggerating teachers' actual practices with technology (Hew & Brush, 2007; Hixon & Buckenmeyer, 2009; Lawless & Pellegrino, 2007). In addition, many studies evaluate the gains attained at the conclusion of a professional development effort rather than examining teacher changes in attitudes and practices over time (Lawless & Pellegrino, 2007; Swan & Dixon, 2006). Furthermore, few studies examine the impact of specific situated professional development activities on teachers' perceptions of the barriers (Mouza, 2009; Wells, 2007) or actual practices with technology (Belland, 2009; Hixon & Buckenmeyer, 2009). Given the increasing presence of technology in today's classrooms, there is a current and pressing need for research on situated professional development in K12 settings that improves on these known issues and advances our understanding of the relationship between those activities, teachers' perceptions of the barriers, and ultimately teachers' instructional practices with technology.

The purpose of this study was to examine the common barriers to technology integration under a program of sustained and situated professional development in the context of an elementary school. A unique feature of the professional development was that teachers transitioned from full-time mentoring to teacher-led communities of practice over a two-year period. Interviews and surveys were conducted to examine changes in teachers' perceptions of the barriers over time, and observations were triangulated with teacher self-reports to improve the validity of the results and strengthen the conclusions drawn from them (Yin, 2009). The program is presented as a unique case that addresses a gap in our limited knowledge of how to use mentoring and teacher-led communities of practice, as well as the effects of each on teacher attitudes and practices with technology in an applied setting.

The research questions guiding this study were:

1. How do teachers perceive the common barriers to technology integration after engaging in a program of situated professional development over a two-year period?
2. How do those perceptions change as teachers' professional development transitions from full-time mentoring to teacher-led communities of practice?
3. What were teachers' instructional practices under teacher-led communities of practice and how do they relate to their perceptions of the barriers?

2. Method

2.1. Context

The elementary (K-5) school in this study consisted of 30 teachers (5 per grade) and 600 students located in an upper middle-class neighborhood within a major city in the Southwest. Professional development at this school was prompted by a campus-wide upgrade of technology, including:

- A teacher computer with document camera and projector
- A lab with 32 new computers and an interactive whiteboard
- Five mobile carts containing 15 wireless laptop computers each
- Online computer-based instruction available for all students
- District technical support three days a week

Following the upgrade, school leaders hired a mentor (30 h/week) to conduct a variety of professional development activities over the course of one school year. The mentor was hired to provide teachers with the skills and knowledge needed to integrate technology into their instruction on a long-term basis. Because the mentor's role was temporary, one of the mentor's goals included transitioning teachers to communities of practice in order to sustain technology use over time. The communities of practice were established during the following school year.

The professional development activities in this study were selected because they align directly with the six research-based principles for effective professional development on technology integration. The six principles include: focus on teacher knowledge, reform-type activities, situate activities in teacher needs, opportunities for active learning, extensive duration, and collective participation. These principles were initially identified by Garet, Porter, Desimone, Birman, and Yoon (2001) and later positioned in the context of technology integration by Mouza (2006, 2009). For example, Mouza identified professional learning communities and workshops aligned with classroom practice as a reform-type activities.

Mentoring, however, was not directly included in these principles. As Garet et al. (2001) noted, effective professional development depends more on the inclusion of specific qualities (i.e. duration, collective participation, content, coherence, active learning) than the type of professional development itself. In other words, effective professional development depends less on the type of professional development (e.g. mentoring, traditional workshop, etc.) and more on the specific activities that take place within the professional development. In the current study, the activities that occurred as part of teachers' mentoring aligned strongly with the principles. For example, the professional development focused heavily on addressing gaps in teacher knowledge and engaging teachers in active learning through in-classroom coaching and support, modeling, and observations.

Table 1 presents the alignment between the first four of Mouza's principles for effective professional development, the specific activities that occurred in this study during both years, and the barriers the activities addressed. The fifth principle, collective participation, was

Table 1
Mentoring strategies by year, barrier type, and Mouza's (2006) principle of effective professional development.

Barrier type & duration	Strategies employed	Principle[a] 1	2	3	4
Year 1	• Initial needs assessment and inventory of available technology resources			X	
Access & Time	• Resolve current technology issues			X	
(1 month)	• Establish systems for accessing and using available technologies			X	
	• Establish systems for accessing and receiving district technical support			X	
Vision & Professional	• Monthly team training on technical skills and systems	X			
Development (Technical)	• Three (3) one-hour after-school workshops on technical skills	X			
(2 months)	• Regular assessment of school-wide technology goals with revision of strategies as needed			X	
	• Align technology integration efforts with existing school-wide initiatives			X	
	• Co-development of technology-integrated lessons with interested teachers				X
	• One or more modeled lessons per teacher on using laptop computers				X
Beliefs & Professional	• Monthly team training on strategies for teaching with technology	X			
Development (Pedagogy)	• Five (5) one-hour after-school workshops on student-centered uses of technology	X			
(5 months)	• Technology-integrated lessons stored and shared by grade level on network drive		X		
	• Grade level learning as a group		X		
	• Continued assessment of school-wide technology goals with revision of strategies as needed			X	
	• In-classroom, individualized one-on-one training with teachers at least once per week			X	
	• Weekly email with technology tips			X	
	• Student helpers trained to assist teachers with maintaining and troubleshooting computers			X	
	• Community sharing of technology integration through monthly newsletter			X	
	• Co-development of technology-integrated lessons with all teachers				X
	• Two or more modeled lessons per teacher on student-centered strategies				X
	• Mentor coaching, observations with feedback, and co-teaching of instruction with technology				X
Year 2	• Weekly and monthly training for teacher leaders	X			
Professional Development	• Grade level teachers engage in learning as a community of practice		X		
w/ Teacher Leaders	• District and in-school technology support from technology leaders			X	
(5 months)	• Peer observation and coaching from technology leaders		X		X
	• Share and develop lessons with peers		X		X

[a] 1 = Focus on Teacher Knowledge, 2 = Reform-type Activities, 3 = Situate Activities in Teacher Needs, 4 = Opportunities for Active Learning.

addressed by including teachers from a single school in the professional development. The sixth principle, extensive duration, was addressed by providing professional development over a two-year period. The activities are described below.

