AN EVALUATION OF INTEL® TEACH TO THE FUTURE

YEAR TWO FINAL REPORT

CENTER FOR CHILDREN & TECHNOLOGY

CCT REPORTS

SEPTEMBER 2002

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EXECUTIVE SUMMARY

This report presents the findings from Year Two of an evaluation of the Intel Teach to the Future professional development program. This evaluation, conducted by Education Development Center's Center for Children and Technology (EDC/CCT), focuses exclusively on the U.S. implementation of this international program.

Our evaluation indicates that Intel Teach to the Future has had a considerable impact on the ability of a large majority of participating teachers to integrate technology into their classroom teaching, on the vision and practice of the use of instructional technology in schools with a large number of Participant Teachers, as well as on the technology-related policies of those districts in which Intel Teach to the Future has a presence. Our report is organized around these three levels of impact, discussing relevant research findings in relation to each one, and concluding with a synthesis and discussion of these findings and recommendations.

Key findings: Teachers and their teaching

- *Teachers leave their training feeling significantly more prepared to use technology than they did before training*. Eighty-eight percent of participants felt "moderately" or "very well" prepared to support their students in using technology in their schoolwork at the end of their training, and 88% felt "moderately" or "very well" prepared to integrate technology into their curriculum/integrate technology into the grade or subject level they teach. Both of these are significant gains over teachers' perceptions of their abilities in these areas prior to participating in Intel Teach to the Future.

- *Teachers follow up on what they learn in Intel Teach to the Future.* A large majority (78%) of trained teachers[1] report that they have implemented all or part of the unit plans they developed in their training. A majority (60%) of those who did not implement a unit plan reported implementing some other technology-rich activity in their classrooms after their training.

- *Teachers are experimenting with new practices.* Both case studies and survey data suggest that teachers are often focusing on research- or project-driven curricula for their students' technology use.

- *Teachers are using a wider range of software with their students.* In addition to an increasing number of teachers using software featured in the training, there was notable growth in the number of teachers using software other than Microsoft PowerPoint and Publisher.

- *Access to technology continues to be a substantial obstacle.* Intel Teach to the Future participants report having access to a greater number of computers in their classrooms than the national average, but negotiating adequate computer time for students to do their work is nonetheless a major challenge for these teachers.

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[1] Throughout this report we will use the phrase "trained teachers" to refer to either Master Teachers or Participant Teachers who completed the Intel Teach to the Future training.

- *Teachers are actively exploring how to assess their students' technology-rich work.* Intel Teach to the Future participants are beginning to make use, or are making greater use, of assessment tools such as rubrics, but are struggling to understand how to adequately assess the content and design of technology-rich student work.

Key findings: Schools and teacher cohorts

- *Important support networks often emerge around Master Teachers.* Master Teachers often help to create a support structure in the schools in which they work, offering both technical and instructional assistance to teachers attempting to implement technology projects in their classrooms.

- *Within-school teacher cohorts support each other in concrete ways.* Participant Teachers support one another's efforts by pooling technology resources, making their own classroom computers available to colleagues, and working together on lesson design.

- *"Critical mass" leads to new demands on resources.* In schools with a large number of Intel Teach to the Future participants, the increase in teacher demand for computers in their classrooms, or access to computer labs, is putting strains on previously underused or adequate technology resources.

- *Trained teachers are seeking further training and schools are responding.* Some schools with a large number of Participant Teachers are helping these teachers build on their skills by dedicating some staff development time to in-service technology professional development.

- *Administrative support is important, but varies widely.* Administrators offer different levels of support for integrating technology in their schools. The primary forms of administrator support are the provision of technical resources and technical support personnel.

Key findings: School districts

- *Intel Teach to the Future helps to grow leadership.* Many Master Teachers and some Participant Teachers are assuming leadership roles in their districts. Master Teachers who already had leadership roles are explicitly building on their Intel Teach to the Future experience to shape developing district technology policies.

- *Districts are adapting technology plans, moving beyond a focus on procurement to emphasize supporting instructional use of the technology.* The approach to educational use of technology embedded in the Intel Teach to the Future curriculum is influencing district technology planning in multiple areas, including budget planning, infrastructure design, and Internet access policies.

- *Districts are shifting professional development offerings away from skills training and toward curriculum integration.* Intel Teach to the Future has also influenced the way some districts are approaching professional development. Where once technology training meant one-shot workshops on specific software programs, districts are now designing professional development that focuses on integrating technology into the curriculum and linking technology-rich lessons to standards.

- *Districts are often unable to provide adequate support.* Many districts lack the resources to provide adequate technical support to a rapidly growing base of technology-using teachers; to equip all computers with software as up-to-date as that used in Intel Teach to the Future; or to provide adequate hardware and Internet connectivity in teachers' classrooms.

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INTRODUCTION

This report reviews findings from the second year of an evaluation the of U.S. implementation of the Intel Teach to the Future professional development program. This program is intended to provide teachers with an opportunity to learn, through the development of a unit plan and the creation of model student work, how to integrate several types of software into the day-to-day work of their students.

The Intel Teach to the Future curriculum focuses on inquiry-oriented and project-based teaching and learning, and stresses the alignment of curricula with standards. The curriculum was prepared by the Institute for Computer Technology (ICT; www.ict.org) and Intel Corporation. The curriculum is delivered through a train-the-trainer model, with senior trainers from ICT training Master Teachers from local districts or consortia of districts, who are then expected to train three groups of twenty teachers each over the next three years. The training uses Microsoft software, focusing primarily on how to use Windows-based versions of PowerPoint and Publisher to support students in creating presentations, web pages, brochures and newsletters. The training also discusses pedagogical and classroom management challenges associated with using technology with students, as well as conducting research on the Internet, and intellectual property issues.

