Impact of Research-Based Professional Development: Investigation of Inservice Teacher Learning and Practice in Wiki Integration

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Abstract

This study reports on a district-wide research-based professional development (PD) that included 207 teachers and administrators. Data were collected from pre/post surveys, content analysis of the participants' wiki pages, and a follow-up questionnaire. Findings indicate that participants significantly improved their foundational and technical wiki skills. The PD had a significant impact on participants' perceptions of preparedness to use wikis in the classroom. Findings provided evidence that research-based PD can foster sustained teacher practice. The study demonstrates that participation in PD that is sustained, student-centered, participatory, and supported by adequate resources can have a significant impact on teacher learning and practice about specific technologies. (Keywords: technology integration, professional development, wiki, collaborative technology)

Extensive research has been conducted in an effort to identify best practices for professional development (PD) of teachers (i.e., Fishman, Marx, Best, & Tal, 2003; Garet, Porter, Desimone, Birman, & Yoon, 2001). This body of research has revealed that teachers benefit from learning in environments that are learner centered (Bransford, Brown, & Cocking, 2000) and intentionally designed to build on the learner's strengths, knowledge, and interests. In addition, learning opportunities are most effective when they are specifically tailored to the learner's needs and housed within a relevant contextual setting (Loucks-Horsley & Matsumoto, 1999). PD for teachers should also be knowledge centered (Bransford, et al., 2000), with a focus on content knowledge and the general pedagogical knowledge

of teaching. More important, it should have an emphasis on pedagogical content knowledge, which is the knowledge of effective teaching strategies for a specific content area (Shulman, 1987). This includes providing explicit opportunities to explore how students learn, potential misconceptions that can arise during instruction, and effective teaching strategies that can be employed to address those misconceptions (Garet, et al., 2001).

While building on the existing research surrounding teacher professional development, there has been a shift in focus to the design of PD targeted to help teachers integrate technology in the classroom. However, training in educational technology often focuses more on learning to use the technology rather than learning how to teach with the technology (Moursund & Bielefeldt, 1999) resulting in teachers lacking the time, encouragement, and support they need to become comfortable with using different technologies for specific instructional purposes (Russell, Bebell, O'Dwyer, & O'Connor, 2003; Schrum, 1999). It has been suggested that the focus should instead be on helping teachers develop skills and knowledge specific to teaching with technology (Koehler & Mishra, 2008; Margerum-Leys & Marx, 2004). Aligned with this notion, the professional development designed for this research project focused specifically on helping teachers learn how to use wikis across the curriculum. This decision was influenced by the results of a needs assessment (conducted across the participating school district where this study took place), which revealed that a majority of teachers and administrators were interested in learning more about wikis and that the current level of knowledge about this technology was quite low.

The Use of Wikis in the Classroom

Wikis are easily editable, collaborative websites that can have multiple authors (Cunningham, 2001). It is not necessary to have advanced knowledge of HTML coding or Web design skills to use a wiki, which makes it a very accessible platform for a wide range of individuals (Ben-Zvi, 2007). Wikis are a particularly good fit for integration in K–12 classrooms, as many students are familiar with these types of social, Web-based technologies (Prensky, 2001), and they can be used to support a wide variety of collaborative writing and problem-solving activities (Pixy Ferris & Wilder, 2006). Students can quickly add, edit, and update content, which makes the wiki environment highly conducive to collaboration (Bold, 2006). Each edit and comment is tracked back to the individual author, making it possible for classmates to see who is correcting and modifying their work. This collaborative creation of content also presents one of the drawbacks of wikis, which is that the accuracy of the content is dependent on the collective knowledge of the group (Wheeler, Yeomans, & Wheeler, 2008), making it necessary for teachers to constantly review student contributions.

In addition to facilitating collaboration, the 2011 K–12 edition of the Horizon Report lists wikis as an effective tool for fostering students' creative

expression (Johnson, Adams, & Haywod, 2011). The use of wikis can also help initiate the transition from individualized learning to a more social construction of knowledge (Mejias, 2006), and teachers who incorporate wikis and other types of technologies are more likely to use constructivist pedagogical approaches in their teaching (Rakes, Fields, & Cox, 2006). Constructivism is a theory of learning that contends that knowledge is created through the collaboration of many actors, including teachers, content experts, and students (Brown et al., 1993; Lave, 1988). The notion that knowledge is constructed indicates that students must take an active role in their learning, as opposed to being passive vessels into which teachers pour information. This also implies that knowledge is not a static entity but instead an evolving process that differs from learner to learner (Gredler, 1997). Another benefit of wikis is that they are neither content nor grade specific, which makes them relevant and accessible across the curriculum. This was particularly beneficial in this study, as teachers from across the K–12 spectrum were involved in the PD.

