Effects of a Long-Duration, Professional Development Academy on Technology Skills, Computer Self-Efficacy, and Technology Integration Beliefs and Practices

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Abstract

A variety of barriers relating to resources, institutional and administrative policies, skills development and attitudes can hinder the effectiveness of technology professional development resulting in underutilized technology resources and lack of integration of those resources within instruction. Multiple methods were used to evaluate the effectiveness of a long-term professional development academy intended to address those barriers and promote increased use of technology in the academy participants' instruction. Results revealed significant gains in participants' self-assessed technology skills and computer self-efficacy, with little or no change to self-assessed technology integration beliefs and practices despite interview data indicating participants felt their teaching had changed as a result of their academy participation. This article suggests the design of the academy was successful in addressing some but not all of its intended objectives. Suggestions for the design of long-term technology professional development are discussed. (Keywords: technology, teacher education, teacher professional development.)

INTRODUCTION

There is general agreement among leaders in the field of educational technology that, due to a variety of barriers, teachers often fail to capitalize on the educational potential offered by technology resources. Barriers are defined as any factor preventing or restricting teachers' use of technology in the classroom (Becta, 2003; Ertmer, 1999). Barriers impacting technology integration may be grouped into four main categories: resources, institutional and administrative support, training and experience, and attitudinal or personality factors.

Resources have been identified by numerous studies as one of the most pervasive barriers impeding technology integration (Butler & Sellbom, 2002; Drenoyianni & Selwood, 1998; Jenson & Lewis, 2001; Pelgrum 2001; Shamburg, 2004). Resource barriers may relate to quantitative issues such as insufficient computers, peripherals and software licenses as well as limited Internet access (Pelgrum 2001; Shamburg, 2004) or qualitative issues such as out-of-date hardware and software as well as slow or intermittent Internet connections (Butler & Sellbom 2002; Shamburg 2004).

In addition to resource factors, numerous studies have identified institutional and administrative barriers as contributing to teachers' reluctance to integrate computers in their classrooms (Cuban, Kirkpatrick, & Peck, 2001; Mumtaz, 2000; Pelgrum, 2001; Raymond, Lawyer-Brook, Jurley & Duffield, 2005; Russell & Bradley, 1997; Shamburg, 2004). For example, some districts ban or restrict teachers from installing their own instructional software on district computers (Shamburg, 2004). Another institutional and administrative barrier to technology use relates to scheduling. Lack of preparation time to plan technology infused lessons was identified as a major obstacle, as teachers stated technology integration was new to them and their workloads and schedules precluded taking time to design lessons that included technology (Butler & Sellbom, 2002; Cuban et al., 2001; Drenoyianni & Selwood, 1998; Mumtaz 2000; Pelgrum 2001; Russell & Bradley 1997; Shamburg 2004). Finding time to explore technology options may be especially difficult in districts where a focus on test preparation is a dominant priority (Shamburg, 2004). Scheduling barriers can be particularly acute at schools on a year-round calendar where students are in buildings throughout the year, making repair and maintenance of equipment difficult (Raymond et al., 2005). Finally, scheduling and institutional factors can leave teachers feeling isolated in self-contained classrooms with little time or opportunity to collaborate on technology-based instructional ideas or observe each other's use of technology (Cuban et al. 2001; Wyer, 1994). Compounding these issues are schedules which can keep technology staff separated from faculty, leaving them unavailable to help teachers when problems arise (Mumtaz 2000; Pelgrum 2001; Russell & Bradley 1997). Teachers can feel uncomfortable asking for help from school technology coordinators who also carry a full teaching load. Such teachers may feel reluctant to integrate technology into their teaching because they feel uncomfortable imposing on the technology coordinator's time when they need help (Mumtaz 2000; Pelgrum 2001; Russell & Bradley 1997).

Institutional barriers relating to training and experience include insufficient professional development focused specifically on technology integration (Butler & Sellbom, 2002; Cuban et al. 2001; Loveless, 2003; Mumtaz, 2000; Pelgrum, 2001; Russell & Bradley, 1997; Subhi, 1999). In a study examining primary teachers' perceptions of Information and Communication Technology (ICT), Loveless (2003) found that teachers acknowledged a need for students to be well grounded in basic skills, yet saw ICT as a distinct subject, which should be taught by a specialist, much like physical education or music. Loveless concluded that such attitudes may result from professional teacher development that is focused on showing evidence of competence in basic computer use rather than on developing pedagogy. Additionally, Cuban et al. (2001) found training was seldom offered at convenient times for teachers, nor was it specific to their needs. Rather than asking teachers what needed to be covered in the training, professional development was driven by the trainers hired by the school and offered after school hours, with the expectation that teachers would attend the trainings on their own time. A lack of support following professional development represents another training related barrier to a teacher's use of technology in instruction (Jenson & Lewis, 2001; Mouza, 2002). Mouza (2002) stated that traditional sit-and-get-training sessions without follow-up support have proven ineffective in impacting teachers' technology integration which suggests a need for ongoing professional development.

The impact of teachers' attitudes and fears towards use of computers in education represents a fourth category of barrier (Ertmer, 1999; Becta, 2003). The anxiety a teacher may feel as he/she attempts to integrate technology into classroom curricula can be overwhelming and a major detriment to the use of computers (Russell & Bradley, 1997). Christensen (2002) investigated technology attitudes of 60 Texas public elementary school teachers who received needs-based instruction on integrating computers into classroom lessons over the course of a school year. At the end of the year, teachers' responses on an attitude questionnaire revealed increased positive feelings toward classroom computer use as well as a more defined perception of the importance of computers in education. However, teachers expressed fears concerning their ability to stay one step ahead of technology savvy students, which negatively impacted their continued use of technology. Christensen suggests a need for ongoing technology integration education to reduce teachers' anxiety levels as students' technology skills continue to advance.

Anxiety concerning technology use may also be found in novice teachers who are vulnerable to the opinions and attitudes of veterans. Experienced teachers who don't see the value of integrating technology into their classrooms (Abbott & Faris, 2000; Hazzan, 2003) can negatively impact the design of instructional technologies by less experienced teachers. For example, Hazzan examined novice high school mathematics teachers' attitudes toward integrating technology into their instruction. Results revealed perceptions of a negative undercurrent from veteran teachers toward such practices, which discouraged novices from continuing to include technology in their lessons.