The core of the curriculum is the creation of a unit plan, including model student work samples, support materials, and an implementation plan. This structure allows teachers to expand their technical skills in the context of a curriculum development process. By stipulating the creation of immediately relevant materials, the curriculum puts the teachers' interests and concerns at the center of the training experience. For more information about Intel Teach to the Future, visit www.intel.com/education.

Intel Teach to the Future was designed to address the overarching goal of the Intel Innovation in Education initiatives: to improve math, science, technology and engineering education worldwide. To achieve this end, the program focuses on two of the four more specific goals of the Innovation in Education initiatives: promoting the effective use of technology in the classroom, and improving science and math education in K-12 schools.

The Intel Corporation chose to operationalize these broad goals in the concrete objective of training 100,000 U.S. teachers over three years. Over 60,000 teachers have been trained as of August 2002 (2,350 Master Teachers; 58,639 Participant Teachers). This objective also reflects the hope that by bringing a high-quality training program to large numbers of teachers, clustered within specific schools and school districts, the concepts and practices emphasized in the Intel Teach to the Future curriculum will spread within local and regional networks of teachers and extend its impact to a national level.

The first-year evaluation of this program produced largely positive findings, while identifying several significant challenges facing local districts and practitioners participating in the program.

Key findings from Year One include:

- *Teachers consistently responded very positively to the training itself.* As of June, 2001, 97% of trained teachers reported that the ideas and skills they learned through the program would help them to successfully integrate technology into their students' activities.
- *Early indicators suggested the program had the potential to have an impact on teachers' classroom practices.* Fifty-one percent of respondents to an April, 2001 survey reported that they had implemented the unit plan they developed in their training, and over 75% of those who had not yet done so expected to in the next school year. Teachers who had implemented their unit plans felt very strongly that the unit had been effective in helping them meet their learning goals for their students.
- *Pre-existing conditions at the classroom, school and district level all played a major role in determining whether teachers would transfer lessons learned from their training into their teaching.* Teachers were best prepared to translate their training experience into concrete changes in classroom practice when they had adequate technology in their classroom, confidence that their school and district administration supported experimentation and innovation in the classroom, and a belief that project-driven curricula and student-centered pedagogy are valuable teaching strategies.

During the second year of evaluation research we have focused on the impact this program has had on the classrooms, schools and school districts where it has been implemented. Our primary interest has been middle school classrooms. Besides paying careful attention to whether and how teachers' participation in this training is influencing how and what students are learning in their classes, we also attended to more systemic aspects of the program's impact, such as its influence on how districts design and deliver other technology-related professional development activities for teachers.

Questions Guiding This Evaluation

This evaluation has focused on understanding the impact of Intel Teach to the Future on teachers' priorities, beliefs and classroom practices with respect to student use of technology and technology-rich, research- and inquiry-oriented curriculum. This area of focus reflects a set of guiding assumptions, based in prior research and theory about the relationship among high-quality student learning, technology use and teaching strategies (National Research Council, 2000). These assumptions are as follows:

- High-quality learning refers to learning that includes: mastery of content, understanding of concepts, and development of explicit strategies for asking good questions and exploring new ideas;
- High-quality learning is most likely to occur when teachers create learning environments that support and guide students through the learning process, balancing structured guidance with

opportunities for exploration, peer collaboration, and communication of knowledge by students;

- Specific attributes of many technologies (such as the ability to support the management of complex data or to communicate with an audience beyond the classroom) can enhance important aspects of a high-quality learning environment, and technologies are most likely to have a positive influence on learning when they are used to support curricular goals rather than used for isolated activities.

Research conducted over the last ten years has shown that the use of technology in classrooms can have a positive impact on a variety of indicators of students achievement. Studies focused on specific uses of technology under specific conditions have demonstrated that students' standardized test scores have improved (Bain and Ross, 1999; Koedinger et al., 1999; Mann et al.,1999; Scardamalia and Bereiter, 1996); students are able to engage in scientific inquiry and other activities that involve higher-order thinking skills (Hunt & Mistrell, 1994; White and Fredericksen, 1998); students' motivation and organization skills increase (Cradler & Cradler, 1999); and students develop critical thinking and collaboration skills (Means and Olsen, 1997; Sandholtz, et.al. 1997; Scardamalia and Bereiter, 1996). However, it is important to note that many of these studies, as well as other research, indicate that technology is only effective as a teaching tool when its integration is tied to curricular standards and larger teaching and learning goals (Bain & Ross, 1999; CEO Forum, 2001; Dede, 1998; Honey, Culp and Carigg, 1999; Mann et al.,1999; President's Commission of Advisors on Science and Technology, 1997).

The professional development literature draws an important link between student achievement and high-quality professional development (Darling-Hammond, 1999; National Commission on Teaching & America's Future, 1996; NEPG Monthly, 2000; Wenglinski, 2000). Studies have shown that the most effective forms of professional development (ones that actually have an impact on the classroom) are those that are sustained over a period of time, that actively involve teachers in meaningful and relevant activities, that promote peer collaboration, and that have a clearly articulated vision for student achievement (National Foundation for the Improvement of Education, 1996; Sparks, 2002; U.S. Department of Education, 2000). It follows that the most effective models of technology professional development would be those, like Intel Teach to the Future, that provide teachers with the time and opportunity to work with colleagues to create usable, technology-rich lesson plans that support their broader educational goals.