Professional Development and Teacher Learning

Guskey (2002) defines PD programs as "systematic efforts to bring about change in the classroom practices of teachers, in their attitudes and beliefs, and in the learning outcomes of students" (p. 381). Citing the studies conducted in the late 1990s and early 2000s (i.e., Cohen & Hill, 2000; Kennedy, 1998; Wang, Frechtling, & Sanders, 1999), Guskey further argues that, contrary to the general acceptance of the importance of PD for educational improvement, reviews of PD research consistently point out the ineffectiveness of most programs. The author highlights two critical factors contributing to this ineffectiveness: not taking into account what motivates teachers to engage in PD, and the process by which change in teachers typically occurs.

Borko (2004) adds to Guskey's discussion, indicating that many PD programs are still short-term experiences that do not take into account what we know about how teachers learn. Borko further points out that studies have documented that PD can lead to improvements in instructional practices and student learning (i.e., Desimone, et al., 2002; Fishman, et al., 2003; Garet, et al, 2001). However, she writes, "we are only beginning to learn about exactly what and how teachers learn from PD, or about the impact of teacher change on student outcomes" (p.4).

Mouza (2009) highlights that another track of research has investigated the connection between specific characteristics of PD and changes in teacher learning and classroom practice (i.e. Franke, Carpenter, Levi, & Fennema, 2001; Grossman, Wineburg, & Woolworth, 2001). These studies focused mainly on the subjects of mathematics, science, and literacy. The author further elaborates that there is a need to study the effectiveness of PD programs that are built around quality principles in areas that have received little attention to date, such as teacher learning with regard to technology.

Mouza highlights that few studies exist to date that demonstrate the impact of technology-focused PD on teacher learning and practice, and even fewer studies have examined teacher learning and practice to understand the sustainability and growth of PD gains.

Mouza (2009) reports on one such instance of research, in which she conducted a longitudinal case study to examine the impact of a "research-based" PD on teacher learning in technology integration. The study findings indicate that participation in research-based PD programs fosters sustained changes in teachers' instructional technology knowledge, ability to design and implement technology-enhanced learning experiences for students, and positive attitude toward teaching and learning with technology. The author sets a full research agenda ahead of us to investigate the impact of research-based PD in different contexts pertaining to teacher learning and practice in technology integration.

In accordance with the existing literature, the purpose of this present study was to examine the impact of a research-based professional development model on inservice teacher learning and practice with respect to wiki applications in the curriculum. We examined the following specific research questions in the study:

1. What was the impact of the PD program on participants' knowledge of wiki skills? Were there any significant differences in the level of gained wiki skills related to participants' (a) grade level, (b) years of teaching, and (c) teaching subject area?
2. What was the impact of the PD program on participants' knowledge of wiki integration strategies in the classroom? Were there any significant differences in the level of learned wiki integration strategies related to participants' (a) grade level, (b) years of teaching, and (c) teaching subject area?
3. What was the impact of the PD program on participants' sustained use of wikis in the classroom? After the PD program ended, to what extent did participants continue to use the wikis in the classroom? What were the factors that facilitated and/or hindered the continued use of wikis in the classroom?

Conceptual Framework and District-Wide Wiki PD

The professional development activities presented in this study include a district-wide wiki PD program. The program used the "Components of Effective Professional Development for Technology Use" (North Central Regional Educational Laboratory [NCREL], 2000) as its conceptual framework. NCREL argues that PD for technology use should contain essential components that research has found to be critical. These components include the following: (a) a connection to student learning, (b) hands-on technology use, (c) a variety of learning experiences, (d)

curriculum-specific applications, (e) new roles for teachers, (f) collegial learning, (g) active participation of teachers, (h) ongoing process, (i) sufficient time, (j) technical assistance and support, (k) administrative support, (l) adequate resources, (m) continuous funding, and (n) built-in evaluation. The PD designed for this study closely adhered to the components listed above in a variety of ways. The following sections describe how the wiki PD implemented in this study addressed these components.

Connection to student learning. The goal of the wiki PD was to provide teachers with a foundational, technical knowledge of wikis and the application of wikis in the teaching and learning process. It placed an explicit emphasis on connecting the PD to student learning by helping participants explore ways that wikis could be used to foster collaboration among students, engagement in authentic problem solving, and taking ownership of their own learning.

Hands-on technology use. Participants in the wiki PD had multiple opportunities to engage in hands-on learning with the technology. Small-group training sessions took place in a computer lab structured with guided instruction on creating and managing a wiki. As these instructions were presented, participants actively worked with their own wikis. Follow-up sessions also required hands-on-technology use in which teachers continued to work with their individual wiki pages.

Variety of learning experiences. Participating teachers in the wiki PD were exposed to a variety of learning experiences over a 6-month timeframe that started with small-group instruction. The focus of these initial sessions was on learning the necessary skills to create, edit, and work with a wiki. In addition, participants were introduced to a wide range of examples illustrating how wikis were being used in K–12 classrooms. Participants created their own wikis and were asked to brainstorm a list of initial ideas for integrating wikis into their respective curricula. These training sessions were followed by one-on-one instruction and follow-up support as well as opportunities for ongoing discussion and reflection during routine school days.

