Factors Influencing Outcomes From A Technology-Focused Professional Development Program

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Abstract

Using survey data, the authors examined the relationship between intensity (as opposed to duration) of a technology-focused professional development program and specific participant characteristics in predicting successful outcomes. The four participant characteristics chosen were: teachers' feelings of preparedness to support student technology use, teachers' perceptions of the usefulness of creating technology-based projects with students, teachers' perceptions of the relevance of the pedagogical approaches emphasized, and teachers' prior use of featured software. Two outcomes were defined: (1) Use of new software applications/technology skills and (2) implementation of new technology-rich lessons. Analyses indicated different combinations of personal characteristics predicted each outcome. In addition, intensity of the program only predicted the latter outcome. Implications of this research are discussed within the framework of the professional development literature. (Keywords: technology integration, professional development, longitudinal studies, inservice learning.)

INTRODUCTION

A high level of agreement exists among practitioners, researchers, and policymakers regarding the key features of effective professional development programs for K–12 teachers (Darling-Hammond, Lieberman, & McLoughlin, 1995; National Commission on Teaching and America's Future, 2003; National Staff Development Council, 2001). For example, the National Staff Development Council's Professional Development Standards stress the importance of features such as organizing teacher-learners into learning communities, providing sustained blocks of time for training and follow-up support, and aligning teachers' knowledge of content, instructional strategies, and assessment practices. The educational technology community has built on this consensus, articulating specific qualities that are important to creating professional development that moves beyond providing teachers with technical skills, and instead helps them to integrate technology into their curriculum and into their students' day-to-day classroom activity (Anderson & Becker, 2001; Dede, 1998; Drazdowski, 1994; Office of Technology Assessment, 2000).

This literature has also suggested that teachers are more likely to build on what they learn from professional development experiences when their existing knowledge and priorities are acknowledged and made central to the learning process (Cochran-Smith & Lytle, 1992; Lieberman, 1995). Building on this research, many policy reports have also emphasized the importance of linking

technology-focused professional development to teachers' immediate needs and interests, rather than simply delivering technical training on software independent of the curricular or instructional needs of participants (CEO Forum on Education and Technology, 1999; Office of Technology Assessment, 1988, 1995). Survey work done by Riel and Becker (2000) has demonstrated that teachers who regularly seek out professional development opportunities or who lead such programs for their colleagues are also more likely than their colleagues to be experienced users of educational technology, suggesting that these are teachers who have found relevant connections between what educational technology has to offer and their own agendas for professional growth.

Despite broad agreement that particular characteristics of professional development programs and of their participants can have a significant effect on the outcomes of these programs, little empirical work has been done to test the possible inter-relationship of these two dimensions of professional development. Building on findings from a three-year evaluation of a large-scale, technology-focused professional development program, our goal was to examine how program-level *and* individual-level variables together may be influencing the type and scope of teachers' follow-up to the program. Using survey data, we specifically examined if (1) the intensity (as opposed to duration) of the training, and (2) the relationship between intensity and four teacher-level characteristics, could predict whether teachers used the technology tools emphasized in the program and/or implemented new technology-rich lessons in their classes.

LITERATURE REVIEW

Elements of Successful Professional Development

Since the mid 1970s, when school districts and other organizations began the relatively new practice of providing ongoing training for inservice teachers, a large body of literature has grown up regarding professional development and its role in teachers' professional lives (SRI International, 2002). The body of published research on professional development is quite varied, ranging from case studies to evaluations to a small number of large-scale survey studies. One strand of the literature centers on the identification of best practices and seeks to articulate programmatic elements shared by effective professional development programs.

Although the language and phrasing vary considerably, a fairly consistent list of key programmatic features has emerged across research studies and policy reports and has remained relatively constant over time (Loucks-Horsley, Hawson, Love, & Stiles, 1998; NPEAT, 1999; Porter, Garet, Desimone, Yoon, & Birman, 2000). For example, a recent review of the literature (SRI International, 2002) offers a succinct list of eight key elements of effective professional development:

1. ***Format:*** Is the training a traditional format such as a workshop or more innovative such as a study group or hands-on activity?
2. ***Duration:*** How many hours of contact time are involved and over how long a span of time?

3. ***Collective participation:*** To what extent are participants currently working together as teachers in the same schools, grades, or departments?
4. ***Inclusiveness:*** Are all teachers within a given community invited to participate?
5. ***Incentives:*** Are teachers provided with reasonable positive motivations to participate?
6. ***Active learning opportunities:*** Are teachers engaged in meaningful and relevant activities?
7. ***Content focus:*** Is the focus on teachers' classroom practice and how students learn?
8. ***Coherence:*** Does the program align itself with standards or teachers' goals?