It is useful to examine Intel Teach to the Future against the National Foundation for the Improvement of Education's criteria for high-quality professional development (1996; see Table 1). These criteria stress not only the quality of the training itself, but also the degree and kind of sustained attention it receives within the district; its alignment with local goals and priorities for teaching; and its level of integration into the daily work life of the teaching staff. While Intel Teach to the Future meets many of these criteria on its own, all these criteria could be met in a district where the program's expectations mesh with current capacity and priorities, and where administrators are able to make a planned, consistent investment in maximizing the impact of this program on their teachers.

Table 1: NFIE Criteria for high-quality professional development: Aspects met by Intel Teach to the Future and those that districts need to address to leverage the training

High-quality professional development includes the following characteristics	**Intel**	**District**
Makes best use of new technologies	√	
Has the goal of improving student learning at the heart of every school endeavor	√	
Helps teachers and other school staff meet the needs of students who learn in different ways and who come from diverse cultural, linguistic, and socioeconomic backgrounds	√	
Is directed toward teachers' intellectual development and leadership	√	
Is site-based and supportive of a clearly articulated vision for students	√	
Provides adequate time for inquiry, reflection, and mentoring and *is an important part of the normal working day of all public school educators* *	√	√
Fosters a deepening of subject-matter knowledge, a greater understanding of learning, and a greater appreciation of students' needs*	√	√
Is designed and directed by teachers, incorporates the best principles of adult learning, *and involves shared decisions to improve the school* *	√	√
Balances individual priorities with school and district needs and advances the profession as a whole		√
Is rigorous, sustained, and adequate to the long-term change of practice		√

*Text in italics refers to portions of criteria that schools or districts can contribute to enhancing the impact of Intel Teach to the Future.

Throughout this evaluation we have sought to understand both the challenges and opportunities associated with disseminating an ambitious, high-quality curriculum to a broad (both geographically and in their teaching specialties) population of teachers. In our first year of research we found that teachers generally had extremely positive responses to this program. Teachers consistently reported that the training was relevant to their needs; that their trainers were well prepared, dedicated and supportive; and that the training had provided opportunities both to build their technical skills and to explore how to connect technology with their own curriculum. Teachers were positive about the training even though some encountered formidable obstacles to course participation and to using what they had learned when they returned to their classrooms. Our Year Two evaluation has focused on looking closely at what teachers who have participated in this training do in their classrooms, and how the presence of Intel Teach to the Future in a school district may be having secondary effects on schools and school districts.

The Structure of This Report

The discussion of research findings begins with a brief overview of teachers' responses to the training itself. The following sections are structured around three inter-related levels of the school system: the classroom, the school and the school district. This summary of findings is followed by a discussion that looks across these three levels and considers the overall impact of the program as well as the qualities of the program and of the teachers, schools and districts themselves that are central to determining the extent of the program's impact. Finally, we present conclusions and recommendations that focus on translating the lessons learned from this program into suggestions for future program development. A description of the schools that participated in the case studies and a summary of our methodology appear in appendices.

FINDINGS

Findings are presented here under four areas: an overview of the teacher population and their response to the training followed by sections discussing program impact on the classroom, the school and the school district. For each of these areas, we present an integrated overview of findings from both case studies and survey data, organized around a series of themes relevant to each level of program impact.

Who Are the Intel Teach to the Future Program Participants?

Demographic Information

These data were collected from 39,960 teachers who participated in Intel Teach to the Future between July 2000 and September 2002. Half of this population completed their training in the period between August and October 2001. This group includes teachers from 14 Regional Training Agencies, with 65% of the population coming from the five charter Regional Training Agencies (Arizona, Northern California, Oregon, and North and South Texas).

This group is generally representative of the national teaching population (for a comparison of this group with the national profile, see Table 2). Eighty percent of these teachers are female (nationally 73%). Eighty-one percent are Caucasian, 10% are Latino, 5% are Black, 1% are Pacific Islander, and 3% reported themselves as “other” (these categories are drawn from those used in the most recent national survey of teacher demographics for purposes of comparison).

Table 2: Demographic comparison of Intel Teach to the Future teachers and national teaching population

	Intel Teach to the Future Participants	**National teaching population***
Sex		
Female	80%	73%
Male	20%	27%
Race/ethnicity		
Caucasian	81%	87%
Latino	10%	4%
Black	5%	7%
Pacific Islander	1%	1%
Other	3%	1%

* (NCES, 2001)

One-third of these teachers work with students in grades K-3, 16% with grades 4-5, 26% with middle school students (grades 6-8) and 25% with high school students (grades 9-12). The two largest groups by subject area are English or language arts teachers (20%) and teachers of self-contained classes (primarily elementary-grade generalists, 25%). Math, science, arts and special education teachers each make up 7-8% of the group. For a complete accounting of teachers’ subject areas, see Table 3.

Table 3: Subjects taught by program participants

SUBJECT TAUGHT	PERCENTAGE
Self-Contained	25
English/Language Arts	20
Computers	4
History	5
Math	8
Science	7
Arts	7
Foreign Language	2
Special Ed	7
ESL	6
Gifted	1
PE	2
Vocational	5
Social Sciences	>1
Other	>1
Total	**100.0**

Finally, almost one-third of these teachers work in schools with 0 to 25% of students eligible for reduced-price or free lunch (an indicator of student poverty). Just over one-quarter (28%) are in schools serving 26 to 50% students eligible for reduced-price or free lunch. The proportions of schools serving 51 to 75% and 76 to 100% of these students are almost identical, including 22% of teachers and 19% of teachers, respectively. A comparison to national figures is presented in Table 4.