Another facet of the attitudinal barrier toward technology integration is teachers' perceptions of their computer competency and the adequacy of their technology preparation (Drenoyianni & Selwood, 1998; Piper, 2003). Drenoyianni and Selwood (1998) found that teachers lacking in perceived competence in the use of computers were less likely to incorporate computers in their teaching. In a survey of 160 elementary and secondary teachers from 11 Pennsylvanian school districts, Piper (2003) reported that self-efficacy had a significant influence on the academic use of technology for novice computer users. For non-novices, self-efficacy and access to technology resources were eclipsed by computer knowledge and perceptions of technology leadership as the most reliable predictors for the instructional use of technology.

This article describes a long-duration professional development academy focused on infusing technology in K–8 instructional settings funded by the U.S. Department of Education intended to address the various barriers identified above. The article will evaluate the effects of the academy on teachers' computer self-efficacy, technology skills, and beliefs toward technology use and integration practices.

THE TECHNOLOGY ACADEMY MODEL

The academy was specifically designed to address barriers identified as limiting the effectiveness of technology professional development. To address the barrier of insufficient time to support mastery of skills and integration practices, the academy's duration extended across two academic years. Participants met from 8:30 a.m. to 4:30 p.m. daily for 15 days in June 2003, followed by five individual inservice days held during the 2003-2004 academic year. A second 15-day session in June 2004 was followed by an additional five inservice days during the 2004-2005 academic year.

To address issues related to the expectation that teachers attend professional development on their own time without compensation, the academy paid participants a stipend for their attendance and a per diem for meals. Additionally, the academy provided motel accommodations for those living beyond commuting distance for the two, three week summer sessions. The academy also paid for teacher substitutes for the one-day inservices held during the academic year. Limited equipment barriers were also addressed. All non-computer based materials associated with academy instruction (books, software and digital still and video cameras) were provided so teachers would have the resources needed to implement the instructional ideas and methods learned.

The academy focused on skills development as stepping stones to new ideas and practices for instruction rather than end goals. All instructional activities included sharing ideas and examples for classroom uses as well as discussions wherein participants generated instructional ideas relevant to their own classrooms. To further sharpen the focus on integration practices, participants completed a self-assessment rubric (Johnson, 2000-2001) to identify their current level of skills and integration practices at the end of the first summer session. The participants then set personal goals for their future instructional use of technology.

To address barriers associated with insufficient support, participants were required to provide a signed administrative endorsement from both their principal and superintendent. This was intended to ensure that the district administration was both aware and supportive of the teacher's participation in the academy, including the required attendance of the five, one-day inservices held during the academic year. Beyond administrative support, support for individual participants was provided through a listserv. Participants shared questions and concerns as well as ideas and successes there.

The academy's curriculum was based on the International Society for Technology in Education (ISTE) National Educational Technology Standards (NETS) (2002) for teachers. Specifically, the curriculum focused on expanding teacher's understanding and abilities with instructional design, the use of technology as a support for student instruction, and student centered instruction that requires higher-order thinking skills.

Implementing the Model

The technology professional development academy was held at a large Southwestern university from June 2003 to May 2005. The academy was developed and presented by the author, an assistant professor of educational technology, and Susan Bowdoin, an instructor of university-level preservice teacher technology courses.

Teacher participants were recruited through application forms distributed by blanket mailings to school districts throughout New Mexico. Applicants provided recommendation letters from administrators or fellow faculty and a description of their experience and training with technology. Applicants with limited previous technology training and recommendation letters suggesting an eagerness to expand their skills were selected as participants.

Twenty-five teachers participated during the first year (24 females and one male). Participants' teaching assignments included regular and special education classes in first through ninth grades in public, private and Native American schools located in a variety of settings from large inner cities to small towns and reservations. Twenty-three participants taught at the elementary level, while the two middle school teachers taught English and science/math respectively. Classroom teaching experience ranged from one to 30 years, while teachers' initial computer skills ranged from negligible to some expertise working with Microsoft Office and a variety of educational software titles.

Summer 2003

The first summer's curriculum addressed the six NETS for teachers under a thematic umbrella focused on the systematic design of instruction intended to engage students in higher-order thinking to address essential questions. Participants completed projects and exercises that culminated in the generation of lessons applicable to their classrooms. These included well written learning objectives aligned with instructional activities and assessment. Skills development emphasized bringing all participants to a baseline level of competence concerning file management, use of Microsoft Office, searching for and validating Internet resources, use of a digital still camera, digital microscope and scanner, and the creation of Web pages.

Academic Year 2003

The five inservice days in the 2003 academic year focused on reviewing skills covered during the previous summer, acquainting participants with grant writing opportunities and strategies for creating successful applications, introducing additional skills and resources for supporting technology-infused instruction, and the setting of individual professional development goals. New skills covered during the five inservice days included publishing Reale books, taking or creating virtual field trips, and use of digital cameras and virtual reality software to create panoramic views and spinable objects viewable from 360 degrees. Participants were asked to use a rubric (Johnson, 2000-2001) to assess their current technology skills and instructional practices—addressing both technical skills and the delivery of instruction before setting personal professional development goals for the remainder of the training.

At the end of the academy's first year, three participants resigned for health or family reasons. An additional three participants were dropped for poor attendance. To take their places, six new female participants were admitted to the academy. Their teaching assignments ranged from first through eighth grade in regular, gifted and special education classrooms, while their teaching experience varied from three to 27 years. Four taught at the elementary level, one taught middle school science and one taught a middle school special education class.

Summer 2004

Four goals were addressed during the summer of 2004. The first was to reinforce participants' technology and integration skills through completion of a real-world, hands-on project: the development of two instructional Web sites for the Maxwell Museum of Anthropology. The first showcased a collection of musical instruments from around the world, while the second provided on-line access to a diary chronicling life in an Alaskan Eskimo village at the turn of the 20th century. Each Web site included links to teaching resources and lesson plans focused on an essential question related to the artifacts.