In this report, as in many other research and policy reports (CEO Forum on Education and Technology, 1999; Loucks-Horsley et al., 1998; National Foundation for the Improvement of Education, 1996; Office of Technology Assessment, 1995), identification of these features has stemmed largely from reviews of existing programs, formative program evaluations, and theoretical models of effective learning in organizations.

Duration vs. Intensity of a Professional Development Program

Providing professional development of an appropriate duration is consistently included in lists of key features of successful professional development programs (NFIE, 1996; NPEAT, 1999; SRI International, 2002; U.S. Department of Education, 1999), and general statements are often made that longer programs are more effective (Garet, Porter, Desimone, , Birman, & Yoon, 2001; U.S. Department of Education, 1999). Some empirical evidence has suggested that this is true, but studies have taken different approaches to identifying whether the influential factor is duration (i.e., the total number of contact hours involved) or intensity (i.e., the frequency and length of training sessions).

A number of studies of the National Science Foundation-funded state systemic reform initiatives, for example, suggest that both the duration and the relative intensity of a given training are related to consequent change in teacher practices (Corcoran, Shields, & Zucker, 1998; Fine & Raack, 1994; Weiss, Montgomery, Ridgway, & Bond, 1998). An evaluation of West Virginia's Preparing Tomorrow's Teachers to Use Technology program (Trek 21) found that the duration of the training seemed to influence program outcomes, but this study did not distinguish duration from intensity (Mitchem, Wells, & Wells, 2003). A three-year study of the Eisenhower Professional Development Program (Porter et al., 2000) defined duration as a combination of total contact hours and time span within which the trainings were completed. Porter and colleagues found that longer durations led to more positive outcomes.

A follow-up study published by Garet and colleagues (2001), based on the data from the three-year Eisenhower study, found that both intensity and duration were important dimensions of quality professional development and that each had a distinct effect on outcomes. They hypothesized that greater duration (more total hours) and lower intensity (longer overall time span) provided more time for teachers to align their activities with the goals of the training, and more opportunities for active learning.

Kennedy (1999), however, cautioned that much of both the rhetoric and the empirical research concerning professional development was too heavily focused on structural features such as duration, and paid inadequate attention to the kinds of activities and topics included in the professional development program. In her meta-analysis of science and mathematics professional development programs that ranged from 2.5 to 150 contact hours, Kennedy demonstrated that very brief programs (in terms of duration) sometimes demonstrated greater effects than longer programs, which she attributed to the strong content focus of the shorter trainings.

Kennedy also looked at intensity of trainings, comparing those spread across a school year to concentrated trainings such as intensive workshops, but found no clear benefit to any structural features related to duration that were independent of high-quality program content. Her analyses suggest that the most important features of a professional development program are a strong focus on helping teachers understand how students learn specific content and how specific instructional practice can support that learning process. In addition, she found that programs that allowed teachers to explore new approaches and refine them for their own use were more successful in causing later changes in teachers' instructional practices than were programs that provided prescriptive approaches to teaching. Kennedy concluded that curricular design should have priority over structural concerns when developing effective professional development.

The Role of Individual Characteristics in Successful Professional Development Outcomes

Other researchers share Kennedy's interest in emphasizing the importance of delivering professional development that is directly relevant to what teachers and students do in the classroom and tightly focused on understanding students' learning processes (e.g., Garet et al, 2001; Loucks-Horsley et al, 1998). Indeed, a growing body of literature has focused on the influence that teachers' personal motivations, interests, and prior knowledge have in determining the effect of a given professional development program on the quality of teachers' instruction. This literature has suggested that teachers are more likely to build on what they learn from professional development experiences when their existing knowledge and priorities are acknowledged and made central to the learning process (Cochran-Smith & Lytle, 1992; Lieberman, 1995).

Researchers working specifically in the educational technology field have emphasized similar issues in relation to technology-focused professional development. In their evaluation of the Trek 21 program, Mitchem, Wells, and Wells (2003) state strongly that the program's emphasis on placing teachers' own curricula and their efforts to improve instruction at the center of the program's structure were fundamental to its success. Dede (1998) has argued that technology-related professional development must engage with and build on teachers' own interests and priorities (rather than on delivering highly structured, predetermined methods for using technology in the classroom) to generate sustained and high-quality use of technology in the classroom. Riel and Becker (2000) have demonstrated that teachers who are most likely to be frequent technol-

ogy users are also teachers who are familiar with constructivist approaches to teaching in general and who are broadly engaged with their professional communities, suggesting that these teachers are likely to demand the opportunity to shape their professional training to meet their own needs and the needs of their local teaching communities.