2.1.1. Year 1

The mentor began by situating the professional development in the needs of the teacher. A needs assessment consisting of surveys, interviews, and observations was conducted to establish the mentor's goals for the first year. The needs that were identified led to the following goals: address issues with access and time, improve teachers' technical skills with technology, create a shared vision for technology use at the school, support teachers' beliefs about using technology for instructional purposes, and introduce teachers to a variety of pedagogical strategies with technology.

The mentor began by addressing the barriers of access and time. While there was a tremendous amount of technology available to teachers, most of the resources did not work, needed troubleshooting, or needed to be set up for teacher and student use. In addition, teachers were concerned that using technology throughout the day would be an interruption in their instructional time. The mentor addressed these barriers through a variety of activities, including: establishing systems for teachers to sign up for, obtain and return, and/or access the available hardware and software, resolving existing technology issues and bringing technology to working order, and establishing systems to receive technology support from the district. These activities lasted approximately one month.

As the technology became more reliable and systems were developed for teachers to access and use technology, the mentor began addressing teachers' lack of technical skills and creating a shared vision for technology use on the campus. Teacher workshops and team trainings focused on teacher knowledge of technical skills such as methods of distributing and using laptops and basic software skills. The training provided opportunities for active learning including co-development and modeling of lessons with the mentor. These activities were situated in teachers' needs by regularly assessing progress on school-wide technology goals and aligning technology-integration efforts with existing school initiatives. These activities lasted approximately two months.

After teachers' technical skills improved, the mentor provided professional development that focused on reinforcing teacher beliefs about using technology for instruction and introducing pedagogical strategies for technology integration. These activities continued to be situated in teachers' needs through continued assessment of school-wide goals and by meeting with teachers individually to help them integrate technology. In addition, students were trained to assist teachers with troubleshooting and maintaining the computers during the school day. Teacher workshops and team trainings focused on teachers' instructional uses of technology, including classroom management techniques, project-based learning, use of interactive web-based materials, and computer-guided instruction. The training provided opportunities for active learning including modeling, peer coaching, co-teaching, and co-development of lessons with the mentor. In addition, the training provided reform-type activities in several ways. Teachers received just-in-time follow-up support and in-classroom teaching support when integrating workshop strategies into their classrooms. Grade-level teams met monthly to share and report on technology integration lessons, and those lessons were made available to all teachers through a shared drive on the school-wide network. These were summarized each month in a community newsletter. These activities lasted approximately five months.

During Year 1, participation in the after-school workshops was tied to a monetary incentive and the workshops were well attended; twelve of the teachers in the study, mainly from grades 3 through 5, attended three or more workshops.

2.1.2. Year 2

The same mentor returned from September to January of Year 2 to facilitate the formation of teacher-led communities of practice. The communities of practice were established in a manner similar to Holahan, Jurkat, and Friedman (2000). The principal selected three teachers (one from each grade 3 to 5) to act as technology leaders for their grade-level team; these were teachers that the principal felt were proficient with integrating technology and best suited to take a leadership role.

The technology leaders were provided with a small stipend to maintain and schedule the laptop computers and lead a community of practice within their grade level. The community met weekly as a team to resolve common issues and coach each other on technology use. Technology leaders supported teachers' active learning by conducting observations of their peers and offered feedback to improve their teaching practices with technology. Technology leaders knowledge was addressed through participation in mentor-led training that consisted of weekly phone meetings to resolve persistent issues (e.g. managing software updates) and monthly workshops on effective mentoring techniques. These efforts lasted approximately five months.

2.2. Participants

A total of 18 teachers (5 from 5th; 4 from 4th and 3rd; 3 from 2nd; 2 from 1st) from this elementary school participated in this study. Teachers had between 3 and 30 years of experience ($M = 13.7$); the majority of teachers were female (17 female, 1 male). Prior to the study, participants had little instructional technology available or professional development on using technology for instruction. The mentor who worked with the teachers had prior experience as a public school teacher and in training teachers to use technology for instruction.

2.3. Data sources and materials

2.3.1. Technology integration survey

The researcher created a survey to examine teacher perceptions of the common barriers to technology integration. Survey items were rated using a standard five-point Likert-type scale ranging from strongly agree (4) to strongly disagree (0). The 15-items in the survey (3 items per barrier) were based heavily on Clark's (2006) Delphi study where 58 teachers, administrators, researchers, and policyholders identified 32 key practices and issues associated with effective technology integration in K12 schools. Survey items were written such that teachers could report on the extent to which they enacted those practices or encountered those issues. For example, Clark suggested that teachers need time to plan for technology and need access to technology that supports teaching and learning. The survey items that these became were, "I received adequate time to plan and prepare lessons that use technology," and "The technology available was, for the most part, useful for learning." The items were written such that higher scores represented the presence of conditions that facilitated technology integration, whereas lower scores represented the presence of conditions that made technology integration more challenging for teachers.

The recommendations made by Patten (2001) were used to establish face validity. Two researchers, a technology professional developer, and 10 teachers not involved with the study informed the categorization and development of the items. Cronbach's coefficient alpha for the final version of the survey was 0.93 or more for each year. Cronbach's alpha within each barrier was also above an acceptable level of 0.70 (Fraenkel & Wallen, 2008).

2.3.2. Technology integration interview protocol

The researcher conducted focused interviews with the participants. Focused interviews are typically shorter in duration than traditional interviews but can effectively bring depth to a case because they are more direct and focused on a specific interest (Yin, 2009). The researcher created a nine-item semi-structured protocol to focus the interview on teachers' experiences with the common barriers over the two years of situated professional development.