Table 4: Students receiving reduced price/free lunch: Comparison to national figures

PERCENT IN SCHOOL ON R/F LUNCH	PERCENTAGE OF INTEL TEACH TO THE FUTURE TEACHERS	PERCENTAGE OF SCHOOLS NATIONALLY*
0-25%	31	34
26-50%	28	34
51-75%	22	16
76-100%	19	16

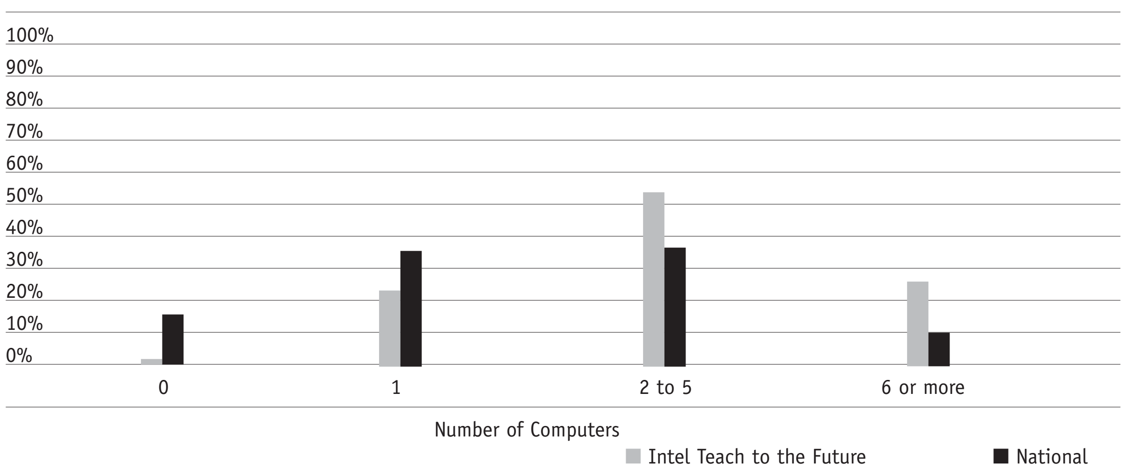
Note that the Intel Teach to the Future numbers include multiple teachers from individual schools, skewing the comparison somewhat.

Access to Computers

Respondents to this survey have more computers available in their classrooms than is typical nationwide, according to the most recent national figures (NCES, 2000; see Figure 1). Three-quarters of respondents to this survey (77%) have two or more computers in their classrooms, while just under half (48%) of teachers nationwide have more than one computer available. However, over half the trained teachers have only two to five computers available, which is fewer than the six to eight computers per classroom that Becker (2001) has found is the minimum needed to support meaningful, sustained use of technology by students.

The mean number of computers available in these teachers' classrooms is 5.78 (SD=7.89), with a median of 3 computers. This number has not changed significantly since the last administration of the survey, in spring 2001 when the mean was 6.12 (SD=8.14)

Figure 1 : Teachers' access to computers in classrooms



Response to the Training

Teachers' responses to this training have been consistently and highly positive. The following summarizes total teacher responses (N=39,960) to questions about their experience with Intel Teach to the Future, as of September 2002.

Perceptions of Program Focus and Goals

Teachers consistently reported that the training focused on and explored the topics the program is intended to address. Between 96% and 98% of respondents reported that the training did the following to a "moderate" or "great" extent:

- Focused on integration of technology into the curriculum
- Provided useful new ideas for teaching strategies to apply with students
- Illustrated effective uses of technology with students
- Provided opportunities to collaborate with other teachers during training.

Perception of Benefits of Participation

Ninety-seven percent of respondents felt that the ideas and skills they learned from Intel Teach to the Future would "probably" or "definitely" help them successfully integrate technology into their students' activities. Seventy-six percent reported that they would "definitely" recommend the training to a colleague, and 20% said that they would "probably" do so.

Perception of Master Teachers or Senior Trainers

Teachers' reactions to their trainers were also very positive. Eighty-three percent said their trainer was very well prepared for each day's activities. Seventy-five percent reported that their trainer was very successful at exposing participants to the overall scope and sequence of the curriculum. Seventy-five percent felt their trainer was very successful at leading participants through the process of creating unit plans, and 67% felt their trainer was very successful at engaging the group in discussions of pedagogical and classroom management issues.

Teachers also found their trainers to be skilled and supportive in their individual interactions with teachers. Eighty-one percent felt their trainer was a very effective facilitator for their training.

Theme I: Classroom-Level Impact

In this section, we discuss how Intel Teach to the Future has influenced teachers' attitudes and practices related to technology use in the classroom. Our observations in this second year of evaluation indicate that Intel Teach to the Future helps teachers take the first step of integrating technology into their traditional teaching methods, and in some cases encourages teachers to experiment with new teaching methods. Intel's Innovation in Education initiative aims not merely at increasing teachers' use of technology, but also at improving the quality of education through technology integration. We therefore looked for evidence of the program's contribution to teachers' ability not only to make more use of technology in their teaching, but also to use the technology in support of specific kinds of teaching and learning, including independent research, project work driven by student questions, and the creation of meaningful student work products that can be shared with a range of audiences.