INTEL TEACH TO THE FUTURE

Intel Teach to the Future is a professional development program for K–12 classroom teachers that focuses on the integration of specific software applications and technology skills into students' project-based classroom work. The program is offered to teachers in more than 35 countries worldwide. This study draws on data collected between 2001–2003 for the evaluation of the U.S. program's inservice implementation. The goal of the program is to help teachers who already have some basic technology skills begin to integrate technology more effectively into their classrooms to enhance student learning.

Divided into ten four-hour modules, the curriculum guides teachers through a process of developing a complete unit plan. Organized around a single research question, the unit engages students in the use of technology to conduct research, compile and analyze information, and communicate with others. The program addresses uses of technology including Internet research, Web page design, and productivity software, focusing specifically on the use of Microsoft PowerPoint and Publisher for both Web page and brochure or newsletter construction. Teachers learn from other teachers how, when, and where they can incorporate these tools and resources into their work with students, particularly to support students' work on sustained projects and original research. In addition, teachers are instructed on how best to create assessment tools and align lessons with district, state, and national standards.

Intel Teach to the Future uses a train-the-trainer model. Districts apply to participate in the program, and then send a group of Master Teachers to trainings conducted by Senior Trainers. Master Teachers then conduct three trainings each within their districts during the next three years, each teacher training a total of 60 K–12 Participant Teachers. Intel Teach to the Future is offered in many states across the United States, and administered by Regional Training Agencies housed in a range of universities and non-profit organizations. In the particular version of the program discussed in this article, Master Teachers received laptop computers and stipends for their work, and Participant Teachers received software and, in some cases, stipends or professional development credits provided by their school districts.

Prior Evaluation Findings

The implementation model for this large-scale program was highly structured, and many features of the training did not vary significantly from one setting to another. One prominent feature of the training, however, could be set by Master Teachers delivering local trainings: the time span within which the training would cover the standard forty-hour curriculum. In other words, the intensity of the delivery of the program could vary considerably. Formative evaluation

of the implementation of this program suggested that this decision did have a notable influence on teachers' experience of the training. For example, Master Teachers were typically trained in a series of five eight-hour days, covering two modules per day. This intensive experience often led to high levels of frustration during the early portions of the training, which shifted into strong feelings of accomplishment by days four and five of the experience.

Participant teachers often experienced the training through weekly four-hour sessions or other similar formats. Formative evaluation suggested that these trainings also provided enough continuity for educators to maintain a focus on their goals for their projects and to create a sense of community within their training group. Interviews with teachers and observations of trainings suggested that when sessions were spread out over a much longer period than this, teachers often lost track of their ideas or of the themes of the curriculum between meetings, and that the group lacked the coherence found within groups that met more frequently (Culp, Shankar, Gersick, & Pedersen, 2001). More specifically, interviews and observations indicated that teachers participating in less intensive trainings had more trouble maintaining a focus on the overall goals of the training and on developing and pursuing their personal agenda within the context of the training than those participating in relatively intensive sessions. When trainings were low-intensity, teachers found they had to make the effort to "re-invent" their purpose for attending at each session, while in intensive settings they felt they had committed to a process that was going to produce a foreseeable outcome that would be directly relevant to their needs and interests as teachers (for more information, see Culp et al., 2001 and Martin, Gersick, Nudell, & Culp, 2002).

These findings suggest that at least one particular structural feature of this program, the intensity of delivery of the curriculum, was being modified extensively from one implementation to another, and that this modification was affecting teachers' perceptions of the relevance and usefulness of the training. These observations and teacher interviews, however, did not provide enough evidence to support any conclusions about the exact relationship between the intensity of the program and teachers' perceptions, or about whether their relationship might have an effect on program outcomes. Consequently, this paper draws on survey data also collected through this evaluation to look more deeply at the interaction of these dimensions of the program and their potential impact on program outcomes.

METHODS AND ANALYSES

Sampling Method

All Participant Teachers enrolled in Intel Teach to the Future were required to fill out an application form before the training and were asked to complete a brief end-of-training survey immediately upon completion of the 40-hour training. The application form contained basic demographic questions including the teachers' sex, racial/ethnic background, and years of teaching experience. The end-of-training survey collected information regarding the teacher's satisfaction with the training and the trainer, their judgments of their preparedness to use technology in the ways emphasized in the training, and their perceptions of training goals, as well as the end date of the training.