Five of the interview questions asked teachers to describe their experience with each of the barriers over the past two years. For example, the item addressing the barrier of beliefs was, "Over the past two years, how has/have *your beliefs about integrating technology* changed, and how has this influenced the way you integrate technology into your instruction?" The structure was similar for each of the five items but the focus of the question changed by barrier. For the items for time, access, vision, and professional development, the statement, "*your beliefs about integrating technology*" was replaced by each of these statements respectively: "the time needed to integrate technology into your instruction," "your access to the technology you need for instruction", "the vision for technology use at this school", and "the professional development you have received, including mentoring and learning from other teachers." The remaining questions on the protocol asked teachers to explain how and why they currently integrate technology into their instruction, describe past and current challenges they have faced while learning to integrate technology, and describe the influence of the mentor and communities of practice on their past and current practices and challenges.

2.3.3. Technology lesson observation protocol

The researcher developed a 15-item observation protocol to assess the qualities of technology-infused lessons identified by Mouza (2006), specifically: Technology Use, Student-Related Behaviors, and Teacher-Related Behaviors. The items on the protocol provided evidence of teachers' instructional practices with technology as evidenced in their own classrooms. For example, an item from Technology Use was, "Technology was used to facilitate problem solving and/or critical thinking." Items were rated on a five-point Likert-type scale ranging from strongly agree (4) to strongly disagree (0). In this way, the items indicated the extent to which the qualities of technology-infused lessons generally were present across an entire lesson.

The items also provided evidence of the barriers that are observable in practice, namely access and professional development. For example, the items that examined whether the technology was working properly or created interruptions in student learning provided evidence of the degree to which access to working technology was a barrier for teachers at this school. Likewise, the items examining teachers' ability to resolve technology issues, align technology use with objectives and content, and facilitate student-centered learning practices offered confirmation of the effect of professional development on teachers' actual practices. The degree to which teachers experienced problems or successes with regard to these barriers can also play a role in teachers' perceptions of the time needed to integrate technology and their beliefs about the difficulty associated with doing so. Teachers who encounter repeated technical and/or classroom problems are more likely to complain about time needed to integrate technology or exhibit negative beliefs about using technology for instruction (Ertmer, 1999; Lim & Khine, 2006; Zhao et al., 2002).

2.4. Procedures

Teachers completed the survey in the fall of Year 2, reporting their perceptions of the common barriers from the previous year (Year 1). Teacher-led communities of practice were established with support from the mentor until January of Year 2, at which time all external mentoring ceased. In April and May of Year 2, teachers were videotaped delivering lessons that used technology as part of the lesson. Videotaped lessons were recorded from two different perspectives: a fixed and a traveling position. The fixed position provided the observers with a view of the entire classroom while the traveling position provided close-up screen shots of each student's computer and teacher–student and student–student interaction. Videotaping from two perspectives allowed the researcher to conduct a more focused and deeper content analysis at a future time. In May of Year 2, participants completed the survey a second time (now referring to Year 2) and were interviewed. Interviews lasted an average of 35 min.

2.5. Relationship with research questions

The survey generated evidence of teachers' perceptions of the barriers at two points in time – at the conclusion of the mentoring activities in Year 1 and several months after establishing teacher-led communities of practice in Year 2. In this way, survey responses examined what teachers' perceptions were after each year of situated professional development (RQ1) as well as how those perceptions changed over time (RQ2). Interview data provided teachers with an opportunity to detail in their own words their perceptions of the barriers at the end of Year 2 (RQ1) while also describing how those perceptions changed over time (RQ2). Teacher observations provided evidence of teachers' instructional practices at the end of Year 2 (RQ3) by focusing on the manner in which technology was used and the behaviors of both teachers and students. The observations also offered confirmation of teachers' perceptions of several barriers (RQ2) and evidence of the relationship between those barriers and their instructional practices (RQ3).

2.6. Design

The purpose of this study was to examine the effect of a program of sustained and situated professional development on teachers' perceptions of barriers to technology integration within the bounded context of an elementary school. This study employed a longitudinal

Table 2
Mean Rating and standard deviation by barrier and survey item ($N = 18$).

Barrier and survey item description	Year 1		Year 2	
	Mean	*SD*	Mean	*SD*
Vision	**3.26**	**(0.70)**	**3.24**	**(0.76)**
I was expected to use technology to support content objectives.	3.42	(0.61)	3.42	(0.51)
There was strong administrative backing for using technology.	3.58	(0.51)	3.32	(0.95)
The demands/goals placed on me for using technology were reasonable.	2.79	(0.98)	3.00	(0.82)
Access	**3.35**	**(0.60)**	**3.21**	**(0.79)**
The technology available was, for the most part, useful for teaching.	3.47	(0.51)	3.53	(0.61)
I received help fixing technology problems in a timely manner.	3.37	(0.50)	3.37	(0.68)
The technology available was, for the most part, reliable.	3.21	(0.79)	2.74	(1.09)
Beliefs	**3.23**	**(0.73)**	**3.14**	**(0.78)**
I believe using computers with students increases their learning.	3.58	(0.51)	3.58	(0.51)
It is easy to design learning activities that incorporate computers.	2.95	(0.85)	3.05	(0.85)
I believe that technology makes my job as a teacher easier.	3.16	(0.83)	2.79	(0.98)
Professional Development	**2.75**	**(0.75)**	**2.51**	**(0.75)**
The training I received could be easily applied in my classroom.	3.32	(0.58)	3.00	(0.47)
I felt adequately trained on the skills needed to use technology.	2.89	(0.88)	2.74	(0.99)
I had enough opportunity to share technology lessons with other teachers.	2.05	(0.78)	1.79	(0.79)
Time	**2.02**	**(0.91)**	**1.84**	**(1.01)**
Integrating technology took less time than I thought it would.	2.00	(0.94)	2.21	(0.92)
I was given time to learn to integrate technology into my lessons.	2.37	(0.90)	1.79	(1.13)
I had enough time to plan and prepare lessons that use technology.	1.68	(0.90)	1.53	(0.97)
Totals	**2.92**	**(0.74)**	**2.79**	**(0.82)**

Note: Ratings appear highest to lowest in Year 2 by barrier then item.

single case study design using multiple methods to examine teachers' perceptions as reported through surveys and focused interviews. Observations were conducted to provide evidence of teachers' instructional practices with technology and classroom experiences with several barriers. The school was selected due to the unique nature of the professional development that teachers received, in which teachers transitioned from mentoring to communities of practice over a two-year period.