Curriculum-specific applications. Wiki PD activities demonstrated projects in specific curriculum areas relevant to the participating teachers to help them better understand how to integrate wikis into their teaching. Presentation of wiki examples included wikis being used for professional collaboration, classroom communication, and student-centered projects. These examples were selected from varying grade levels and content areas.

New roles for teachers. As teachers participated in the wiki PD with their colleagues, they came to realize that using wikis with their students would require them to take on different roles in the classroom. These roles included providing support to students as they acquired ownership of their learning. Wikis also provide an efficient, rich environment for student collaboration. In a wiki, students are no longer bound to the limited time and physical

space requirements of traditional collaborative projects. The PD activities emphasized this new role for the participants as well.

Collegial learning. In most cases, the wiki PD included cohorts of teachers working at the same school. The planned PD activities in each cohort were facilitated by one of their fellow colleagues who trained initially for the assumed role. To enrich the sharing of ideas over the long term, we developed a collaborative wiki page to provide a common place for posting experiences and successes with wiki implementations.

Active participation of teachers. The wiki PD was a district-wide initiative to allow all teachers in the district to learn about wiki applications in the classroom. The district implemented an incentive structure to encourage the use of wikis in the classroom. This included purchasing a wiki license for district teachers and providing small technology gifts to reward active participation throughout the project.

Ongoing process. We implemented the wiki PD over a 6-month period and included multiple phases as well as opportunities for online and offline learning and support. Scheduled PD sessions provided experiences to learn about wiki applications in the classroom. Subsequent training and sharing ensured continued learning as participants applied their new knowledge in the classroom. Ongoing support and follow-up activities allowed participants to support one another in taking risks in using their wikis for new activities.

Sufficient time. Each cohort received an initial 2-hour PD session to learn the necessary skills to create, edit, and work with a wiki. Additional follow-up activities allowed participants to share ideas and seek support as they evolved in their thinking about individual classroom applications of wikis. The second formal PD session allowed participants to engage in discussions and a hands-on approach to learning advanced integration methods. Trainers and the district's instructional technology coordinator (ITC) provided ongoing face-to-face and online support to participants outside of the scheduled PD sessions.

Technical assistance and support. The ITC provided systemic technical and PD support throughout all phases of the wiki PD. Opportunities for online and offline assistance and support was readily available.

Administrative support. Because the wikis were a district-wide initiative, including administrators in the process was important. Several of the district's instructional leaders attended the planned sessions of the wiki PD to show their support for the educational use of wikis in the classroom. The director of instructional services was implementing and modeling a collaborative wiki with all district administrators at the time the wiki PD started. As administrators became familiar with the functionality of wikis, they were expected to promote them in their respective schools. When the wiki PD was initiated, participating teachers understood that wikis were being promoted, modeled, and supported monetarily by district administrators.

Adequate resources. The district purchased a district-wide Wikispaces (www.wikispaces.com) license to provide unlimited online storage for teachers. The district had an approximate computing ratio of one computer for every four instructional staff and students. The district network provided sufficient bandwidth to accommodate users in online environments.

Continuous funding. The school district where the wiki PD was implemented considers funding for technology hardware and infrastructure as a short-term, 3-year capital expense. Generally, this expense is renewed without interruption in support or scheduled upgrades. However, instructional technology funding tends to fluctuate frequently and unpredictably, leading to caution with the investment of time in any particular technology. The district acquired Wikispaces with the understanding that it would be a core and sustainable technology application across grade levels.

Built-in evaluation. Effective PD uses evaluation to ensure that each PD activity is meeting the needs of the participants and providing them with new learning experiences. We developed preformative, summative, and formative assessments while planning the wiki PD to ensure relevance and quality of experience.

Methods

Research Design

We used a mixed-methods design in this study. As Gay, Mills, and Airasian (2006) describe, mixed-method research combines both quantitative and qualitative data collection and analysis in a single study. The use of descriptive, comparative, and interpretive components in this study required a combination of quantitative and qualitative research methods to appropriately answer the research questions. The first step of the study involved the dissemination of the pretest wiki survey prior to the beginning of the program. The second step involved an ongoing collection of program participation data and artifacts from the PD activities. The third step involved administering a posttest wiki survey. The fourth step included the content analysis of the program participants' wiki pages. The final step of the study included a follow-up questionnaire with a selected group of study participants.

Participants and Setting

The study took place in a midsize suburban school district near Detroit, Michigan. We completed the first phase of the study in the fall 2009 term, the second phase in the winter of 2010, the third phase in the fall of 2010, and the last phase in the winter 2011 semester. We invited all teachers and administrators across the district (approximately 695 teachers and 90 administrators) to participate, and 218 (28%) individuals accepted that invitation. From this initial group, we trained 11 individuals to be facilitators of the PD sessions during the first phase of the study. The district's ITC, who is

a co-author of this article, was in charge of this portion of the training, and he "trained the trainers" by modeling for them what they were expected to do in the PD sessions they would be leading the following semester. During the second phase, we assigned the 11 trainers and the ITC to cohorts of teachers (32 cohorts across 10 schools) to train and support. In most cases, we assigned the trainers two cohorts each, averaging 10 participants per cohort, but in a few cases a trainer had only one cohort. We assigned cohorts by school when possible so that teachers would be learning together with colleagues from their building.