In April of each year of the evaluation (2001—2003), all teachers who had completed either a Master Teacher or Participant Teacher training were contacted by e-mail and asked to fill out a voluntary end-of-school-year survey. This Web-based instrument survey collected data on topics including teachers' use of technology, their use of the materials they created during their training, and their instructional practices.

End-of-training surveys from more than 26,000 Participant Teachers who completed their training in the 2002 calendar year were matched with the end-of-school-year data from April 2003. Although more than 4,000 responses to the 2003 follow-up survey were collected, this sample size includes responses from Master Teachers and Participant Teachers who were trained before 2002, as well as teachers who did not provide the identifying information necessary to make a successful match, all of whom were not included in this analysis. In addition, because the literature on professional development considers summer institutes to be distinct from training during the school year in multiple ways (Henriquez & Riconscente, 1998; SRI International, 2002), teachers who began their training during the summer months were eliminated from the analyses. The resulting sample (N = 237) is described in detail below.

Current Sample

All 237 K–12 teachers began their training during the school months (January-May or September-December) of 2001 or 2002 and completed their training during the 2002 calendar year. An overwhelming majority of the teachers (95%) reported teaching in public schools and identified themselves as White (87%) and female (82%). When asked to select the grade levels they primarily teach, 27% reported teaching lower elementary (K–3rd grade), 19% reported teaching upper elementary (4th–5th grade), 27% reported teaching middle school (6th–8th grade), and 28% reported teaching high school (9th–12th grade). The teachers represent more than 130 different school districts, and were uniformly distributed across the fifteen regions of the United States in which the program was being delivered, indicating a wide geographic diversity, with percentages ranging from 2.5–13.1% of the teachers per region. In addition, 33% of the teachers reported teaching in schools where 0–25% of the students qualify for free/reduced price lunch (FRP), 27% in schools where 26–50% of the students qualify for FRP, 15% in schools where 51–75% of the students qualify for FRP, and 16% in schools where 76–100% of the students qualify for FRP.

Measures

Outcome variables. Two levels of outcomes were defined as "successful" program outcomes. The first, basic outcome is considered a baseline for success, and requires only that teachers report using one or more of the software applications or technology skills covered in the training that they had not used prior to the training (these included using Microsoft PowerPoint/creating a presentation; using Microsoft Publisher/creating a newsletter or brochure, and using Microsoft Publisher/creating a Web site). The second, optimal outcome requires that teachers implement with their students a new technology-rich lesson in addition to the unit plan they had developed in their training. This optimal level

of implementation is taken as an indicator that a teacher has not only used the unit developed during her training but also is now at least beginning to integrate technology into the curriculum more broadly, and in ways not done prior to the training. Specific indicators for defining the two outcomes were selected or derived from questions in the 2003 follow-up survey.

1. **Basic outcome: Using new software applications/technology skills.** Teachers were asked to select which of the three specific software applications/technology skills emphasized in the training they had used with their students in the classroom. Teachers were able respond with "Used before training," "Started using after training," or "Never used." If a teacher reported that she started using any one of the three software applications/technology skills after the training, he or she received a code of 1 for success. Teachers were coded a 0 for non-success if they reported having used all three software applications/technology skills before the training or never using any of the software applications/technology skills. Of the 228 teachers who completed these questions, 66% (*n*=151) were successful and 34% (*n*=77) were not successful on this outcome. Of the 77 who were not successful, 22 (9.6% of the full group) were teachers who had used all three software applications/technology skills prior to the training, and therefore could not be defined as "successful" on this outcome.
2. **Optimal outcome: Using new technology-rich lessons.** Teachers were asked "Have you implemented other new technology-integrated lessons or activities with your students during the 2002–2003 school year?" A response of "yes" was coded 1 for success and a response of "no" was coded 0 for non-success. Of the 235 teachers who answered this question, 78% (*n*=184) were successful and 22% (*n*= 51) were not successful on this outcome.

Predictor variables: All five predictor variables were chosen or derived from questions in the end-of-training or follow-up surveys:

1. **Prior technology use:** An index of each teacher's prior technology use was created by calculating the number of the three key software applications/technology skills teachers reported having "Used before training" with their students in the classroom (*n* = 215, M = 1.02, SD = 1.01). Of the 215 respondents, 40% (*n*= 85) reported having no previous experience with any of the software applications/technology skills, 29% (*n*=62) reported having previous experience with one, 21% (*n*=46) reported experience with two, and 10% (*n*= 22) reported experience with all three of the software applications/technology skills covered in the training.
2. **Length of training:** This variable describes the intensity of the training. The number of days between the first day and the last day of the training was calculated and coded into the following three categories:

a. Compressed Length (0–44 days)
b. Standard Length (45–95 days)
c. Extended Length (96 days or more).