The second goal was to introduce participants to telecooperative and telecollaborative Internet-based projects as described in the book *Virtual Architecture* (Harris, 1998). The third goal was to familiarize participants with digital video cameras and editing software and the various ways they could be used to support instruction. The final goal was to introduce implementation requirements for the various technologies and instructional practices covered during the summer 2004 session. Informal observations had revealed that some participants were not actively using the materials, resources and ideas from the academy in their classrooms. Consequently, permanent ownership of the materials used in the second year of the academy was made provisional on participants' completion of classroom projects based on those materials. Accordingly, teachers were required to identify or create a telecooperative or telecollaborative project they would use in their classroom, as well as develop plans for using digital video in their classrooms during the coming academic year.

To help teachers implement their technology integration plans, support groups were created. Members of the group met on each subsequent inservice day to share successes and brainstorm potential solutions to challenges they encountered. As participants completed required projects, they shared their experiences and student artifacts with the entire academy.

Academic Year 2004

The major goal of the five inservice days held in the 2004 academic year was to help teachers use technology in the classroom. The academy revisited the concept of essential questions and how technology might be used to support inquiry. Additionally, new technology skills and instructional ideas were introduced. Participants explored the Library of Congress's American Memory Collection online and identified ways that access to these original source documents could be used to support learning in their classrooms. Participants also learned to create claymation animations and discussed how they might be used instructionally.

ASSESSING THE MODEL

The effectiveness of the academy model was assessed through surveys of participants' self assessed technology skills, beliefs regarding the use of technology in classrooms, feelings concerning technology integration in instruction, and computer self-efficacy. Additional insight into the effectiveness of the academy model was obtained through teacher interviews.

Participants completed a Technology Beliefs and Competencies Survey (Brinkerhoff, Ku, Glazewski & Brush, 2001) on the first and last days of the 2003 summer session and again on the final day of the academy. The Technology Beliefs and Competencies Survey was created as part of a Preparing for Tomorrow's Teachers to Use Technology (PT3) grant at Arizona State University. It was developed through a process of assessing and examining several existing surveys for scope and content. Technology skills and beliefs were identified, and items covering each were drafted. Content validation was achieved by having educational technology faculty examine the survey to ensure the survey objectives were met and the items were clear. The survey consisted of four sections: Background Information, Technology Skills, Technology Beliefs and Technology Integration. The Background Information section contained eight items covering such things as grade level assignment, years of teaching experience, gender, age and frequency of computer use at home. The Technology Skills section included 32 Likert-style items ranked on a four-point scale from, "I can't do this," to "I can teach others how to do this," covering the following six categories: basic computer operation, use of productivity software, electronic communication skills, use of electronic references, World Wide Web utilization, and use of multimedia software and hardware. The Cronbach Alpha reliability for this section of the survey was 0.96. The third section, Technology Beliefs, asked participants to rank 12 Likert-style items regarding the use of technology in classrooms on a four-point scale from "strongly disagree" to "strongly agree." This section had a Cronbach Alpha reliability of 0.69. The final section, Technology Integration, contained 11 Likert-style items asking participants to rank their perception of a variety of factors relating to successful technology integration in classrooms on the same four-point scale from "strongly disagree" to "strongly agree." Cronbach Alpha reliability for this part of the survey was 0.96.

Participants also completed a computer self-efficacy survey on the first and last days of the 2003 summer session and again on the last day of the academy in 2005. The survey was a modified version of the Computer Self-Efficacy Scale (Cassidy & Eachus, n.d.) and consisted of 20 items ranked on a six point scale from 1, strongly disagree, to 6, strongly agree. Sample items included, "I enjoy working with computers," and "I find it difficult to get computers to do what I want them to." Cronbach Alpha reliability for the Computer Self-efficacy Survey was 0.94.

Individual, audio-taped interviews were conducted after the final academy meeting with six participants selected to represent a cross section of teaching assignments, grade levels, and initial technology skills. The protocol included three questions, one each concerning perceived change in computer self-efficacy, technology skills, and feelings toward technology integration during the course of the academy. For example, to uncover changes in feelings concerning technology integration, interviewees were asked, "Have your feelings concerning the integration of technology within your teaching changed during the course of the academy?" Follow-up questions asked participants to describe any change if they perceived one, as well as what they attributed any change, or lack of change, to. Additional follow-up questions based on individual responses further explored their experience as academy members.

Table 1. Computer Skills Results

	Beginning Summer Session 2003		End Summer Session 2003		End of Academy 2005	
	M	*SD*	*M*	*SD*	*M*	*SD*
Basic Operations	2.82	.804	3.36	.420	3.71	.317
Productivity Software	2.42	.643	3.33	.489	3.58	.307
Communications	2.78	.783	3.25	.534	3.63	.388
Electronic References	2.50	.905	3.46	.498	3.56	.620
World Wide Web	2.31	.664	3.10	.441	3.43	.565
Multimedia	2.34	.558	3.25	.410	3.60	.305

Note. N = 12. Responses range from 4 (I can teach others how to do this) to 1 (I can't do this).

DATA ANALYSIS

Analysis of survey results was limited to those teachers participating in the entire two-year academy who completed all three implementations of the surveys. Participants' responses were aggregated for the Computer Self-Efficacy Scale and within the six subscales (basic operations, productivity software, communications, electronic references, World Wide Web, multimedia) of the Technology Skills section of the Technology Beliefs and Competencies Survey. A one-way repeated-measures analysis of variance (ANOVA) was conducted on these aggregated responses, with alpha set at .05 and Bonferroni adjustment made when conducting multiple comparisons of main effects. For the Technology Beliefs and Technology Integration sections of the Technology Beliefs and Competencies Survey, individual survey items were examined using one-way repeated-measures ANOVA. To compensate for the multiple analyses, alpha was set to .005 for the initial ANOVAs, and .05 with Bonferroni adjustment for follow-up comparisons of main effects. An examination of frequency and graphical displays showed only minor and statistically non-significant departures from statistical assumptions. The sphericity assumption was assessed using Mauchly's Test with the Greenhouse-Geisser adjustment used in cases where the sphericity assumption failed.