Each cohort received an initial 2-hour PD session in January or February during the second phase of the study. The focus of this session was on learning the necessary skills to create, edit, and work with a wiki. In addition, the trainers introduced participants to a wide range of examples illustrating how wikis were being used in K–12 classrooms. Participants created their own wikis and were asked to brainstorm a list of initial ideas for integrating wikis into their respective curriculum. These participants shared and more fully developed these ideas during a second PD session that took place in March or April (depending on the cohort). Trainers and the ITC provided ongoing face-to-face and online support to participants outside of the scheduled PD sessions.

The demographic profile of the participant group with respect to gender was 85% female and 15% male. The distribution was fairly equal in regard to teaching experience, with 31% having 1–9 years of experience, 37% having 10–19 years of experience, and 32% having 20 or more years of experience. The majority of participants came from elementary schools (44%), with the remainder comprised of teachers from junior high (32%) and high school (10%) as well as support staff/administrative personnel (14%).

Instrumentation

We, the authors of this study, who have extensive expertise in the field of educational technology, developed a survey to obtain demographic information, participant perceptions of our own wiki skills, and knowledge about the integration of wikis in the classroom (see Appendix, pp. 332–334). We reviewed and revised the instrument multiple times for content validity. We administered the 43-item survey before and after the facilitation of the PD sessions. We also developed a protocol for the content analysis of the participants' wiki pages to identify the patterns of use of wiki pages. The protocol included visiting each participant's wiki page and reviewing the "History" component to understand if participating teachers continued to use their wiki pages after the PD program ended. We also analyzed wikis to determine how the participants were using them. We used criteria established in the "wiki applications" section of the pre- and postsurvey instrument as part of this analysis considering professional and instructional use of wikis. Based on the content analysis of the wiki pages,

we invited a targeted number of teachers to participate in a follow-up questionnaire. We developed the questionnaire, which included six questions, to identify the factors that facilitated and/or hindered the continued use of wikis in the classroom.

Data Collection and Analysis

We collected various forms of data relating to each of the research questions by applying a combination of quantitative and qualitative methodologies. We collected quantitative data from the pre and post wiki survey. We collected qualitative data from the content analysis of the participants' wiki pages and follow-up interview questionnaire.

The research questions drove the data analysis. We acquired the data through the wiki survey, which we administered twice in a pretest/posttest design. To treat the missing data, we excluded cases analysis by analysis and used all cases that had valid data for two variables in a pair in the test for that pair. To analyze between- and within-group differences, we first needed to check the assumptions of the parametric tests. The first assumption to employ a parametric test was normal distribution (Field, 2005). Thus, we conducted normality tests. The tests of normality (both Kolmogorov-Simirnov and Shapiro-Wilk) revealed that the distribution of the participant responses was not within the normal range for each item or total scores. Because the data was not normally distributed, we used nonparametric counterparts of the parametric comparison tests. As a result, we employed a descriptive statistics, nonparametric comparison test (Wilcoxon Signed Rank) for paired samples and a between-by-within design test for nonparametric data to analyze the data collated through pre/posttest. We administered a Mann-Whitney U test as follow-up after the significant between-by-within design test results. We used Bonferroni correction, which means that the critical value (Alpha Error) of .05 (for this study) is divided by the number of the tests conducted, for adjustment of the critical value after administering a series of U tests.

We analyzed each participant's wiki page after the new school year started (2010–2011). Review of the "History" component of the wiki pages allowed us to understand if participating teachers continued to use their wiki pages after the PD program ended. Wiki pages were also analyzed to determine how they were being used.

We also conducted data collection via an online questionnaire in the winter 2011 semester to follow up with teachers on their use of wikis. We employed a maximum variation sampling method for the selection of the follow-up interview participants. We purposefully identified and invited a total of 25 participants for the follow-up interviews. From each cohort group, we identified one participant who updated his/her wiki and one who did not to ensure a maximum variation of teaching grade level. We selected teachers with different levels of updates (light, moderate, heavy) from

among those who updated their wiki pages. We invited seven more participants to the interviews after observing a low participation rate for the first round, bringing the total number to 32. We organized and sorted the data collected through the questionnaire, following three repeating steps (reading/memoing, describing, and classifying) for analyzing the data (Gay, et al., 2006) to identify/verify some of the factors that promoted and/or influenced the continued use of wikis in the classroom.