Our inquiries into this question were informed by EDC/CCT's past research into the developmental course of teachers' use of technology in the classroom. Between 1994 and 1998, EDC/CCT worked with the New York City Public Schools and the Bertelsmann Foundation to establish a professional development center called the New York Media Workshop. In research conducted for this project, EDC/CCT found that there was no quick path to fully mature teaching with technology. Rather, teachers move through a multi-stage process of experimenting with and gradually mastering a series of steps. Technology integration by itself is not synonymous with teaching that enhances student learning. Teachers first have to become comfortable with technology by using it to teach in ways that are already familiar to them. Only then can teachers begin to think critically about new learning opportunities that technology might provide their students.

In applying some of our learning from the New York Media Workshop project to our study of the Intel Teach to the Future evaluation, we anticipated that the process of pedagogical growth could take a number of years, longer than the current scope of this evaluation. We therefore did not look for teachers to have revolutionized their pedagogy a year, or less, after their Intel Teach to the Future training. We did, however, discover that teachers had taken many steps along the technology integration path. First, teachers were making use of technology to teach curriculum content. Second, teachers were beginning to employ certain teaching techniques emphasized in the Intel Teach to the Future curriculum that, while perhaps not completely new to them, they used in conjunction with technology in order to meet their teaching goals. Third, we found that some teachers, primarily those already comfortable with technology or with the teaching practices emphasized in the curriculum, were learning how to use technology to provide students with complex learning experiences carefully designed to exploit the strengths of particular technologies or applications.

Teaching Content with Technology

Data from both our survey and case studies reveal that trained teachers brought their newly acquired knowledge back to the classroom, thus taking the first step toward effective technology integration. Over 80% of teachers implemented at least some of the unit plan they developed in the training. Twenty-two percent said they implemented the entire unit, and 59% implemented part of the unit. Only 19% said they did not implement the unit at all, and nearly 60% of those who had not implemented the unit plan had implemented a different technology-rich lesson since the training.

One likely reason teachers were able to integrate their unit plan or another technology lesson was that the training had given them considerable confidence in their technical abilities. Ninety-three percent of respondents to our end-of-year survey either “disagreed” or “strongly disagreed” with the statement “I did not have strong enough computer skills to lead the unit [or technology–rich activity] effectively.” This increased confidence, coupled with a technology unit based on a familiar lesson, helped to ease teachers through what might otherwise be an intimidating enterprise. The teachers with whom we spoke in our case studies cited their unit plans as an important factor in their effort to integrate technology: possessing this ready-made, well-thought-out activity for use in the classroom spared teachers the difficulty of searching for ways to squeeze technology into already busy schedules. Eighty-five percent of those who implemented at least part of their unit plan or some other technology-rich activity reported that they were "satisfied" or "very satisfied" with the implementation experience.

Teacher perceptions of their students' responses to the units were very positive and consistent with last year's findings, with the large majority of respondents agreeing or strongly agreeing with the following statements: students were motivated and actively involved in the lesson (97%), students with different learning styles were addressed well by the unit (94%), student work was more creative than prior, comparable assignments (87%), student work showed more in-depth understanding than prior, comparable assignments (78%), students gave positive feedback on the lesson (97%).

Perceptions of the most problematic obstacles to unit plan implementation were also consistent with last year's reports, with respondents agreeing more strongly than last year's that these issues impeded their implementation efforts. The most commonly cited obstacles were not having enough time to implement the unit plan (52% agree or strongly agree, compared to 42% last year), and not having enough computers available (51% agree or strongly agree, compared to 47% last year). Difficulty scheduling adequate time in computer labs was also rated highly as a concern this year (47% agree or strongly agree – this was a new item on the survey). There was also some concern this year about students not having adequate computer skills to complete the unit, with 30% of respondents agreeing with this statement (although only 6% of respondents strongly agreed with the statement).

Unit plans were most useful when Master Teachers had advised teachers to bring a relevant lesson plan to the training and the teachers had modified this lesson to incorporate technology. Unit plans were least useful when, lacking such advice, teachers had designed creative but lengthy units that did not conform to their larger curricular plans. Two teachers who co-developed such a unit described their experience as follows:

> *We took a very small piece of our curriculum and created this very time-consuming unit and we should have chosen something that was a more important part of the curriculum. We were really naïve in not knowing what we were getting ourselves into — what we chose kind of snowballed. We should have picked a bigger part of our curriculum.*

In cases where teachers did not modify a relevant lesson plan in the training, they often implemented only part of their unit, or else they abandoned it altogether and implemented some other technology-rich activity that fit more comfortably into the curriculum.

Perception of Preparedness

We asked teachers a series of questions about how prepared they felt to use technology when teaching. These questions were asked both at the time of application to the program and immediately after the Intel Teach to the Future training. The questions specifically asked how prepared teachers felt to:

- Implement methods of teaching that emphasize independent work by students
- Integrate educational technology into the grade or subject they teach
- Support students in using technology in their schoolwork
- Evaluate technology-based work produced by students
- Align teaching and assessment with state learning standards.