Interview data were transcribed, coded and evaluated for emergent themes common to participants' perceptions based on a comparison of categories using a thematic analysis approach (Shank, 2002). Next, representative excerpts supporting those categories were identified. The preliminary analyses was then refined through telephone interviews with the teachers. Each teacher interviewed was asked for his/her perceptions of the validity of the identified themes and supporting interview excerpts. Based on this feedback, the analysis was revised a final time.

Table 2. Technology Beliefs Results

Item		Beginning Summer Session 2003		End Summer Session 2003		End of Academy 2005	
		M	*SD*	*M*	*SD*	*M*	*SD*
1	I support the use of technology in the classroom.	3.67	0.49	3.67	0.49	3.92	0.29
2	A variety of technologies are important for student learning.	3.67	0.49	3.83	0.39	4.00	0.00
3	Incorporating technology into instruction helps students learn.	3.67	0.49	3.83	0.39	3.92	0.29
4	Content knowledge should take priority over technology skills.	3.00	0.85	3.17	0.84	3.25	0.97
5	Most students have so many other needs that technology use is a low priority *	1.50	0.52	1.75	0.62	1.75	0.45
6	Student motivation increases when technology is integrated into the curriculum.	3.50	0.52	3.67	0.49	3.75	0.45
7	Teaching students how to use technology isn't my job. *	1.58	0.90	1.50	0.91	3.75	0.87
8	There isn't enough time to incorporate technology into the curriculum. *	2.17	1.03	1.92	0.90	3.50	0.52
9	Technology helps teachers do things with their classes that they would not be able to do without it.	3.42	0.52	3.25	0.87	3.50	0.52
10	Knowledge about technology will improve my teaching.	3.73	0.47	3.55	0.93	3.82	0.41
11	Technology might interfere with "human" interactions between teachers and students. *	1.92	0.90	2.00	1.04	3.42	0.90
12	Technology facilitates the use of a wide variety of instructional strategies designed to maximize learning.	3.67	0.49	3.33	0.89	3.67	0.49

Note. Responses range from 4 (strongly agree) to 1 (strongly disagree). Asterisked items (*) were reverse coded and the responses in the table reflect this reverse coding.

Table 3. Technology Integration Results

		Beginning Summer Session 2003		End Summer Session 2003		End of Academy 2005	
Item		*M*	*SD*	*M*	*SD*	*M*	*SD*
1	I integrate computer activities into the curriculum.	3.00	0.89	3.18	0.75	3.55	0.52
2	Technology plays an integral role in supporting content learning in my class.	3.00	0.63	3.27	0.65	3.45	0.69
3	I encourage students to work collaboratively on technology-based activities.	3.09	0.70	3.18	0.60	3.18	0.98
4	I locate and evaluate educational technologies, including software, hardware, and online resources for use with my students.	3.09	0.83	3.18	0.75	3.09	0.94
5	I require students to use a variety of software tools and electronic resources to support learning.	2.91	0.70	3.18	0.75	3.09	0.83
6	I use technology to support project- and problem-based learning activities in my classroom.	2.91	0.83	3.18	0.75	3.45	0.52
7	I use technology in my classroom to help support the state curricular standards.	3.00	0.63	3.18	0.87	3.55	0.52
8	I use technology to assist me with classroom management and recordkeeping activities (e.g., grading, attendance).	3.45	0.52	3.64	0.51	3.73	0.47
9	Technology helps me meet the individual needs of a variety of students in my classroom.	3.18	0.60	3.36	0.67	3.45	0.52
10	I encourage my students to use technology to demonstrate their knowledge of content in non-traditional ways (e.g. Web sites, multimedia products).	3.09	0.70	3.27	0.65	3.45	0.69
11	I use technology to design new learning experiences for students incorporating the unique capabilities of technology.	3.00	0.78	3.36	0.67	3.55	0.69

Note. Responses range from 4 (strongly agree) to 1 (strongly disagree).

RESULTS

Mean scores and standard deviations for the six subsections of the Computer Skills portion of the Technology Beliefs and Competencies Survey are shown in Table 1.

A one-way repeated-measures ANOVA revealed a significant main effect for time for all six subsections: Basic Operations $F(2, 20) = 9.43$, $p = .001$, $eta^2 = .49$; Productivity $F(2, 15.078) = 33.22$, $p < .001$, $eta^2 = .75$; Communications $F(2, 14.868) = 22.28$, $p < .001$, $eta^2 = .67$; Electronic References $F(2, 22) = 11.04$, $p < .001$, $eta^2 = .50$; World Wide Web $F(2, 22) = 21.09$, $p < .001$, $eta^2 = .66$; Multimedia $F(2, 20) = 33.11$, $p < .001$, $eta^2 = .77$. Eta squared is a measure of practical significance indicating the amount of variance in scores explained by the treatment. Eta squared values ranging from .49 to .77 indicate that 49 to 77% of the variance in the three scores for each section of the computer skills survey is attributable to participation in the two-year academy.

Follow-up analyses of simple main effects revealed a significant difference in Basic Operations mean scores between the beginning and end of the academy. Significant differences in mean scores for Productivity, Electronic References, World Wide Web and Multimedia were revealed between the beginning and end of the first summer session and between the beginning and end of the academy. Significant differences in Communications mean scores were found to be significantly different between the beginning and end of the first summer session, between the end of the first summer session and the end of the academy, and between the beginning and end of the academy.

Mean scores and standard deviation results for the Technology Beliefs section of the Technology Beliefs and Competencies Survey are shown in Table 2.

A one-way repeated-measures ANOVA revealed a significant main effect for time for three Technology Beliefs Survey items: A teacher's job includes teaching students how to use technology $F(2, 22) = 39.25$, $p < .001$, $eta^2 = .78$; there's sufficient time to incorporate technology into the curriculum $F(2, 14.976) = 15.17$, $p = .001$, $eta^2 = .58$; and using technology doesn't interfere with teacher-student interactions $F(2, 22) = 8.68$, $p = .002$, $eta^2 = .44$.