The Standard Length encompasses a common implementation model of covering one four-hour module per week for ten weeks. The Compressed Length requires repeatedly combining multiple modules within a week. The median length of training was 71 days (n = 228, M = 76.53 days, SD = 42.69 days), with 19% (n=44) of the teachers completing the training in Compressed Length, 55% (n=126) in Standard Length, and 25% (n=58) in Extended Length. For the purposes of the analysis, "Extended Length" was coded as the baseline.

3. **Technology preparedness (composite variable):** Teachers were asked four 4-point Likert scale questions regarding how prepared they felt to use technology with their students after participating in the training. The answer choices ranged from 1 (not at all prepared) to 4 (very prepared). A score was derived for each respondent by calculating his or her mean response to these four questions (n = 228, M=3.4, SD = .58). See Table 1 for the specific questions used in all the composite measures.
4. **Student work (composite variable):** Teachers were asked three 4-point Likert scale questions regarding how useful the program was in training them to create specific technology-based projects with students. Answer choices ranged from 1 (not at all useful) to 4 (very useful). A score was derived for each respondent by calculating his or her mean response to these three questions (n = 228, M=3.62, SD = .58).
5. **Pedagogical usefulness:** Teachers were asked two questions regarding how useful the pedagogical topics and strategies covered in the training were to them. Again, answer choices ranged from 1 (not at all useful) to 4 (very useful), and a score was derived for each respondent by calculating his or her mean response to these questions (n = 228, M = 2.94, SD = .80).

RESULTS

Descriptive statistics were run on each predictor variable for both outcome measures. The results are listed in Tables 2 and 3. All five predictor variables were entered in forward stepwise logistic regression analyses, which predicted each outcome separately. This generated two models, one illustrating the relationship of these predictor variables to the baseline outcome (new software use) and one relating the same predictor variables to the optimal outcome (using new technology-rich lessons). For each case, the significant model with the most predictors was chosen and reported. Results are listed in Tables 4 and 5.

Using New Software Applications or Technology Skills

As Table 4 illustrates, only "Prior technology use" and "Usefulness of pedagogy" were significant predictors of the basic outcome: whether or not teachers use at least one new software application with their students after the training ($p < .01$ for both). The odds ratios reveal that the probability of using new

Table 1: Original Questions Used to Derive Composite Measures for Predictor Variables

Composite Measures	Questions from End-of-Training Questionnaire
Technology preparedness	Having completed your training, how well prepared do you feel to do the following activities with your students? • Integrate educational technology into the grade or subject that I teach • Support my students in using technology in their schoolwork • Evaluate technology-based work my students produce
Usefulness of pedagogical topics	How useful was each of the following components of the training in helping you learn how to integrate technology into your teaching practices? • Creating and exploring the uses of Essential Questions and Unit Questions • Discussing and thinking through the pedagogical topics
Usefulness of creating specific technology-based projects with students	How useful was each of the following components of the training in helping you learn how to integrate technology into your teaching practices? • Creating student multimedia presentations • Creating student publications • Creating teacher support materials • Creating student Web sites

Table 2: Descriptive Statistics for Basic Outcome: Using New Software in Classroom (*N* = 237)

	Used		Did Not Use	
Predictor Variable	*n*	Mean (SD), Percent	*n*	Mean (SD), Percent
Prior Tech Use	141	.75 (.76)	71	1.58 (1.21)
Technology Preparedness	151	3.44 (.56)	71	3.36 (.63)
Student Usefulness	151	3.68 (.53)	71	3.52 (.67)
Pedagogical Usefulness	151	3.03 (.74)	71	2.76 (.86)
Length (Compressed)	31	70.5%	13	29.5%
Length (Standard)	80	63.5%	46	36.5%
Length (Extended)	40	69.0%	18	31.0%

software increases as perceived usefulness of the pedagogical approach emphasized in the program increases, even after controlling for prior technology use. Conversely, the probability of using new software decreases as prior technology use increases after controlling for perceived usefulness of pedagogical topics, presumably because of the limited number of software applications/technology skills included in the measure.