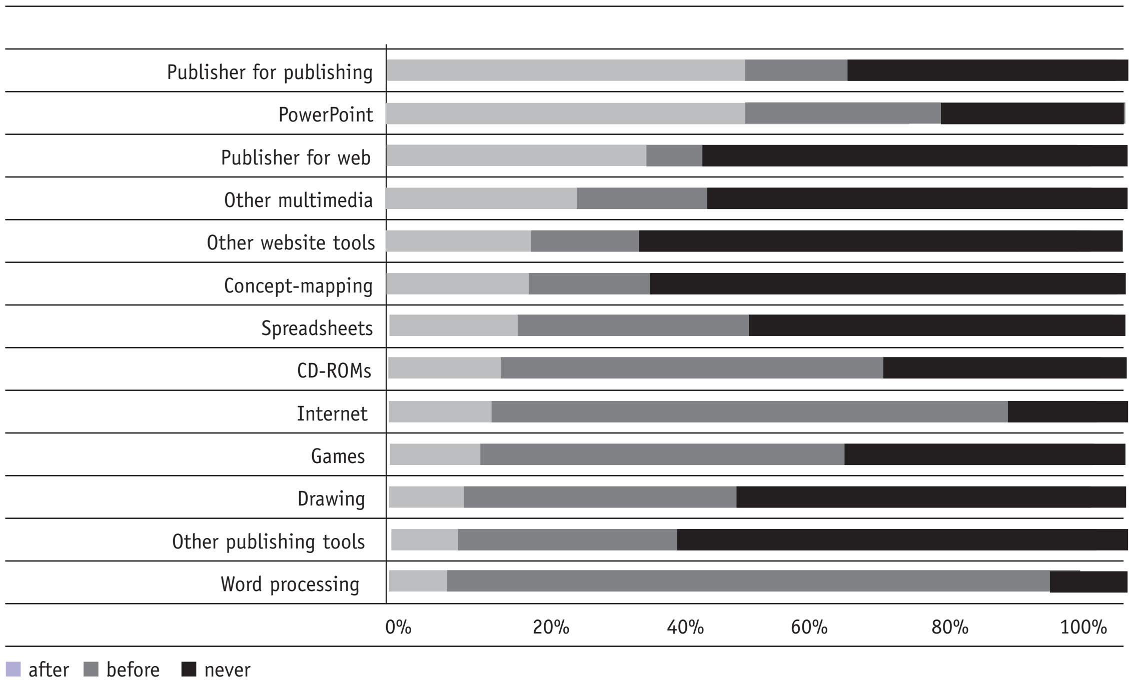
Teachers consistently reported feeling high levels of preparedness for each of these items after their training, with the majority of respondents reporting feeling "moderately" or "very well" prepared to do each of these things. For example, at the end of their training, 88% of survey respondents said that they felt "moderately" or "very well" prepared to support students in using technology in their schoolwork.

Significant changes occurred between teachers' reports of their preparedness before and after the training (gains were tested using paired t-tests). The strongest gains were in teacher perceptions of their abilities to evaluate technology-based work produced by students. Before training, the teachers felt, on average, just over "somewhat" prepared to evaluate such work. After training, the teachers felt between "moderately" and "very well prepared". Teachers also reported feeling increased ability to integrate technology into the curriculum and to support student use of technology in their schoolwork.

Specific Software Being Used

We also asked teachers to report what types of software they were using with their students before and after participating in Intel Teach to the Future. Our findings indicate that teachers are making much more use of the software targeted in the training than they did previously (particularly PowerPoint), but that they are also making more use of other kinds of software as well. Specifically, before taking part in the training, teachers most commonly made use of word processors, the Internet, reference CD-ROMs, and instructional games with their students. After the training, the most commonly used tools were the Internet, word processors, and PowerPoint. The tools that teachers most frequently tried out with their students for the first time after their training were Publisher for publishing, PowerPoint, Publisher for the web, and other multimedia production tools. These findings suggest that the training is encouraging the use of the tools targeted in the training (PowerPoint, Publisher, and the Internet) but is also more broadly encouraging teachers to focus their students' use of technology on tools for research and production. See Figure 2 for a complete reporting of responses to this question.

Figure 2 : Software used with students before/after training



Changes in Teaching Practices

For some teachers, simply taking the step of having students work on computers was an enormous pedagogical transition. Other teachers, however, took more from the training than the ability to make technology part of a classroom activity. In our end-of-year survey, we found that teachers understood that the purpose of the training was not merely technology skill-building. When asked whether the pedagogical ideas presented in the training were new to them, 59% said this was “somewhat true” and 16% felt this was “very true.” Whether or not the ideas were new, almost all the respondents (97%) said that it was “very true” or “somewhat true” that the pedagogical ideas presented at the training were relevant to their teaching.

Survey participants were asked to describe how frequently they made use of various teaching strategies, and whether they were using these strategies more or less often than before the training. Responses varied widely, but large numbers of teachers are using many of the strategies emphasized in the Intel Teach to the Future curriculum “sometimes” or “often,” and, more important, fairly large minorities indicated that they are using these strategies more often than they did before the training. These responses suggest that many teachers are beginning to make use of more project-oriented teaching strategies than they had previously. (See Figures 3 and 4 for a summary of responses to these questions.) As one Participant Teacher in our case studies put it, "I feel like I'm spending more time on the good teaching practices part of this [than] the basic technology part."