The researcher was a participant–observer – that is, the researcher was the mentor who conducted the professional development activities (e.g. workshops, one-on-one follow-up, lesson design, etc.) across both years of the model. To minimize the potential for bias due to the researcher's participant–observer role, data were collected and analyzed with a research assistant who had no prior association with the participants or researcher. The research assistant was a doctoral student in educational technology with extensive K12 experience.

2.7. Analysis

The data were analyzed across teachers rather than with each teacher as an individual case. This analysis provided insight into the effects of the program of professional development across the entire bounded context. Descriptive statistics with measures of central tendency were calculated on the survey and observation items. To establish reliability on the observations, both the researcher and research assistant initially watched both perspectives of one lesson. After reaching agreement on the meaning of the items and in rating items on that one lesson, they then separately viewed and completed an observation protocol for each of the remaining lessons. A Cohen's kappa statistic was calculated on 4 (out of 16) randomly selected observations. Cohen's kappa is an estimate the level of agreement between the reviewer's scores (Stemler, 2004). The kappa statistic on the observations was 0.65; Landis and Koch (1977) suggest that a kappa greater than 0.60 indicates strong agreement. On the items where there was disagreement, the researchers met to discuss items and come to consensus on the final rating for those items.

Interview data were transcribed and analyzed using inductive analysis (Patton, 2002). To begin this analysis, the researchers separated the responses to each interview question into a series of distinct statements by teacher in an electronic spreadsheet. Statements were edited to remove irrelevant comments and varied from one to seven sentences in length ($M = 2.58$, $SD = 1.16$). The researchers initially selected and analyzed the statements from three interviews. Teacher statements were coded using the barriers (access, vision, beliefs, professional development, and time) as the coding scheme. The researchers then met to discuss their coded data and come to agreement about the application of the coding scheme. After reaching agreement, they continued to apply the codes to the remaining data. In all, 178 statements were evaluated and a total of 141 codes were applied.

The coded interview data were organized into a matrix that displayed coded statements by barrier and person. The matrix was then analyzed to identify common patterns and elements (Patton, 2002) within and across barriers, including changes in the nature of those barriers over time. The researchers separately reviewed each barrier and generated descriptions for the distinct patterns and elements that occurred within each barrier and across barriers. They met to discuss and refine the descriptions of those elements, and then re-analyzed the data with the refined descriptions. This continued until the researchers came to agreement about the nature of the patterns and elements and the specific statements that best represented each. Throughout this analysis, consistency among researchers was not statistically tested but rather established and improved through an on-going process of discussion of consensus and continued adjustments to the analysis based on any lack of consensus (Baxter & Jack, 2008).

After analyzing each data source separately, the three sources were triangulated to identify points of convergence and divergence. Interview results were compared to survey data to explain key trends that emerged on the survey and identify areas where sources differed. Observation results were then compared with surveys and interviews to confirm teachers' reports of key barriers as well as their instructional practices with technology. The goal of this analysis was to identify consistencies and discrepancies both within and between sources to inform the discussion of the results (Patton, 2002). The results are presented below by individual data source.

3. Results

3.1. Technology integration survey

The mean ratings and standard deviations for the 18 teachers who completed both versions of the survey are reported in Table 2 by barrier and item. Overall, the mean ratings across all 15 items were slightly higher for Year 1 ($M = 2.92$) than Year 2 ($M = 2.79$), with ratings closer to agree (3) than neither agree nor disagree (2).

3.1.1. Ratings by barrier

The mean ratings for the barriers of vision, beliefs, and access were relatively high across both years, consistently between a rating of agree (3) and strongly agree (4). The ratings for the barrier of access were the highest among all the barriers for Year 1 ($M = 3.35$) and second highest for Year 2 ($M = 3.21$). The ratings within the barrier of vision were second highest for Year 1 ($M = 3.26$) and the highest for Year 2 ($M = 3.24$). The mean ratings for the barriers of professional development and time were among the lowest across years; time received the lowest ratings on the survey for both Year 1 ($M = 2.02$) and Year 2 ($M = 1.84$). These scores were closer to a rating of neither agree nor disagree (2) than disagree (1). Across all five barriers, the mean ratings decreased slightly from Year 1 to 2.

3.1.2. Rating by item

Seven survey items received the same or slightly higher mean ratings in Year 2, most frequently within the barriers of vision, beliefs, and access. The item from beliefs, "I believe using computers with students increases their learning," was the highest-rated item across both years ($M = 3.58$). The item from access, "The technology available was, for the most part, useful for teaching," also received some of the highest ratings for Year 1 (3.47) and Year 2 (3.53).

Eight items received lower mean ratings in Year 2 than Year 1; five of those items were from the barriers of professional development and time. Within the barrier of professional development, the item, "The training I received could be easily applied in my own classroom," received somewhat high ratings for Year 1 (3.32) and Year 2 (3.00). In contrast, the item, "I had enough opportunity to share technology lessons with other teachers," had low ratings for Year 1 (2.05) and Year 2 (1.79). Within the barrier of time, the item, "I had adequate time to plan and prepare lessons that use technology," received the lowest ratings on the entire survey for both Year 1 (1.68) and Year 2 (1.53). The item, "I was given time to learn to integrate technology into my lessons," was the second-lowest rated item in Year 2 and had the largest decrease on the entire survey from Year 1 (2.37) to Year 2 (1.79). Among the remaining items that decreased across years, the item from access, "The technology available was, for the most part, reliable," had the second-largest decrease from Year 1 (3.21) to Year 2 (2.74).