Results

Wiki Skills (Foundational, Technical)
At the beginning and end of the PD program, participants completed the 43-item wiki survey. Section B of the instrument included a total of 30 items related to foundational and technical wiki skills. On this section, participants rated their competency on each of the survey items on a 4-point scale (1 = poor, 2 = fair, 3 = good, 4 = excellent). The nonparametric comparison test (Wilcoxon Signed Rank) results indicated a significant increase (at the .05 level) in scores from pretest to posttest for each item tested on the survey. As shown in Table 1, the data indicated that after their participation in the PD program project, participants felt competent creating wiki sites, managing them, and using common wiki features on their sites. The posttest survey median scores for each item listed on the survey indicated that most participants were still willing to rate their knowledge and skill levels as "fair" or "good." This suggests that further training is necessary to move more individuals into the "good" and "excellent" categories.

We conducted further analysis to test if the studied independent variables (teaching grade level, years of teaching, or teaching subject area) had a significant impact on improving participants' wiki skills. We employed Wilcox's (2007) nonparametric test of statistics for between-by-within design to analyze the main effects and interactions between pre/postsurvey scores and these independent variables. The test results showed no significant interaction between the levels of gained wiki skills related to participants' teaching grade level, years of teaching, or teaching subject area.

Wiki Applications
Section C of the survey instrument included a total of 13 items related to wiki applications in the classroom. Participants responded to the survey items indicating their preparedness to use wiki applications in the classroom, rating their level of preparation for each item on a 4-point scale (1 = not adequately prepared, 2 = somewhat prepared, 3 = prepared, 4 = very well prepared). The nonparametric comparison test (Wilcoxon Signed Rank) results indicated a significant increase (at the .05 level) in scores from pretest to posttest for each item tested on the survey. As shown in Table 2 (p. 325), the results indicated that the PD had a significant impact

Table 1. Wilcoxon Signed Rank Test Results for Wiki Skills

Wiki Skill		n		Mean Rank		Sum of Ranks		Pre-Mdn	Post-Mdn	Z**	p
	N	NR*	PR*	NR	PR	NR	PR				
Level of awareness	133	6	102	32.75	55.78	196.50	5689.50	2	3	8.63	.00
Level of experience	133	1	112	35.50	57.19	35.50	6405.50	1	2	9.44	.00
Level of competency	133	2	108	35.50	55.87	71.00	6034.00	1	2	9.22	.00
Creating a wiki site	133	1	117	32.00	59.74	32.00	6989.00	1	3	9.58	.00
Having students create wiki sites	132	1	60	20.50	31.18	20.50	1870.50	1	2	6.90	.00
Helping other teachers create wiki sites	132	1	82	26.50	42.19	26.50	3459.50	1	2	8.07	.00
Creating accounts	133	1	91	30.50	46.68	30.50	4247.50	1	2	8.52	.00
Deleting accounts	132	0	82	0.00	41.50	0.00	3403.00	1	2	8.07	.00
Setting appropriate level of wiki permissions	133	0	88	0.00	44.50	0.00	3916.00	1	2	8.37	.00
Inviting new members	133	0	86	0.00	43.50	0.00	3741.00	1	2	8.25	.00
Classifying members	132	0	73	0.00	37.00	0.00	2701.00	1	2	7.62	.00
Reclassifying/removing members	132	0	75	0.00	38.00	0.00	2850.00	1	2	7.71	.00
Changing wiki theme	133	1	104	24.00	53.28	24.00	5541.00	1	3	8.99	.00
Changing wiki colors	133	1	109	24.50	55.78	24.50	6080.50	1	3	9.20	.00
Changing domain name	133	0	88	0.00	44.50	0.00	3916.00	1	2	8.34	.00
Setting wiki-wide notifications	133	2	74	23.50	38.91	47.00	2879.00	1	2	7.56	.00
Following recent changes	133	1	85	23.00	43.74	23.00	3718.00	1	2	8.15	.00
Tracking wiki statistics	133	2	73	24.50	38.37	49.00	2801.00	1	2	7.53	.00
Adding a new page	133	0	117	0.00	59.00	0.00	6903.00	1	3	9.53	.00
Adding/editing text	133	0	115	0.00	58.00	0.00	6670.00	1	3	9.45	.00
Adding/editing symbols	133	0	101	0.00	51.00	0.00	5151.00	1	3	8.87	.00
Adding/editing tables	133	1	93	21.50	47.78	21.50	4443.50	1	2	8.48	.00
Adding/editing graphics/images	133	1	100	23.00	51.28	23.00	5128.00	1	3	8.81	.00
Adding/editing hyperlinks	133	0	94	0.00	47.50	0.00	4465.00	1	3	8.57	.00
Adding/editing multi-media	133	0	89	0.00	45.00	0.00	4005.00	1	2	8.35	.00
Adding/editing tags	133	0	80	0.00	40.50	0.00	3240.00	1	2	7.99	.00
Adding/editing badges	133	0	76	0.00	38.50	0.00	2926.00	1	2	7.84	.00
Uploading external files	133	0	91	0.00	46.00	0.00	4186.00	1	2	8.43	.00
Using discussion forum	133	2	80	21.00	42.01	42.00	3361.00	1	2	7.84	.00
Embedding widgets	133	1	77	20.50	39.75	20.50	3060.50	1	2	7.74	.00
Total Mean Scores	133	1	131	7.00	66.95	7.00	8771.00	1.03	2.27	9.95	.00