Figure 3 : How frequently teachers use teaching strategies

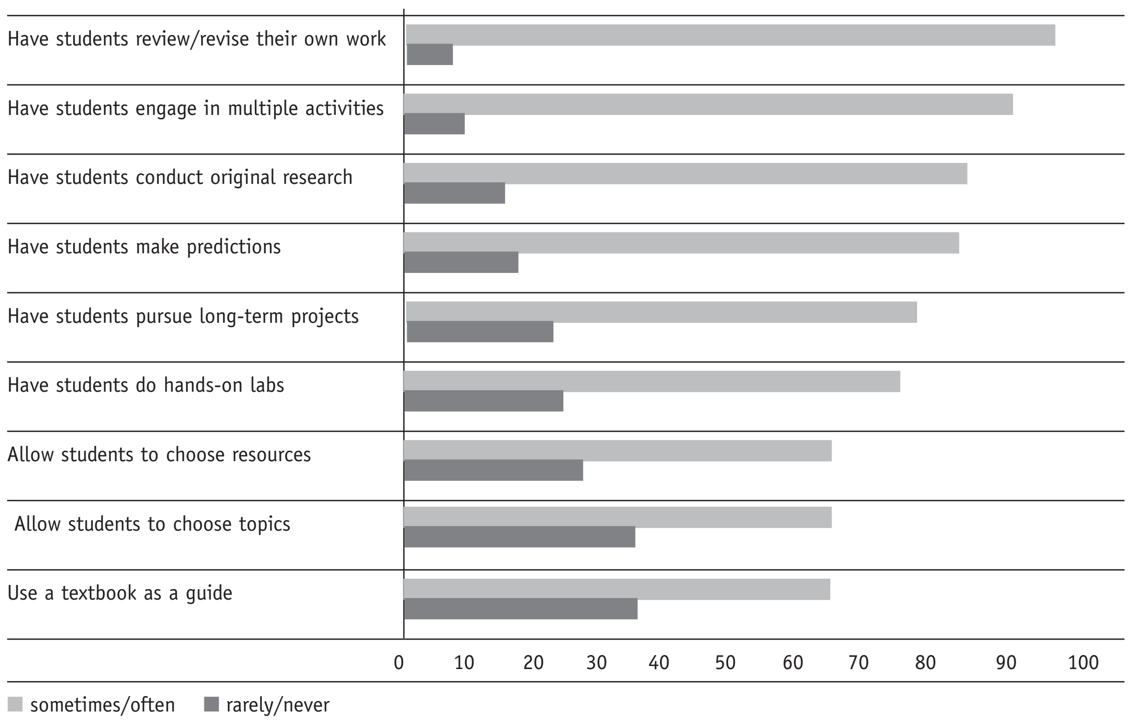
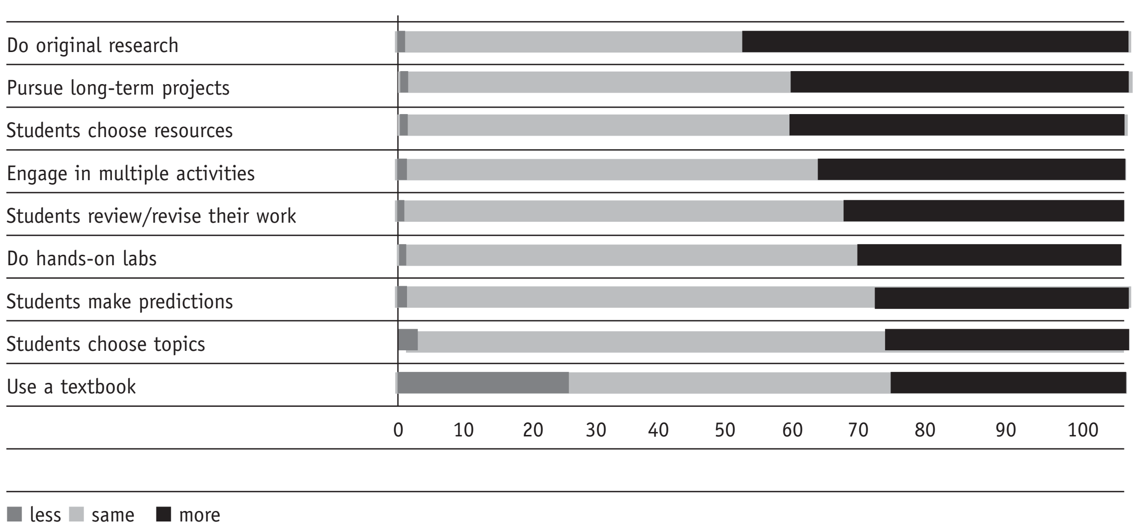


Figure 4 : Changes in use of teaching strategies



The following are examples of teaching techniques that our survey and case studies suggest teachers are incorporating into their technology-rich lessons.

Group work. Whether by default or by design, we observed many instances where teachers had their students working in small groups on technology projects. Sixty-four percent of survey respondents said that "Learning to work collaboratively" was a "very important" objective for using technology with their students, but these teachers also noted that limited technology resource often forced them to make use of small groups when students engaged in technology lessons. This instructional technique required careful management from teachers. Some mentioned that they had learned the importance of deliberately selecting the groups so that all the students participated in the activity. Other teachers employed techniques such as modeling the desired interaction and closely monitoring what students were doing during the lesson. In one class in which two teachers were co-teaching, the teachers play-acted the group activity before having students begin their work. Once the students were engaged in the lesson, these teachers walked around the classroom and observed what the children were doing. When they saw a student who was not participating, the teachers would ask him or her questions about the lesson, which prompted the student to engage in the activity.

Techniques such as those described above were used to mitigate what teachers described as the biggest challenge to conducting successful group work, namely, ensuring that all members of the group contribute equally to the project. "The one thing that's hard to do is get [students] to help [their peers] and not do [the work] for them," said one teacher. In her view, it was not surprising that students took the opportunity presented by group projects to assert themselves. "There aren't many other opportunities for them to help out their peers....Most of the time they work independently." Group projects on the computer gave "[students] the chance to shine a little, show what they know."

Despite the difficulties presented by conducting group activities, teachers in general felt the experience was worthwhile. A teacher who had small groups working on a botany project said, "There is a difference in the kind of work they're producing. Even in understanding the concept of photosynthesis. Even the kids reading at a first-grade level, and we do have some of those, they were understanding it because they were working with a partner who could understand it and explain it."