Follow-up analyses of simple main effects revealed a significant difference in mean scores between the end of the first summer session and the end of the academy, and between the beginning and end of the academy for all three items.

Mean scores and standard deviation results for the Technology Integration section of the Technology Beliefs and Competencies Survey are shown in Table 3.

A one-way repeated-measures ANOVA revealed no significant main effect.

Mean scores and standard deviation results for the Computer Self-Efficacy Survey are shown in Table 4.

The individual item mean scores for the Computer Self-Efficacy Scale were aggregated, resulting in an initial overall mean of 3.22 ($SD = 0.20$), a mean of 3.32 ($SD = 0.15$) at the end of the fist summer session, and a mean of 5.18 ($SD = 0.38$) at the end of the academy. One-way repeated-measures ANOVA results indicated there was a significant main effect for time $F(1.34,10.71) = 199.79$,

$p < .001$, $eta^2 = .96$. Mean self-efficacy scores showed little change from the beginning of the academy to the end of the first summer session; however, a significant increase in mean self-efficacy, t (8) = 14.08, p >.001, $eta^2 = .96$, was revealed when comparing mean self-efficacy at the end of the first summer session to mean self-efficacy at the end of the academy.

Three themes emerged from the analysis of participant interviews related to computer skills, computer self-efficacy and technology beliefs and integration.

Theme 1

Participants perceived an increase in their technology skills as a result of their academy experiences.

Concerning initial technology skills, all those interviewed either acknowledged a minimal starting level or described having the realization that their initial self assessment had naively overestimated their skills. One teacher said, "When I started it was just basic typing kind of things." Another stated, "I always felt I was pretty good with the computer, but…the little tricks, you know, with Excel. Things like that. I had no idea." All these participants indicated the academy had raised their technology skill levels. The most frequently cited contributor to their gains was the various learning experiences and required projects related to both software and hardware completed during the academy. When asked what had facilitated her perceived increase in skills, one teacher stated, "I think the experience from the academy and having time to work with others to learn the information." Another said, "Just what basically was learned in the academy…all those handouts. I have my notebook so I can refer back to it. I love my notebook; it's underneath my bed." Another factor identified by several participants included individual practice on their own time. One teacher said, "Not only do I have the skills you gave me, but I have also taken them and experimented. Like, if I can do that, can I do this?" Working with others was also perceived as an effective way to reinforce learning and help demonstrate what was possible through the sharing of ideas and products. One teacher described her feelings this way: "Well, I think just seeing the others…I mean, I'm nowhere near where a lot of them are, but it's kind of exciting to see what can be done. But I know the basics—a little more than the basics—and can maybe put more effort to do what they're doing."

Theme 2

Participants were less fearful and more confident toward technology following completion of the academy.

All those interviewed expressed that they were feeling more confident toward technology as a result of their participation in the academy. As one teacher noted, "I thought it [technology] was more complicated than it sometimes really is. You know, it's just sometimes really taking the time. I think I felt like it was kind of a little nerve wracking. There's so much there and I didn't know what to do. Now I feel a little bit more like I'm willing to challenge myself to try something, you know, a spreadsheet or whatever, where before I would have never attempted to do that…." These participants also reported feeling less fearful they

Table 4. Computer Self-Efficacy Results

		Beginning Summer Session 2003		End Summer Session 2003		End of Academy 2005	
Item		*M*	*SD*	*M*	*SD*	*M*	*SD*
1	I can usually deal with most difficulties I encounter when using computers.	3.75	1.29	4.08	1.31	4.58	0.70
2	I find working with computers very easy.	3.67	1.23	4.42	1.17	4.42	1.08
3	I am very unsure of my abilities to use computers.*	2.92	1.31	2.00	0.95	5.42	0.52
4	Computers frighten me.*	1.92	1.38	1.42	0.90	5.25	1.36
5	I enjoy working with computers.	5.27	0.47	5.36	0.51	5.45	0.69
6	Computers make me much more productive.	4.73	1.10	5.36	0.67	5.55	0.52
7	Computers are far too complicated for me.*	2.17	1.47	1.75	0.97	5.25	1.14
8	Using computers is something I usually enjoy.	5.09	0.54	5.36	0.51	5.73	0.47
9	Sometimes when using a computer, things seem to happen and I don't know why.*	3.90	1.58	3.81	1.25	3.63	1.21
10	As far as computers goes, I consider myself to be pretty competent.	3.42	1.24	4.50	0.80	4.67	0.65
11	Computers help to save me a lot of time.	4.91	0.83	5.18	0.60	5.64	0.51
12	I find working with computers very frustrating.*	2.67	1.50	2.17	1.19	5.50	0.52
13	I always seem to have problems when trying to use computers.*	2.27	1.01	1.73	0.79	5.18	0.75

14	When using computers, I worry that I might press the wrong button and damage it.*	1.92	1.17	1.42	0.90	5.42	1.44
15	I am very confident in my abilities to use computers.	3.91	1.04	4.82	0.87	5.18	0.75
16	I find it difficult to get computers to do what I want them to.*	2.55	1.21	1.81	0.98	5.46	0.52
17	I would rather that we didn't have to learn how to use computers.*	1.00	0.00	1.00	0.00	5.75	0.87
18	I usually find it easy to learn how to use a new software package.	3.91	1.22	4.18	1.69	4.45	1.04
19	I seem to waste a lot of time with computers.*	2.00	1.27	1.73	1.01	5.36	0.64
20	I consider myself a skilled computer user.	3.42	1.44	4.25	0.97	4.50	0.80

Note. N = 9. Responses range from 6 (strongly agree) to 1 (strongly disagree). Asterisked items (*) were reverse coded and the responses in the table reflect this reverse coding.

might damage equipment which had translated into a greater willingness to troubleshoot when problems arose. One teacher put it this way: "Well, I think just the academy in general showed me what you can do and how you just can't break it. You know, you've just got to sort of play with it to figure out the problem and troubleshoot and things like that." Another said, "By no means am I an expert…but…I'm not afraid to try and see what happens …you now, like I tell the kids, 'You might lose something, but you can always start over.'" Some interviewees reported an increased sense of confidence during discussions of technology related topics, feeling they now knew enough to participate in the conversation.