*NR: Negative Ranks, PR: Positive Ranks

**Based on negative ranks.

on participant perceptions of preparedness to use wikis in the classroom. Similar to the results reported earlier pertaining to wiki skills, the post-test median scores tested for each item listed on the wiki application survey indicated that the majority of participants still only felt "somewhat prepared" to use wikis in their professional practice, except in the case of items 1 and 5, for which participants felt "prepared" to create a classroom website using a wiki and to use a wiki for classroom communication. These results suggest that further training would be necessary to move more individuals into the "prepared" and "very well prepared" categories.

We employed Wilcox's (2007) nonparametric test of statistics for between-by-within design to analyze the main effects and interactions between pre/postsurvey scores and the independent variables. The test results indicated no significant differences in the level of learned wiki integration strategies related to participants' grade level, years of teaching, or teaching subject area.

Sustained Use of Wikis in the Classroom

To determine if participants were actively using and regularly updating their wiki pages, we analyzed the entire collection of wikis created as part of this project after the 2010–2011school year started. Wikispaces tracks the history of edits made to individual pages within a given wiki, and we reviewed this history for each wiki to ascertain when each participant made the most recent edit and how many edits he/she completed after the final training session. Of the 181 participants who participated for the duration of the study, 104 (57%) made edits and changes to their wikis. The range of edits extended from a low of 1 to a high of 821 changes made to a single wiki. Participants were then placed into one of three groups (light, moderate, heavy use) depending on the number of edits made to their wikis. The breakdown of these groups indicated that 67% had light use (30 or fewer edits), 16% had moderate use (31–80 edits), and 17% had heavy use (more than 80 edits). Although the editing of wikis tapered off once the prior school year ended, 37 (36%) of the 104 who made changes to their wikis continued editing through the summer and into the next school year. These individuals took the initiative to update their wikis and add content independent of any additional training since the last scheduled PD occurred in late March.

We also analyzed wikis to determine how they were being used. We used criteria established in the "wiki applications" section of the pre- and post-survey instrument as part of this analysis. Content analysis revealed that the majority of participants used their wikis to communicate information (81 participants). This included posting dates of upcoming events, maintaining a homework page, and providing access to other information relevant to the particular classroom. Teachers who used their wikis to communicate information treated the wiki as a class website where they could disseminate information to parents and students, and the communication was one-way in nature, flowing from the teacher exclusively.

Table 2. Wilcoxon Signed Rank Test Results for Wiki Applications

Wiki Application	n			Mean Rank		Sum of Ranks		Pre-Mdn	Post-Mdn	Z	p
	N	NR	PR	NR	PR	NR	PR				
Creating a classroom website using wiki	104.00	0.00	90.00	0.00	45.50	0.00	4095.00	1	3	8.42	0.00
Co-authoring a wiki site with colleagues	102.00	1.00	74.00	22.00	38.22	22.00	2828.00	1	2	7.61	0.00
Co-authoring a wiki site amongst students	99.00	1.00	67.00	23.00	34.67	23.00	2323.00	1	2	7.31	0.00
Becoming a part of a wiki-based online professional learning community	104.00	1.00	77.00	25.50	39.68	25.50	3055.50	1	2	7.82	0.00
Using a wiki for classroom communication	104.00	2.00	84.00	20.50	44.05	41.00	3700.00	1	3	8.04	0.00
Using a wiki to foster student collaboration	101.00	2.00	71.00	21.00	37.45	42.00	2659.00	1	2	7.39	0.00
Using a wiki to blend face to face learning with online learning	100.00	0.00	72.00	0.00	36.50	0.00	2628.00	1	2	7.57	0.00
Using a wiki promote student-centered collaborative writing	100.00	2.00	64.00	18.50	33.97	37.00	2174.00	1	2	7.00	0.00
Using a wiki to create artifacts of student learning	103.00	1.00	73.00	23.00	37.70	23.00	2752.00	1	2	7.58	0.00
Using a wiki to increase student control and promote ownership of learning	99.00	0.00	67.00	0.00	34.00	0.00	2278.00	1	2	7.27	0.00
Using a wiki to promote project-based learning opportunities	101.00	0.00	70.00	0.00	35.50	0.00	2485.00	1	2	7.48	0.00
Using a wiki to design and facilitate problem-solving activities	100.00	0.00	68.00	0.00	34.50	0.00	2346.00	1	2	7.40	0.00
Using a wiki to promote higher-order thinking skill activities	99.00	0.00	65.00	0.00	33.00	0.00	2145.00	1	2	7.16	0.00
Total Mean Scores	106.00	0.00	101.00	0.00	51.00	0.00	5151.00	1	2.08	8.73	0.00

*NR: Negative Ranks, PR: Positive Ranks

**Based on negative ranks.

Another common use of the wikis was to create blended learning experiences (35 participants) by providing links to external websites or embedding videos, animations, or other multimedia elements in their wiki pages to support learning around specific topics. Teachers also had students contribute content to their wikis as a way to promote learning. Examples of this included students conducting research and then collaborating on a page related to their research and engaging in book reviews as a way to support reading of different novels.