3.1.3. Rank–order agreement

A Spearman rank–order correlation was calculated comparing the ranking of the 15 survey items for Year 1 and Year 2. Table 3 contains the rank ordered items by year. The Spearman rank–order correlation was 0.89, $p < 0.01$, a relatively high correlation. A high rank–order correlation indicates strong agreement between two variables (Harris, 1998) – in this case, that teachers' perceptions were consistent from year to year despite overall ratings for one year being higher or lower than the other.

3.2. Technology integration interview protocol

A total of 17 teachers (5 from grade 5, 4 from grade 4, 4 from grade 3, 2 from grade 2, and 2 from grade 1) were interviewed at the end of Year 2 regarding their perceptions of the common barriers to technology integration over the past two years. Teachers' years of experience ranged from 3 to 30 ($M = 15$ years). Interview results were organized by the themes that emerged within each of the following barriers: time, beliefs, access, vision, and professional development (mentoring and communities of practice). Table 4 contains the themes and examples of the interview data that reflect those themes.

Table 3
Rank order of Item ratings across years.

Barrier and survey item[a]		Year 1	Year 2
B	I believe using computers with students increases their learning.	1.5	1
A	The technology available was, for the most part, useful for teaching.	3	2
V	I was expected to use technology to support content objectives.	4	3
A	I received help fixing technology problems in a timely manner.	5	4
V	There was strong administrative backing for using technology.	1.5	5
B	It is easy to design learning activities that incorporate computers.	9	6
P	The training I received could be easily applied in my own classroom.	6	7.5
V	The demands/goals placed on me for using technology were reasonable.	11	7.5
B	I believe that technology makes my job as a teacher easier.	8	9
A	The technology available was, for the most part, reliable.	7	10.5
P	I felt adequately trained on the skills needed to use technology.	10	10.5
T	Integrating technology took less time than I thought it would.	14	12
T	I was given time to learn to integrate technology into my lessons.	12	13.5
P	I had enough opportunity to share technology lessons with other teachers.	13	13.5
T	I had enough time to plan and prepare lessons that use technology.	15	15
Spearman Rank–Order Correlation		**0.89**[b]	

Note: Items with the same mean rating received the average rank of the tied scores.
[a] A = Access, V = Vision, T = Time, P = Professional Development, B = Beliefs.
[b] The correlation was statistically significant, $p < 0.01$ (two-tailed).

Twelve teachers stated that time was currently their biggest challenge when using technology in their instruction. Four found it most challenging to find time to plan for activities that integrated technology, while another four were frustrated over spending instructional time on technology issues (e.g. software updates, connectivity issues) rather than teaching. The remaining four found it challenging to find time to learn new skills needed to teach with technology.

Ten teachers reported that this challenge had changed over the past two years. Overall, teachers found it increasingly difficult to find time to plan for and implement technology lessons as their access to technology or skills (technical, pedagogical, or both) improved over time. A 4th grade teacher explained,

> Two years ago my biggest challenge was a lack of know-how. I was afraid to try to do things with the computers because I didn't know how to do it well. Now my biggest issue is finding the time to use it. It takes time to prepare lesson that use technology and sometimes I just don't have it.

Other teachers (3rd and 5th grade) similarly noted, "Last year I didn't even know what to do with the kids and the computers. My challenge now is finding time to explore Internet sites that are good for kids," and, "The more I learn about what I can do with technology, the more time it takes – I need to keep finding [resources] and that takes a lot of time."

With regard to beliefs, thirteen (13) teachers stated that they always believed that technology was important for improving student learning. Over half (8) felt that their beliefs grew stronger as a result of the mentor introducing them to classroom practices that aligned with their beliefs and were effective with students. The remaining teachers felt that the mentor helped them gain confidence in their ability to teach with technology. One 4th grade teacher stated, "I got over my fear of technology by doing it with the mentor. This changed by beliefs about myself most. I could see what I could do, and I wouldn't have tried it without the mentor." A 2nd grade teacher stated, "After working with the mentor, I'm more able to come up with programs that fit the curriculum. I'm no longer looking for what I *can* do, but choosing from what I know is available."

With regard to communities of practice, ten (10) teachers reported collaborating with peers about using technology for instruction as part of regular team meetings or during conversations in the lunchroom. Six of those teachers noted that it was more difficult to integrate technology under the communities of practice because of an increase in technology issues (e.g. software upgrades, connectivity problems) that interrupted their instructional time. Those teachers felt that the mentor helped improve their access to technology the previous year. A 3rd grade teacher described, "Either we don't get the laptop carts when we need them, or when we do get them we spend 10 min clearing

Table 4
Summary of interview themes by barrier.