Theme 3

Participants felt the academy had altered their teaching.

All the interviewed participants indicated their experience in the academy had precipitated more positive attitudes toward technology integration, with four interviewees reporting that a consideration of technology integration options had become a standard component of their instructional planning. As one teacher said, "When I come up with a project or some kind of idea for the classroom, I try to automatically see how I can fit technology into it."

Additionally, all those interviewed reported the academy had changed their teaching; however, the nature of those changes varied. Four interviewees described more frequent use of group and project-based learning, providing descriptions such as, "I mean, I've always done projects and I've always tried to use technology, but not integrated. It was always kind of a separate kind of Friday club thing. And now it's throughout [the year]." Another stated, "When I taught history, there would be a chapter test. And [now], it's more can they show me with a project."

Two participants indicated they more frequently assumed facilitating roles as instructors rather than relying on teacher-centered instructional practices. Said one, "Now, I think I'm more of a facilitator…instead of a, well, I don't want to say teacher – I'll say lecturer." Additionally, two participants reported they more frequently put technology in the hands of students rather than maintaining control themselves. One described it this way: "It was always me using it [technology] and not so much the kids. And through the technology academy that we did …all that hands-on stuff, it was very easy to bring it [student hands-on use of technology] back into the classroom." One participant indicated she was now taking control of her students' computer lab instruction rather than relying on the technology instructional aid. Finally, three of those interviewed indicated the academy had renewed their interest and enjoyment in teaching as evidenced by the comment, "It was like the best thing that ever happened to me because it even sparked my interest in education and teaching." Two went on to suggest they felt they were better teachers for having participated in the academy. One teacher described his feelings this way: "I figured this [technology] can make my life a lot easier, and it has, and I think it's turned me into a lot better teacher because of it."

DISCUSSION

The purpose of this study was to examine the efficacy of a long-duration, professional development academy on teachers' self-assessed technology skills, computer self-efficacy and technology integration beliefs and practices.

Results suggest the academy was successful in increasing these participants' technology skills. Participants' self-assessed skills increased significantly over the course of the first summer session and maintained that increase through the end of the academy program. Two factors may have contributed to this success. First was the extended nature of the professional development. At the National Education Summit (1999), Gene Carter noted that the majority of American teachers receive eight hours or less of professional development annually. In contrast, the academy's first summer session provided roughly 90 hours of curricula focused on raising participants' technology skills through direct instruction and a series of exercises and projects. These skills were reinforced during the second summer session through creation of the museum Web sites and supporting instructional materials. This provision of instruction and practice over an extended time was effective in increasing participants' self-assessed skills—findings that are consistent with Franklin, Turner, Kariuki and Duran (2002), who found it can take longer than expected for teachers to gain new technology skills.

A second possible factor contributing to gains in technology skills has to do with the academy schedule and the volunteer nature of the participants. Typically, professional development is not specific to teachers' needs nor offered at convenient times (Cuban et al., 2001). In the case of the academy, teachers volunteered to participate based on their own interest in technology, while most of the instruction took place during the summer.

Results for participants' computer self-efficacy showed no significant increase between the beginning and end of the first summer session. In contrast, there was a significant increase between the end of the first summer session and the end of the academy. This suggests the academy's extended duration was key to supporting change in these teachers' feelings toward technology. These findings are consistent with those of Milbrath and Kinzie (2000) and Smith (2001), who found the development of computer self-efficacy requires time. The academy may have supported increases in participants' computer self-efficacy in a number of ways. Specifically, academy participants were required to successfully complete a variety of projects working at times individually, in pairs and in groups. Various researchers have reported that mastery experiences with computers contribute to an individual's computer self-efficacy (Kinzie, Delcourt & Powers, 1994; Martocchio, 1994; Smith, 2001). Working in pairs and groups and sharing final projects may also have supported computer self-efficacy gains. As one interviewee stated, "I think out of the academy I got more out of just being able to work with others, you know. It was so nice just to be able all day to…banter back and forth and work on projects and stuff and get ideas." According to Smith (2001), computer self-efficacy may be derived from vicarious learning through the observation of other people's successful efforts using computers.

Results for teachers' technology beliefs revealed a significant change between the end of the first summer session and the end of the academy, and between the beginning and end of the academy, for three Technology Beliefs Survey items: a teacher's job includes teaching students how to use technology; there's sufficient time to incorporate technology into the curriculum; and using technology doesn't interfere with teacher-student interactions. Changes in beliefs for these survey items may reflect teacher comments made during both whole-group and small, support-group discussions of barriers encountered using technology in participants' classrooms. One consistent comment had to do with technical support. If technology was going to be used by teachers, they themselves needed to take responsibility for its implementation in terms of time and instruction because there was limited technical support. Another factor that may have contributed to changes in feelings concerning these three survey items was incentive. Rather than letting academy materials sit on teachers' shelves, participants were required to complete projects using those materials during the second year of the academy in order to keep them. This incentive resulted in most participants using the materials in their classrooms, which may have supported increased awareness that there was, indeed, sufficient time to incorporate technology into the curriculum. However, informal assessment of teachers' projects, as they were presented to the group at the final meeting of the academy, revealed several of low quality. Weaknesses in these projects included minimal if any ties to content objectives, poorly developed instructional processes and lack of assessment. In short, the projects appeared to have been completed simply to keep the materials. Accordingly, these projects may have failed to reflect any potential benefits associated with classroom technology use. This may have contributed to the limited number of Technology Beliefs Survey items showing significant change. Establishing clearer project expectations as well as rubrics for their assessment may have supported completion of higher quality projects, which in turn may have translated to more positive ratings of technology beliefs.