Finally, teachers used their wikis to post artifacts of student learning (10 participants). In most cases, this consisted of teachers uploading an image, document, or presentation file that a student had created. In essence, these teachers were using their wikis as a repository for student work in order to make that work more easily accessible to others.

Factors That Affected Teacher Practice

To identify/verify some of the factors that promoted and/or influenced the continued use of wikis in the classroom, we conducted follow-up data collection via an online questionnaire in the winter 2011 semester. Of the 32 participants invited to participate in the follow-up questionnaire, 16 responded (50%). Data analysis indicated that those who responded to the follow-up questionnaire were representative of the initial group invited to participate. Of the 16 participants, 11 respondents stated that they were still using their wiki pages developed during the PD program. When asked about what motivated or helped them to continue using the wiki in their classrooms or with colleagues, one-third of the respondents expressed "the ability to communicate" with their students through their wiki pages. Similarly, one-third of responses indicated the "positive professional development experience" they had received. Other factors that motivated or helped respondents to continue using their wikis in the classroom included ease of use of wikis, ease of access to information by teacher's intended audience (e.g. students, colleagues, parents), culture of wiki use in the school district, interactive teaching and learning features of wikis, and timely and accurate support. When asked about their impressions of the wiki PD, participants listed the following as strengths of the training:

- The PD did a good job of introducing participants to wikis and showing the basics of using Wikispaces to create a wiki.
- Participants appreciated being able to learn about wikis from a colleague they knew and within their own building and district.
- Participants valued having a follow-up session rather than just a single, standalone training.

Of those who responded to the follow-up questionnaire, five reported that they were not using the wiki pages they developed during the PD. When asked about what hindered the use of wikis in their classroom, one

respondent highlighted the length of the PD stating, "The PD was too brief." Another respondent pointed out the lack of students' access to computers at school and/or home. Lack of time to practice and/or learn new skills and lack of confidence in skills to continue using wikis were other factors that two other respondents expressed. One respondent indicated a teaching assignment change from last year (i.e., "lost" work) as the factor. In response to a follow-up question directed to the nonuser group, respondents indicated the need for additional ongoing training, further support and resources, structured time for collegial teaching of wiki skills and/or sharing of experiences, additional time to work on wikis, and individualized support to develop existing and/or new skills.

Discussion

Key Findings

As the findings suggest, participation in the research-based PD program investigated in this study provided a significant impact on the development of knowledge and skills about wikis. In addition, the PD helped participants feel more prepared to use wikis in the teaching and learning process. Findings also suggest that, although the research-based PD program provided significant improvements in these areas, there is still room for further development of the participating teachers so that they can feel confident and competent about using wikis in their professional practice on a regular basis. This finding might be partly explained by the fact that the majority of teachers who participated in this study started out with very little knowledge about wikis and, consequently, felt the need for further development at the end. In essence, the gap in their knowledge was so vast that even with significant improvement in understanding, the chasm between their initial knowledge and the point at which they would feel "very well prepared" was too vast to bridge within the scope of this project.

Findings provided evidence that research-based PD can foster teacher learning and a sustained change in classroom practice. The majority of teachers (57%) continued to use their wiki sites after the formal PD ended. One-third of the participants in this group continued to use wikis for professional and/or instructional purposes, indicating the long-term impact of the research-based PD program investigated in this study. Findings of this study are aligned with the finding of another study, in which Mouza (2009) reports the impact of research-based PD for sustained teacher learning in technology use.

The findings revealed several factors that contributed to the continued use of wikis. One thing that participants mentioned multiple times was that they felt a great deal of support from the district throughout this project. The fact that the district purchased a district-wide site license from Wikispaces to give teachers and administrators access to this tool was a clear indication that the use of wikis was valued and expected. District support was also

evident from the fact that teachers and administrators were put in charge of the PD and made available for mentorship and consultation throughout the year. Findings indicated that this ongoing support from the district made it easier to take on the task of learning a new technology and provided the necessary motivation and guidance to continue using wikis in the classroom. Another motivating factor that seems to have affected teacher use of the wikis was the fact that the tool was fairly easy to learn and had broad application across the curriculum and grade levels. In a sense, a wiki provides something for everyone and can be customized and adapted for many uses. The flexibility and ease of use of this tool was an important contributing factor for those teachers who continued to use the technology.