Barrier	Theme and frequency		Sample response (grade – teacher)[a]
Time	Lack of time is currently the biggest challenge	12	My challenge now is finding time to explore Internet sites that are good for kids. There's so much available and I want to make sure it's appropriate for my students. (3 – 1)
	To plan/develop activities	*4*	I need more time to plan now. If I want to use [technology] well, I have to take time to do that. (5 – 1)
	Technology issues take time from learning	*4*	It's the little problems that are the biggest challenges – the real tech stuff. It hangs up the whole lesson. Like when the computer is running slowly or students do not save correctly. Little things like that take a lot of time to address. (3 – 2)
	To learn/practice skills	*4*	It's still really hard to find time to practice. The professional development really helped, but I still really need time to practice. (5 – 2)
	Teachers' biggest challenge was originally a lack of skills and/or knowledge	10	Two years ago my biggest challenge was a lack of know-how. I was afraid to try [teaching] with the computers because I didn't know how to do it well. Now it's finding the time to prepare lessons that use technology – sometimes I just don't have it. (4 – 2)
Beliefs	Teachers always believed technology was important in student learning	13	It's very important for [students] to go online on their own, get the information they are interested in, on topics they are interested in. I need to teach them how to do that. (5–3)
	Beliefs grew stronger after working with mentor	*8*	I always thought [technology] was important, but wasn't able to instruct with it. After working with the mentor, I'm more able to come up with programs that fit with the curriculum. I'm no longer looking for what I can do, but choosing from what I know is available. (2 – 1)
	Confidence in own ability improved with mentor	*5*	I got over my fear of technology by doing it with the mentor. This changed by beliefs about myself most. I could see what I could do, and I wouldn't have tried it without the mentor. (4 – 2)
Vision and Access	Vision was strong and teachers were positive about access	16	The vision is to get technology into the hands of the kids and to use it with kids when I teach. (3 – 1)
	Mentor played a role in communicating the vision and improving access	*5*	The vision is to use technology across the curriculum and integrate it into the work the students do. This came from the top down – from the principal through the mentor. (4–1)
Prof. Dev.	Communities of practice consisted of weekly team meetings or informal lunchtime conversations	10	[All the teachers in our grade level] would talk about what we were doing at lunch, and I could turn around and put it into practice that afternoon, and troubleshoot it, too, based on what the other teachers did. (1 – 2) We pair off with each other, so one of us sets up a Jeopardy Game in Power Point, and all the third grade teachers can personalize it and play it with their kids if they want. (3 – 3)
	Integrating technology was more challenging under communities of practice (Year 2)	10	When we had a mentor, I tried everything that the mentor taught me. This made it easier to get new ideas without taking more of my time. (4 – 3)
	Technology/access issues increased	*6*	This year [Year 2] did not compare to last year [Year 1] – I don't think the resources are as useful or reliable without the mentor. (1–1) Either we don't get the laptop carts when we need them, or when we do get them we spend 10 min clearing software updates. (3 – 1)
	More difficult to find time to locate resources/learn practices without mentor	*4*	It's much harder to learn new ideas for using technology without the mentor. The mentoring was good because I could learn to be successful through the use of technology. Workshop classes are useless unless I get to try it myself, in my classroom. I need to do some trial and error, and there has been less of that without the mentor. (3 – 4)

[a] *Note:* Sample responses are labeled by grade level (1–5) and teacher (1–4) to demonstrate a variety of responses by theme across grades and teachers.

software updates." A 1st grade teacher said, "This year did not compare to last year – I don't think the resources are as useful or reliable without the mentor."

Another 6 teachers felt it was more difficult without the mentor to find time to develop technology-infused activities and learn new skills. A 3rd grade teacher described,

> It's much harder to learn new ideas for using technology without the mentor. The mentoring was good because I could learn to be successful through the use of technology. Workshops are useless unless I get to try it myself, in my classroom. I need to do trial and error, and there has been less of that without the mentor.

Similar comments from teachers (5th and 4th grade) included, "The amount of time I need to plan to incorporate technology has increased without the mentor helping me," and, "When we had a mentor, I tried everything that the mentor taught me. This made it easier to get new ideas without taking more of my time."

3.3. Technology integration observation protocol

A total of 9 teachers (3 from grade 5, 4 from grade 4, and 2 from grade 3) were videotaped while delivering technology-infused lessons; 6 were videotaped two or more times. Lessons ranged in length from 25 to 55 min for a total of 603 min ($M = 37$ min). In all the lessons, students used wireless laptop computers as the primary technology. The mean ratings for the 15 Likert-type items on the observation protocol are presented in Table 5 from highest to lowest score by category: Technology Use, Student-Related Behaviors, and Teacher-Related Behaviors. The overall mean rating of 3.47 across the 15 items was between the rating of agree (3) and strongly agree (4). The mean ratings for each category are presented below.

3.3.1. Technology use

Teachers were observed using technology in ways that were contributed to, rather than detracted from, the learning process; the mean rating for this category was 3.57. The mean ratings on the items that pertained to the manner in which technology was used as part of the instruction were also quite high. Those items were: "The technology supported learning subject-specific content" ($M = 3.81$), "The major student activity was to create a product that demonstrated their knowledge of a subject or topic" ($M = 3.63$), and "Technology was used to facilitate problem solving and/or critical thinking" ($M = 3.31$).

3.3.2. Student-related behavior

Students were generally well behaved and focused on their learning; the mean rating for this category was 3.55. The items directly pertaining to student time-on-task were, "Students exhibited on-task behavior for most of the lesson," and, "Students were actively engaged for most of the lesson"; both received a mean rating of 3.56. In all the lessons, students worked individually or in pairs.

3.3.3. Teacher-related behavior

The teacher was observed as being capable of using technology to support instruction; the mean rating for this category was 3.30. The highest-rated items ($M = 3.75$) in this category were, "The teacher looked comfortable teaching with the technology in the lesson," and, "The teacher appeared to have the skills needed to use the technology." The lowest-rated items were, "Very little class time was spent on resolving technology issues," ($M = 2.88$) and, "The teacher spent most of the time facilitating learning (rather than lecturing or resolving technology issues)," ($M = 2.75$).

4. Discussion

The purpose of this case study was to examine the effect of sustained and situated professional development on teachers' perceptions of the common barriers to technology integration and their instructional practices with technology in the bounded context of an elementary

Table 5
Mean rating by category on technology-integrated lessons.