Table 3: Descriptive Statistics for Optimal Outcome: Implementing New Technology-Rich Activities (N = 237)

Predictor Variable	Implemented *n*	Implemented Mean (SD), Percent	Did Not Implement *n*	Did Not Implement Mean (SD), Percent
Prior Tech Use	167	1.15 (1.03)	47	.60 (.80)
Technology Preparedness	184	3.49 (.54)	51	3.12 (.65)
Student Usefulness	184	3.68 (.54)	51	3.41 (.68)
Pedagogical Usefulness	184	3.04 (.73)	51	2.59 (.92)
Length (Compressed)	43	89.6%	5	10.4%
Length (Standard)	103	79.8%	26	20.2%
Length (Extended)	38	65.5%	20	34.5%

Table 4: Logistic Regression Model Predicting Basic Outcome: Using New Software in the Classroom (*N* = 237)

Predictor	B (log)	S.E. (log)	eB (Odds Ratio)
Prior Tech Use	0.87	0.16**	.42
Pedagogical Usefulness	0.52	0.20**	1.69
Constant	0.19	0.61	1.21
χ^2		39.19**	
df		2	
Nagelkerke R^2		.23	

*** p < .01*

Using New Technology-Rich Lessons

"Prior technology use" and "Usefulness of pedagogy" were also significant predictors of the optimal outcome: implementing new technology-rich activities in the classroom. However, as Table 5 reveals, "Length of training" and "Technology preparedness" are also significant predictors for this outcome ($p < .05$ for all except "Prior technology use," where $p < .01$). The odds ratios reveal that for the three continuous, significant predictors, the probability of implementing new technology-rich activities in the classroom increased as the intensity of the training increased, even after controlling for the other predictors. In the case of "Length of training," both the Compressed and Standard Lengths significantly increased the odds of implementation compared to the baseline Extended Length. Specifically, the odds of implementing increased by more than 200% when teachers completed the training in Standard Length, and by more than 300% when teachers completed the training in Compressed Length compared to Extended Length.

Table 5: Logistic Regression Model Predicting Optimal Outcome: Implementing New Technology-Rich Activities in the Classroom (*N* = 237)

Predictor	B (log)	S.E. (log)	eB (Odds Ratio)
Length (compressed)	1.24	0.59*	3.46
Length (standard)	0.84	0.40*	2.32
Prior Tech Use	0.62	0.22**	1.87
Technology Preparedness	0.62	0.31*	1.87
Pedagogical Usefulness	0.92	0.24*	1.87
Constant	-3.73	1.07**	.02
χ^2		37.85**	
df		5	
Nagelkerke R^2		.25	

**p< .05, **p < .01*

DISCUSSION

An abundance of previous research has found that certain structural, program-level characteristics are important to the creation of a successful teacher professional development program. A growing body of literature has also found that individual-level characteristics of the teachers are also important in determining the success of such programs. But few studies have investigated the role of program-level and individual-level characteristics on professional development outcomes at the same time. The program-level characteristic isolated for these analyses was intensity of the program. In addition, for this study, two separate outcomes were chosen to measure success of the program: the increased use of the software emphasized in the program, and the implementation of new technology-rich lesson plans in the classroom.

This study suggests that, in the case of Intel Teach to the Future, different combinations of factors are influencing programmatic outcomes. First, as Table 4 illustrates, teachers' perceptions of the relevance of particular pedagogical topics emphasized in the training (specifically, supporting students' project-based learning) is a significant predictor of whether teachers achieve the basic program outcome of beginning to use one or more new software applications/technology skills in the classroom after the training. This finding suggests that a perception of relevance is important to support the integration of new tools into current practice.

Second, as Table 5 illustrates, a different combination of factors was important in generating the optimal outcome of implementation of new technology-rich lessons or units in the classroom (in addition to the unit developed during the training). Both teachers' perceptions of the relevance of the pedagogical approaches emphasized in the training and the intensity of the training were significant determining factors in whether teachers achieved this outcome. This finding suggests that the intensity of the training experience is important in promoting a change in teacher practice to include both new tools and new practices. Further, teachers' reports of how prepared they felt to use technology with their students after their training was also a significant predictor of this outcome.

Taken together, these findings reveal that intensity of delivery has influenced this professional development program's outcomes. Specifically, teachers were more likely to implement multiple new technology-rich lessons or units when the training had been delivered in a relatively intensive format (covering the 40-hour curriculum in approximately three months or less). This provides a deeper understanding of the general recommendation in the professional development literature that "longer is better," both in terms of contact hours and time span of delivery (Garet et al, 2001; Porter et al, 2000). This effect did not apply, however, to the basic outcome of expanded use of software applications/technology skills, as time span was not shown to influence whether teachers achieved this outcome. Therefore, duration and contact hours are likely to have independent, differential effects on program outcomes. Their interaction needs to be examined more carefully in future research.