Results for teachers' technology integration practices revealed no significant change over the course of the academy for any of the survey items. According to a variety of researchers, transitioning teachers from novice technology users to effective technology integrators capable of supporting student learning generally takes three to five years (Helsel DeWert & Levine Cory, 1998; McKenzie, 2001; Saylor & Kehrhahn, 2003; Wasser & McNamara, 1998). Such change is a slow, uncomfortable process rather than an event, and as such, requires extended time for changes in attitude and acceptance of differing perspectives to take place (Horsley & Loucks-Housley, 1998). So, despite the academy's two year duration, it may have encompassed insufficient time to significantly impact these participants' integration practices. Additionally, Guskey (1995) found that the magnitude of change individuals are asked to make is inversely related to their likelihood of making a change. For these changes to occur, teachers need opportunities to apply newly acquired skills to personal use, experiment with the effectiveness of technology in the classroom, and collect student data to justify conclusions. Positive student data sufficient to drive a change in technology integration practices may have been lacking during the academy. Many participants demonstrated minimal use of the technologies they had been taught during the first year of the academy. While a requirement to complete projects using the various technologies was implemented in the second year of the academy, specifics concerning project implementation were left up to individuals in an effort to allow participants freedom to adapt projects to their specific instructional needs. While participants' projects weren't formally evaluated, during the sharing of projects some trends became apparent, with many projects lacking a clear instructional goal or assessment. The purpose of many projects appeared to focus on letting students experience the technology rather than on standards-based instructional objectives. As such, these projects may not have demonstrated clear learning benefits associated with technology use sufficient to impact teachers' technology integration practices.

However, findings of no significant change in teachers' self-reported integration practices on the survey stand in contrast to comments made during the interviews, where all interviewees described feeling their teaching had changed as a result of their academy experience. This apparent contradiction may represent differing, individualized definitions of technology integration. Pierson (2001) investigated teachers at various levels of technology expertise and teaching ability who used technology, and how their technology use related to general teaching practice. Results revealed several assertions illustrating teachers' attitudes toward teaching with technology, including: the ways teachers personally used technology determined their definitions of technology integration; teachers taught with and about technology according to their own personal learning strategies; and teachers' individual definitions of technology integration directed their management of student computer use. These individual interpretations concerning the nature of technology integration may not have been captured by the Technology Integration section of the survey, suggesting a need for improvement of the instrument.

An examination of the Technology Integration Survey items suggests that two fundamental constructs were being assessed. Items one, two, four, five, seven, and eight investigate aspects of technology integration related to supporting current teaching practices (see Table 3). As such, change in feelings on these items need not reflect a substantive change to teachers' roles or practices. In contrast, the remaining items imply a significant transformation in teaching practice from teacher-centered to student-centered instruction.

These constructs represent two possible intentions for technology professional development, both of which were supported by the academy curriculum. However, as these participants entered the academy as relative technology novices, expecting them to embrace student-centered and problem-based instruction as part of the academy curriculum may have been unrealistic despite the academy's extended duration. This raises questions concerning the purpose of technology professional development. Harris (2005, Choosing an Agenda section 1) maintains that "using technology as a 'Trojan horse' for educational reform has succeeded in only a minority of K-12 contexts" and raises ethical issues concerning respect for teachers, academic freedom to choose instructional practices that work for their given content and context. In the same vein, Woodbridge (2004) suggests any learning opportunity that challenges teachers' personal beliefs, values, and assumptions reflects a barrier that may impede professional development.

This study has several limitations. First, it relies on self-report data from questionnaires and data collected through interviews. Direct observation of teachers and evaluation of student products may have provided additional insights into the effects of the academy on teaching practice. Coupled to the limited number of participants, these factors reduce the validity of the statistical analyses. Additionally, other professional development training or teaching experiences occurring during the extended duration of the academy may have impacted participants' skills and attitudes. Accordingly, these results may best be interpreted as preliminary, requiring additional research with larger numbers of individuals to more fully assess the academy model.

Despite these limitations, these results support findings from previous research as well as suggest some professional development design considerations that may be of value to those planning similar long-term technology training. Results from this academy confirm earlier conclusions that there is a need for incorporating extended contact hours for instruction and practice of technology skills. It also confirms the need to provide necessary materials, so teachers may return to their classes and use their new skills and integration ideas immediately. Results from this academy also support the following recommendations:

Center instruction around participants' teaching interests, using hands-on activities and projects with end products that are shared with the whole group.

Vary instruction so participants work individually, in pairs, and in small groups.

Hold participants accountable for creating realistic lesson plans based on their technology integration ideas. These lesson plans should be assessed by the professional development trainers to ensure they meet minimum standards. The process of creating lesson plans should be repeated throughout the duration of the professional development.

Hold participants accountable for implementation of their integration ideas. One means for doing so might be to require completion of an evaluative reflection on the lesson's effectiveness. Lesson evaluations and student products should be shared.

Finally, clearly define the goal of the technology professional development and design instruction and evaluative assessments focused on that goal. Is the intent to teach technology skills, to support infusion of technology into current teaching practices, or to promote instructional reform favoring student centered and problem-based technology supported instruction? Setting an unambiguous goal will foster more focused instruction and assessment of the professional development effort.

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References

Abbott, J. & Faris, S. (2000). Integrating technology into pre-service literacy instruction: A survey of elementary education students' attitudes toward computers. *Journal of Research on Computing in Education, 33*(2), 149–182.

Becta. (2003). *What the research says about barriers to the use of ICT in teaching.* Retrieved April 2, 2004 from http://www.becta.org.uk/research/ictrn/

Brinkerhoff, J., Ku, H., Glazewski, K. & Brush, T. (2001). *Development, results and validation of technology integration surveys for preservice and practicing teachers.* Presentation at the meeting of the Association for Educational Communications and Technology, Atlanta, GA.

British Educational Communications and Technology Agency. (2003). *What the research says about barriers to the use of ICT in teaching.* Available from: http://www.becta.org.uk/corporate/publications/publications_detail.cfm?currentbrand=all&pubid=206&cart=

Butler, D. & Sellbom, M. (2002). Barriers to adopting technology for teaching and learning. *Educause Quarterly, 2,* 22–28.