Category/item	Rating
Technology Use	**3.57**
Technology supported the objectives of the lesson.	3.81
Technology supported learning subject-specific content.	3.81
The major student activity was to create a product that demonstrated their knowledge of a subject or topic.	3.63
Technology was used to facilitate problem solving and/or critical thinking.	3.31
Technology supported, rather than interrupted, student learning.	3.31
Student-Related Behavior	**3.55**
Students worked individually or in pairs.	4.00
For the most part, technology in this lesson worked correctly for students.	3.56
Student exhibited on-task behavior for most of the lesson.	3.56
Students were actively engaged for most of the lesson.	3.56
Students were able to continue the lesson without repeated teacher intervention.	3.06
Teacher-Related Behavior	**3.30**
Teacher looked comfortable teaching with technology in this lesson.	3.75
Teacher appeared to have the skills necessary to use the technology.	3.75
Teacher handled technology issues in a timely manner.	3.38
Very little class time was spent on resolving technology issues.	2.88
Teacher spent most of the time facilitating learning (rather than lecturing or resolving technology issues).	2.75
Total	3.47

school. While our knowledge of the barriers is well established, this study offers valuable insight into teachers' perceptions of those barriers as they transitioned from full-time mentoring to teacher-led communities of practice over a two-year period. The triangulated data offer a rich description of the relationship between this unique program of professional development and teachers' attitudes toward and practices with technology.

The most apparent finding is that situated professional development activities can play a key role in shaping teachers' perceptions of the common barriers across a school site. The mean survey ratings on the barriers of vision and access and the items within those barriers were relatively high across both years. Teachers reported that this was due, in part, to the mentor who communicated the vision for using technology and helped them keep the technology working on a consistent basis. These results are consistent with prior studies where mentored teachers reported improved access to technology (Boulay & Fulford, 2009; Franklin et al., 2001; Smith & Smith, 2004) and a clear vision for using technology for instruction (Kariuki et al., 2001; Sprague & Cooper, 2004).

The mentor also played a role in promoting positive beliefs about technology. Nearly half of the teachers reported that their beliefs remained strong or grew stronger as a result of their mentoring, and the highest-rated item on the entire survey was from beliefs. Other teachers reported that the mentor helped improve their beliefs in their own ability to plan and implement technology-integrated lessons. Teacher beliefs can present a large barrier to successfully integrating technology in the classroom yet play a critical role in a teacher's decision to use technology for instructional purposes (Ertmer & Ottenbreit-Leftwich, 2010; Inan & Lowther, 2010; Vannatta & Fordham, 2004). Researchers have theorized that long-term, situated professional development such as mentoring can improve teacher attitudes about using technology for learning (Hixon & Buckenmeyer, 2009; Hu, Clark, & Ma, 2003; Wells, 2007). The results of this study suggest that those theoretical gains can be realized in applied settings.

It was somewhat surprising that teachers' perception of time was consistently negative, even as their access to technology and training improved and they learned more about teaching with technology. This is likely due to the fact that act of integrating technology requires planning, teaching, and classroom management practices that are new to many teachers and demands attention that is not normally spent in those areas. Teachers often perceive technology as a burden on their time because it interrupts instruction, requires additional training, and takes time to plan (Lim & Khine, 2006; Swan & Dixon, 2006; Wachira & Keengwe, 2010). Until those new practices are as established and routine as their prior practices were, teachers are likely to perceive technology as an additional burden on their time (Belland, 2009). This supports the argument for designing professional development that supports teachers' changing needs over time as they establish new practices and routines for teaching (Hixon & Buckenmeyer, 2009; Levin & Wadmany, 2008; Zhao et al., 2002).

Despite teachers' negative perception of time, teachers under this program of sustained and situated professional development adopted a number of desirable practices and routines. Teachers were observed nearly a year after being mentored using technology in student-centered ways to support learning subject-matter content. Students in those lessons were on-task and frequently engaged in problem solving and critical thinking. In addition, the Spearman rank–order coefficient indicated that teachers' perceptions of the barriers remained relatively consistent across both years of the study. One possible reason for these positive outcomes is that the communities of practice continued to provide teachers with the support and professional development needed to sustain their attitudes toward and practices with technology over time. Cifuentes et al. (2011) similarly reported that teachers continued to use technology for instruction over time after participating in learning communities as a follow-up to intensive workshop training.

Deeper analysis of teacher self-reports and observations, however, suggests that the communities of practice in this study did not substantially provide support or influence teachers' professional learning during Year 2. Of the eight items that had lower ratings in Year 2, five were from the barriers of professional development and time. Interviewed teachers similarly reported that it was more difficult to learn to integrate technology or find time to share and locate resources without the mentor. In addition, teachers noted an increase in technology issues under communities of practice. One of the largest decreases on the survey was on the access-related item, "The technology available was, for the most part, reliable." The two lowest-rated items on the observation protocol confirmed that several teachers experienced technology issues that interrupted their teaching and student learning. These issues were likely a result of teachers' limited use of the communities of practice. Teachers reported using their communities to aid in troubleshooting common technology issues or share lesson ideas. While the activities are important, it is not likely that teachers were able to attend to many of the issues with access or advance their instructional practices with technology to the same extent as when learning with a mentor.

A more likely reason for the positive outcomes realized at the end of Year 2 is the nature of the professional development offered in Year 1. Professional development is more likely to sustain teacher perceptions of and practices with technology over time when it combines a variety of research-based strategies (i.e. long-term; situated; learner-centered; active engagement; peer collaboration; evaluation driven) (Mouza, 2006, 2009; Wells, 2007). In this study, teachers engaged in a variety of activities that aligned with the principles for effective professional development as part of their mentoring in Year 1. This included workshops focused on knowledge and practice, opportunities for active learning such as in-classroom mentoring and feedback on technology-infused lessons, and other activities that situated the professional development in the needs of the teachers. In contrast, teachers reported that they had fewer opportunities for professional development during Year 2 as well as an increase in a number of barriers. These issues suggest that the positive outcomes realized at the end of Year 2 were more likely a result of teachers continuing to engage in the practices established during Year 1 rather than the professional development offered through the communities of practice. Others have similarly found that it is more difficult to facilitate teacher change under communities of practice than maintain existing attitudes and practices with technology (Glazer et al., 2009; Hughes & Ooms, 2004).