This research elaborates on Kennedy's (1999) conclusions about the need for focused, quality content that teachers find relevant to their students' needs. The findings show that teachers' belief in the relevance of the pedagogical approaches emphasized in this training was a significant predictor of their achievement of both the basic outcome (use of new tools) and the optimal outcome (use of multiple new technology-rich lessons). Kennedy (1999) contends that a strong focus on effective instructional strategies for supporting student learning and opportunities for teachers to explore new concepts and create their own materials are central to successful professional development. Furthermore, she concludes that the extended duration of professional development, independent of quality content, offered no benefits. Indeed, maintaining an emphasis on specific instructional strategies that can support students' learning processes is relevant even to achieving what may seem to be relatively constrained, skill-based outcomes such as increasing teachers' use of technology applications in the classroom. Our findings suggest that intensity of training, in conjunction with program content, plays a crucial role in supporting teachers in achieving the optimal outcome of changing their practice by making use of multiple new technology-rich lessons.

Finally, the results show that, in the case of this professional development program, programmatic and individual factors influence one another to shape program outcomes. Although prior technology use and perceptions of usefulness of the pedagogical emphasis of the curriculum were important in predicting use of the software applications and technology skills emphasized in the training, intensity of training and teachers' perception of preparedness to use technology in the classroom after training were necessary to predict teachers' achievement of the larger goal of advancing their integration of these tools into their curriculum.

CONCLUSIONS

The findings of this study confirm and refine findings from prior formative evaluation of this professional development program regarding the effect of program intensity on outcomes. Formative program evaluation had suggested that teachers participating in low-intensity trainings (those stretching over more than approximately three months time) had difficulty maintaining a focus on or com-

mitment to either the overall goals of the program or their own personal goals for developing new curricular materials. In contrast, teachers participating in intensive trainings formed more coherent, if short-lived, communities of practice with their colleagues and were able to maintain a clear focus on the broad goals of the program and their own goals for their participation in the program.

These findings also demonstrate the importance of designing professional development programs that invite teachers to begin from their own knowledge base, needs, and interests, as opposed to dictating to teachers the reasons why they should commit themselves to the goals or ideals the training chooses to extol. When teachers are ready to engage with the ideas being presented, and when they can easily perceive a connection between those ideas and their own perspectives and goals, then they are likely to find the opportunity and motivation to follow up on what a particular professional development program may offer.

It is possible that selection bias has influenced these findings, as the 237 teachers included in the analysis represent a small portion of the 7,000 teachers trained in the U.S. through this program during the 2002–2003 school year. Therefore, similar analyses should be conducted on other professional development programs being delivered with varying intensity and duration in the future. However, both the sample examined here and the overall population of participants in this program closely resembles the national average of teachers in terms of sex and race/ethnicity (U.S. Department of Education, 2002), suggesting that selection bias is unlikely to have played a very prominent role in influencing the outcomes.

This study provides empirical evidence for the need to measure different levels of professional development outcomes regarding education technology integration (e.g., learning new technology skills vs. implementing new technology lessons), as well as for examining different combinations of programmatic and individual characteristics that may predict these outcomes. However, the outcomes defined in this study and the factors considered as predictor variables in this case are far from exhaustive and many other dimensions of both program structure and individual interest and engagement with professional development remain to be examined. Future research should measure and incorporate other predictive factors that have been identified as key components to professional development within education technology, as well as isolate and measure other levels of outcomes. For now, however, it is clear that the achievement of different outcomes from professional development programs is being influenced by different combinations of both programmatic and individual characteristics.

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References

Anderson, R., & Becker, J. (2001). School investments in instructional technology. *Teaching, Learning, and Computing Report*, Report 8. Retrieved August 2, 2004, from http://www.crito.uci.edu/tlc/findings/report_8/startpage.htm.

Cochran-Smith, M., & Lytle, S. (1992). *Inside/out: Teacher research and knowledge.* New York: Teachers College Press.

Corcoran, T. B., Shields, P., & Zucker, A. (1998). *The SSIs and professional development for teachers.* Menlo Park, CA: SRI International.

Culp, K.M., Shankar, S., Gersick, A., & Pedersen, S. (2001). *An evaluation of Intel Teach to the Future: Year one final report.* New York: EDC Center for Children and Technology. Available: http://www.edc.org/cct.

Darling-Hammond, L., Lieberman, A., & McLaughlin, M. (1995). *Practices and policies to support teacher development in an era of reform.* New York: NCREST.