Findings indicated that a little more than one-third of the participants (37%) did not continue to use the wiki pages they created during the course of the PD. Some of the participants in this group expressed a need for additional time and ongoing training, further support and resources, and collegial learning and mentoring. Findings also uncovered suggestions for improvement of the training, which included the need for more training in how to actually teach with wikis and one-on-one assistance or mentorship to help with the integration of wikis into classroom instruction. One proposed solution to address this issue and further help teachers who need additional training and support would be to incorporate a mentoring component in the PD structure. Many technology enhancement projects have used one-on-one mentoring strategies (Howland & Wedman, 2004) and a combination of workshops and mentoring (Brush, et al, 2003) to train teachers with regard to technology integration. Research has shown that an effective way to support the integration of technology in the classroom is by partnering teachers with "tech savvy" mentors who can provide the technical and pedagogical support they need when attempting to use new tools (Cole, Simkins, & Penuel, 2002). In addition, these collaborative partnerships help to allay the fears many teachers have about using technology with their students (Mulqueen, 2001) and can increase the motivation and enthusiasm teachers exhibit toward technology-based training (Holbein & Jackson, 1999).

Limitations of the Study
The present study has some limitations that need to be taken into account when considering this research and its contributions. The participants in this study were volunteers who self-selected based on their interest in using wikis in the classroom. These participants may not be representative of all teachers in the district where this study was conducted. In addition, 26 of the initial PD participants (14%) either retired or moved out of the district when the new school year started, which reduced the study population from 207 to 181 for the purposes of content analysis of participating teachers' wiki pages.

Implications for Practice

This study provides evidence that research-based professional development that is sustained, student-centered, participatory, and supported by adequate resources can have a significant impact on teacher learning about specific technologies and the level of integration of these technologies in the classroom. The study findings have implications for PD developers who are directly involved in designing and implementing technology-focused PD programs for practicing teachers. As a result, the study adds to the field's understanding of the effectiveness of research-based PD efforts. The study further suggests that developing a core team of trainers from within a district can also be an effective way to disseminate training and knowledge to the broader population of teachers, administrators, and staff. Districts looking to train teachers, staff, and administrators in the implementation of technology should consider forming training teams that can provide ongoing support and PD to district personnel.

Recommendations for Future Research

Although the PD program offered participants in the current study one-on-one assistance and tutoring, the program did not implement a systematic program of mentoring. Exploring the impact of incorporating mentoring into the training process is a recommended area of future investigation.

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Appendix

Wiki Survey

CODE NUMBER:

Dear FPS Teacher,

Thank you for taking your time and assisting the FPS/UM-Dearborn research team with this data collection. The goal of this survey is to understand your foundational and technical knowledge of wikis and the application of wikis in the teaching and learning process. Your responses are strictly confidential. The data collected through this survey will only be used for research purposes as a group data.

   Please do not put your name on this form but USE THE CODE NUMBER given to you by your instructor.

Thanks,
The Research Team

Demographic Information

What is your gender?

What grade(s) do you teach?

How many years have you been teaching?

What subject(s) are you teaching this school year?

In what subject areas do you have a teaching endorsement(s)?

Wiki Skills (Foundational, Technical)

Please rate your competency on each of the following items on a 4-point scale: 1 = poor, 2 = fair, 3 = good, 4 = excellent.

	1(Poor)	2 (Fair)	3 (Good)	4 (Excellent)
Overall				
Level of awareness (heard, seen)				
Level of experience (edited, contributed)				
Level of competency (created, managed, used)				
Creating a Wiki site				
Creating a wiki site				
Having students create wiki sites				
Helping other teachers create wiki sites				
Managing a Wiki site				
Creating accounts				
Deleting accounts				
Setting appropriate level of wiki permissions				
Inviting new members				
Classifying members				
Reclassifying/removing members				
Changing wiki theme				
Changing wiki colors				
changing domain name				
Setting wiki-wide notifications				
Following recent changes				
Tracking wiki statistics				
Using Wiki Features				
Adding a new page				
Adding/editing text				
Adding/editing symbols				
Adding/editing tables				
Adding/editing graphics/images				
Adding/editing hyperlinks				
Adding/editing multimedia				
Adding/editing tags				
Adding/editing badges				
Uploading external files				
Using discussion forum				
Embedding widgets				

Wiki Applications (Collaborative Use of Wiki)

Rate your level of preparation for each item on a 4-point scale: 1 = not adequately prepared, 2 = somewhat prepared, 3 = prepared, 4 = very well prepared.

Professional Applications	1	2	3	4
Creating a classroom website using wiki				
Co-authoring a wiki site with colleagues				
Co-authoring a wiki site amongst students				
Becoming a part of a wiki-based online professional learning community				
Instructional Application				
Using a wiki for classroom communication				
Using a wiki to foster student collaboration				
Using a wiki to blend face-to-face learning with online learning				
Using a wiki to promote student-centered collaborative writing				
Using a wiki to create artifacts of student learning				
Using a wiki to increase student control and promote ownership of learning				
Using a wiki to promote project-based learning opportunities				
Using a wiki to design and facilitate problem-solving activities				
Using a wiki to promote higher-order thinking skill activities				