This study does offer valuable insight into the relationship between research-based professional development activities and a teacher's decision to use technology for instructional purposes. A teacher's decision to integrate technology is based heavily on the level of support they receive, their own beliefs about using technology for learning, and their skills with using technology for instruction (Ertmer & Ottenbreit-Leftwich, 2010; Inan & Lowther, 2010; Mueller et al., 2008). Teachers in this study acknowledged that the workshops and follow-up, in-classroom mentoring they received during Year 1 led to positive changes in their beliefs, skills, and instructional practices. Many of the changes in teachers' beliefs and practices persisted nearly a year after engaging in those activities, even as teachers' support decreased and technology issues increased. This suggests that the professional development activities that took place during Year 1 were highly effective at supporting the factors that lead to a teacher's decision to integrate technology. Others have reported long-term changes in teacher attitudes toward and practices with technology as a result of mentoring that involves sustained workshop and in-classroom training focused on addressing teacher skills and pedagogy (Lowther et al., 2008; Swan & Dixon, 2006).

5. Limitations

Both survey and interview data suggest that teachers' beliefs about technology were initially quite strong. Since teachers with strong beliefs are more likely to persist in their attempts to integrate technology (Ertmer & Ottenbreit-Leftwich, 2010; Ottenbreit-Leftwich et al., 2010; Vannatta & Fordham, 2004), it is difficult to assess the influence of participant's beliefs on the results of this study. In addition, the context is unique – professional development at this school was initiated in conjunction with a substantial technology upgrade and followed a particular model of technology integration. The mentor who developed the professional development at this school was also a researcher in the study. These issues, when combined with the small number of participants, make it difficult to determine whether the results would be the same among teachers with different beliefs or in a school with different initial circumstances.

The purpose of case study, however, is not to generalize across populations but to inform theory by examining constructs and phenomena in the context in which they occur (Yin, 2009). This makes the case study method well-suited for the current study. As Borko (2004) noted, context is an integral part of professional development that often cannot be separated from teacher outcomes. At the same time, the nature of case study has led qualitative researchers to question whether the indicators of quality in quantitative research (i.e. reliability and validity) fully reflect the quality of a case (Patton, 2002; Yin, 2009). Patton (2002) argues that the quality of a case is also indicated by the strategies used to improve the credibility and accuracy of the reported data. While traditional measures of validity and reliability are important in this regard, they must be considered with all the measures taken to improve the methods of data collection and analysis. This is especially important in case study research because it helps others determine the extent to which a case may transfer to a similar situation or inform theory.

In the current study, a number of steps were taken to improve the data collection methods and strengthen the credibility and accuracy of the reported results. First, data were collected over an extended period of time and were analyzed through triangulation across multiple sources. Consistency across data sources that are studied over extended periods of time improves the likelihood that the results accurately reflect the events that were reported by participants or observed by the researchers (Desimone, 2009; Patton, 2002). In addition, interview themes were built through consensus across reviewers and reliability scores were calculated on observation data. These efforts help reduce the potential for bias due to the researcher's role as participant–observer (Yin, 2009) and improve the credibility of the reported findings (Baxter & Jack, 2008). Finally, the researchers who conducted the analysis had expertise in both K12 education and educational technology. Analysis that includes consensus-building experts is an important step toward accurately interpreting the data and presenting it in a way that informs the theories underlying the case (Patton, 2002).

The case also draws heavily on established theories, which improves the strength of the case and the degree to which the case informs theory (Patton, 2002). The barriers to technology integration served as a well-established lens that provided insight into a known gap in the technology integration literature. While the methodological limitations may prevent generalizing the results across populations, this study provides much-needed insight into the complex relationship between teacher professional development and the factors that lead to technology integration (Belland, 2009; Hew & Brush, 2007; Mouza, 2006). The attempts to improve the credibility and accuracy of the case add a level of confidence to the description of the case and the conclusions drawn from the results.

6. Implications

This study offers several implications for professional development on technology integration. Educational technologists, administrators, and decision-makers adopting technology in K12 or higher education should consider ways to offer in-classroom training and follow-up support as part of their efforts. In addition, offering activities that align with the principles of effective professional development may be a critical step toward long-term changes in teacher perceptions and practice. A mentor can play a substantial role in creating such an environment and supporting the factors that lead to a teacher's decision to use technology for instruction (e.g. beliefs, skills, and support).

While communities of practice are promoted as a cost-effective alternative to mentoring, this case suggests that not all communities of practice can or will contribute to positive teacher outcomes when learning to integrate technology. It seems that the specific activities that occur as part of or even prior to establishing a community of practice may play a larger role in promoting changes in teacher attitudes and practices with technology. Teacher educators and educational technologists interested in implementing communities of practice should consider including activities that align with the principles of effective professional development (i.e. active learning, situate learning in teachers' needs, focus on teacher knowledge, etc.) in their efforts to improve teacher outcomes with instructional technology. At the very least, teachers implementing communities of practice around technology may need a technician or support person to help them manage the technology and keep it working reliably. Future research on communities of practice should more closely examine the relationship between such activities and specific teacher outcomes.

Future research is also needed to determine the extent to which mentoring, communities of practice, and teacher beliefs play a role in creating an environment that promotes technology integration and, ultimately, teachers' instructional practice. A comparison study with a control group or group of teachers under a different type of professional development would help isolate the direct influence of situated professional development on teacher attitudes and performance. Other research could include examining the relationship between each barrier and specific changes in a teacher's use of technology under this model over time.

7. Conclusion

There are a number of models of technology integration that promote the use of long-term, situated professional development activities (see Mouza, 2006; Wells, 2007) in an effort to improve the frequency and quality of technology integration in K12 schools. This case study provides teacher educators, administrators, and educational technologists alike with a valuable example of the effect of these activities in an applied setting. The results suggest that enacting a variety of situated learning activities around the principles of effective professional development may be the key to providing teachers with the knowledge and support needed to integrate technology more fully into their instruction. Examining the relationship between such activity and teachers' long-term practices with technology is a critical first step in making lasting changes in the way teachers use technology to support student learning in the classroom.

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