Dede, C. (1998) Introduction. *Association for Supervision and Curriculum Development (ASCD) Yearbook: Learning with Technology.* Alexandria, VA: Association for Supervision of Curriculum Development.

Drazdowski, T. A. (1994). Preservice teachers and computer technology: A case study perspective. *Journal of Technology and Teacher Education, 2*(4), 251–263.

Fine, C., & L. Raack (1994). *Professional development: Changing times.* NCREL Policy Briefs 4.

Henriquez, A., & Riconscente, M. (1999). *Rhone Island Teachers and Technology Initiative: Program evaluation final report*. New York: EDC Center for Children and Technology. Retrieved August 28, 2004, from http://www2.edc.org/CCT/publications_report_summary.asp?numPubId=64.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915–945.

Kennedy, M. (1999). *Form and substance in mathematics and science professional development.* NISE Brief, 3(2), 7. Madison: University of Wisconsin-Madison, National Institute for Science Education.

Lieberman, A. (1995). Practices that support teacher development. *Phi Delta Kappan*, April, 591–596.

Loucks-Horsley, S., Hawson, P. W., Love, N., & Stiles, K. E. (1998). *Designing professional development for teachers of science and mathematics.* Thousand Oaks, CA: Corwin Press, Inc.

Martin, W., Gersick, A., Nudell, H., & Culp, K. M. (2002). *Evaluation of Intel Teach to the Future: Year two report*. New York: Education Development Center Center for Children and Technology. Available: http://www.edc.org/cct.

Mitchem, K., Wells, D., & Wells, J. (2003). Effective integration of instructional technologies (IT): Evaluating professional development and instructional change. *Journal of Technology and Teacher Education, 11*(3), 397–414. [Electronic version]. Retrieved August 6, 2004, from http://dl.aace.org/13574.

National Commission on Teaching and America's Future. (2003). *No dream denied: A pledge to America's children.* Washington, DC: Author.

National Foundation for the Improvement of Education. (1996). *Teachers take charge of their learning: Transforming professional development for student success.* Washington, DC: Author.

National Partnership for Excellence and Accountability in Teaching (NPEAT). (1999). *Characteristics of effective professional development.* Retrieved July 20, 2004 from http://ed-web3.educ.msu.edu/npeat./

National Staff Development Council (NSDC) (2001). *NSDC standards for staff development, revised.* Available: http://www.nsdc.org/standards/index.cfm.

Office of Technology Assessment. (1988). *Power on! New tools for teaching and learning* (OTA-SET-379). Washington, DC: US Government Printing Office. Retrieved July 28, 2004, from http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/disk2/1988/8831/8831.PDF.

Office of Technology Assessment. (1995). *Teachers and technology: Making the connection* (OTA-HER-616). Washington, DC: U.S. Government Printing Office. Retrieved August 2, 2004, from http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/disk1/1995/9541/9541.PDF.

Office of Technology Assessment. (2000). *eLearning: Putting a world-class education at the fingertips of all children*. Retrieved July 28, 2004, from http://www.ed.gov/Technology,elearning/e-learning.pdf.

Porter, A. C., Garet, M., Desimone, L., Yoon, K. S., & Birman, B. (2000). *Does professional development change teaching practice? Results from a three-year study.* Washington, DC: U.S. Department of Education.

Riel, M., & Becker, H. (2000, April). *The beliefs, practices, and computer use of teacher leaders*. Paper presented at the meeting of American Educational Research Association, New Orleans, LA. Retrieved August, 2, 2004, from http://www.crito.uci.edu/tlc/findings/aera/startpage.html.

SRI International. (2002, May). *Technology-related professional development in the context of educational reform: A literature review*. Prepared for the U.S. Department of Education under GSA Contract # GS-35F-5537H.

The CEO Forum on Education and Technology. (1999). *School technology and readiness report. Professional development: A link to better learning*. Washington, DC: Author. Retrieved July 9, 2003, from http://www.ceoforum.org/downloads/99report.pdf.

U.S. Department of Education. (1999). *Designing effective professional development: Lessons from the Eisenhower program.* Washington, DC: U.S. Department of Education.

U.S. Department of Education. (2002). *Digest of education statistics, 2002*. Washington, DC: National Center for Education Statistics, U.S. Department of Education.

Weiss, I. R., Montgomery, D. L., Ridgway, C. J., & Bond, S. (1998*). Highlights of the local systemic change through teacher enhancement year three cross-site report*. Chapel Hill, NC: Horizon Research.