Carter, G. (1999). *In the aftermath of the 1999 national education summit: New hope for 21st century teaching and learning.* Retrieved September 15, 2005, from http://www.ascd.org/cms/index.cfm?TheViewID=1317

Cassidy, S. & Eachus, P. (n.d.). *The Computer Self-Efficacy Scale.* Available from: http://www.chssc.salford.ac.uk/healthSci/selfeff/SELFEFFa.htm

Christensen, R. (2002). Effects of technology integration education on the attitudes of teachers and students. *Journal of Research on Technology in Education, 34*(4), 411–434.

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technology in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal, 38*(4), 813–834.

Drenoyianni, H. & Selwood, I. (1998). Conceptions or misconceptions? Primary teachers' perceptions and use of computers in the classroom. *Education and Information Technologies, 3*, 87–99.

Ertmer, P. (1999). Addressing first and second order barriers to change: Strategies for technology integration. *Educational Technology Research and Development, 47*(4) 47–61.

Franklin, T., Turner, S., Kariuki, M. & Duran, M. (2002). Mentoring overcomes barriers to technology integration. *Journal of Computing in Teacher Education,* 18(1), 26-31.

Guskey, T. R. (1995). Results-oriented professional development: In search of an optimal mix of effective practices. *North Central Regional Educational Laboratory.* Retrieved September 18, 2005 from http://www.ncrel.org/sdrs/areas/rpl_esys/pdlitrev.htm

Harris, J. (1998). *Virtual architecture designing and directing curriculum-based telecomputing*. Eugene, OR: International society for Technology in Education.

Harris, J. (2005). Our agenda for technology integration: It's time to choose.

Contemporary Issues in Technology and Teacher Education [Online serial], *5*(2). Retrieved September 5, 2005 from http://www.citejournal.org/vol5/iss2/editorial/article1.cfm

Hazzan, O. (2003). Prospective high school mathematics teachers' attitudes toward integrating computers in their future teaching. *Journal of Research on Technology in Education, 35*(2), 213–246.

Helsel DeWert, M., & Levine Cory, S. (1998). Educators go to SCOUT camp for technology-enhanced learning. *Journal of Staff Development, 19(1).*

Horsley, D., & Loucks-Housley, S. (1998). Tornado of change. *Journal of Staff Development, 19(4), 17–20.*

Jenson, J., & Lewis, B. (2001). Beyond the workshop educational policy in situated practice. *Education Canada*, *41*(3), 28–31.

Johnson, D. (2000-2001). Now that you know the basics: Rubrics to guide professional development: Part 1. *Learning & Leading with Technology*, 28(4), 10–13.

Kinzie, M. B., Delcourt, M. A. B., & Powers, S. M. (1994). Computer technologies: Attitudes and self-efficacy across undergraduate disciplines. *Research in Higher Education, 35,* 745–768.

Loveless, A. (2003). The interaction between primary teachers' perceptions of ICT and their pedagogy. *Education and Information Technologies, 8*(4), 313–326.

Martocchio, J. J. (1994). Effects of conceptions of ability on anxiety, self-efficacy, and learning in training. *Journal of Applied Psychology, 79*(6), 819–825.

McKenzie, J. (2001). Head of the class. *Electronic School.* Retrieved September 3, 2005 from http://www.electronic-school.com/2001/01/0101f2.html

Milbrath, Y. L., & Kinzie, M. (2000). Computer technology training for prospective teachers: Computer attitudes and perceived self-efficacy. *Journal of Technology and Teacher Education, 8*(4), 373–396.

Mouza, C. (2002). Learning to teach with new technology: Implications for professional development. *Journal of Research on Technology in Education, 35*(2), 272–289.

Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: A review of the literature. *Journal of Information Technology for Teacher Education, 9*(3), 319–341.

National Educational Technology Standards for Teachers. (2002). Eugene, OR: International Society for Technology in Education.

Pelgrum, W. (2001). Obstacles to the integration of ICT in education: Results from a worldwide educational assessment. *Computers and Education, 37*, 163–178.

Pierson, M. (2001). Technology integration practice as a function of pedagogical expertise. *Journal of Research on Computing in Education*, *33*(4), 413–430.

Piper, D. (2003). The relationship between leadership, self-efficacy, computer experience, attitudes, and teachers' implementation of computers in the classroom. In C. Crawford, D. Willis, R. Carlsen, I. Gibson, K. McFerrin, J. Price & R. Weber (Eds.), *Proceedings of Society for Information Technology and*

Teacher Education International Conference 2003 (pp. 1057–1060). Chesapeake, VA: AACE.

Raymond, M., Lawyer-Brook, D., Hurley, J., & Duffield, J. (2005, April). *Unique characteristics of K-12 schools influencing the integration of technology*. Paper presented at the meeting of the American Educational Research Association, Montreal, CA.

Russell, G., & Bradley, G. (1997). Teachers' computer anxiety: Implications for professional development. *Education and Information Technologies*, *2*, 17–30.

Saylor, P., & Kehrhahn, M. (2003). Teacher skills get an upgrade. *Journal of Staff Development, 24*(1).

Shamburg, C., (2004). Conditions that inhibit the integration of technology for urban early childhood teachers. *Information Technology in Childhood Education Annual,* 227–244.

Shank, G. (2002). *Qualitative research: A personal skills approach.* Upper Saddle River, NJ: Merrill Prentice Hall.

Smith, S. M. (2001). The four sources of influence on computer self-efficacy. *Delta Pi Epsilon Journal, 43*(1), 27–39.

Subhi, T. (1999). Attitudes toward computers of gifted students and their teachers. *High Ability* Studies*, 10*(1), 69–85.

Wasser, J., & McNamara E. (1998). Professional development and full-school technology integration: A description of the professional development model of the Hanau model schools partnership. *Hanau Model Schools Partnership Research Report.* Cambridge, MA: TERC.

Woodbridge, J. (2004). Technology integration as a transforming teaching strategy. *Tech-Learning: The Resource for Education Technology Strategy.* Retrieved on September 9, 2005 from http://www.techlearning.com/showArticle.jhtml?articleID=17701367

Wyer, D. (1994). Apple classrooms of tomorrow: What we've learned. *Educational Leadership, 51*(7), 4–11.