Student research. One of the main benefits of technology that teachers identified was its usefulness as a research tool. When asked their reasons for using technology with their students, a majority of survey participants rated as "very important" the items "To provide students with a broader range of resources (such as images or texts) to stimulate their learning" (74%) and "To provide students with tools to support them in analyzing and interpreting information and ideas" (63%). Many of the activities we observed involved students conducting Internet research. Simply bringing technology into a lesson, however, did not ensure that the lesson effectively facilitated student learning. Some of the least successful lessons we observed were those in which

Internet research was the centerpiece and students were given very little instruction on how to conduct research. Often these lessons involved students choosing a specific topic related to a larger unit of study, conducting searches on the Internet by entering keywords into commercial search engines, and transferring images and textual information from the Internet into a PowerPoint presentation or a Publisher document.

In one class we observed in which students were giving PowerPoint presentations on different topics related to World War II, it was apparent that many had copied and pasted significant portions of their information directly from the Internet. The text included words the students did not know how to pronounce, and some of the images and audio had only a tangential relationship to their topic. One group appeared to have written most of the text in their presentation themselves. However, when questioned about their presentation, the students admitted, "[The teacher] thinks we got that from the Internet, but we just made most of it up." A teacher in another class explained that the format of Internet searching was not always conducive to careful study of a topic. He noted that the students rarely spent much time on any one site, often did not read the information they accessed, and equated finding information with learning information.

The use of the Internet as a research tool was more successful when Internet research figured as one component of a larger, structured activity. For example, in a biology lesson on plant structures and processes, students had been given specific questions to research on the Internet, and specific websites that were designed as educational resources. The students had to read the information they accessed in order to answer the questions and did not have to spend a lot of time conducting fruitless searches on keywords. In addition, this activity was part of a larger project involving different kinds of activities, such as experiments, recording the growth of plants in a journal, and baking plant cell cookies. As the students conducted their research on the Internet, the teacher would remind them of how the information they were accessing related to what they learned from their other activities.

Students as teachers. A few teachers, particularly those who already employed many of the teaching techniques emphasized in the Intel Teach to the Future curriculum, structured technology activities to provide students with the opportunity to take on the role of teacher or mentor in the classroom. This is not a common practice. It requires teachers to cede some degree of control over their classrooms and to admit that they do not have all the answers. One teacher admitted that having students as technology mentors "puts you in a state of discomfort.... I think some teachers aren't willing to do that, they want a handle on things.... There's a fear of failure among teachers." However, increased confidence in their technical abilities, coupled with an openness to student-centered pedagogy, inspired some teachers to encourage students to take on technology leadership roles in their classrooms. "I think that our teachers walked in [to the training] and were uncomfortable with the technology and knew they didn't know anything and weren't comfortable with letting a kid help them," said one Master Teacher. "I don't know if it's because of Intel or not, but they are a lot more comfortable now with letting kids show them things." Some teachers claimed that before the training, it was difficult for them to accept help from students because they did not have the knowledge to properly assess their own or their students' skills or to learn from their students. "For me [the training] helps because I understand the student when he's showing me something."

Often students' helping behavior was informal. However, in a few cases teachers had assigned technology leadership roles to students in their classes. In one classroom we observed, a teacher had designated 10 students to serve on a regular basis as technology mentors. Having mentors who could act as the first line of defense for basic technology questions enabled the teacher to provide more one-on-one assistance to students with questions about the lesson content. This teacher stated that she would not be able to use technology in her classes without their help. She added, "The kids are really good about helping each other out because they know it will take a while for you to get around to them…. Learning is kind of a social thing. Kids can explain things that teachers can't because [kids] tend to simplify it. They've done that no matter what the level or kind of work, and in the computer lab it's really helpful." She felt that the technique of having students teach their peers was more successful in classes involving technology than in other classes. "It seems as though [designating students as mentors] doesn't help in any other learning environment. Mentoring comes more naturally in a technology environment. It's not as contrived."

A teacher in another school had different students take on the teacher role for different lessons, whether they involved technology or not. This approach to teaching was a regular part of her practice. "The kids-as-teachers thing is just a part of the way this school works." In the classes we observed in this school, the students appeared very comfortable providing advice and support to their peers. In a structured lesson on genetics, student-mentors took small groups of their peers outside, with no supervision from their teacher, to show them how to take digital pictures of creatures they created out of marshmallows and straws. The mentors then assisted the peers in using Publisher to make brochures and web pages about their creatures. The teacher modeled the kind of mentoring behavior she wanted the students to engage in. When the mentors ran into difficulties, rather than directly answering their questions, she would encourage them to try to solve the problem on their own.

Teachers in our case studies recognized the value of having students take on leadership roles in their classes. "Sometimes it's a humbling experience," said one teacher, but she acknowledged that, however uncomfortable it might be for her to get technical advice from a student, "that's a good experience for me and also helps that child." Other teachers noted that having the chance to assist their peers gave students who might not succeed in other subjects a chance to gain confidence in their abilities. "[The students] help each other with things like where you find music clips, clips that move. They help find things online. This is true for kids that are not otherwise academically oriented." Not only do students gain confidence in themselves by acting as peer mentors, they also gain an appreciation for the challenges of teaching. One teacher described the response a student had to his experience as a peer teacher. "We have the kids who finish [the assignment] first help the other kids. In one student teacher's class, this boy was helping out and he came up to her and said, 'Ms. Hughes, now I understand why you're so tired all the time. I understand what hard work this is.'"

Classroom Management Techniques

Teachers responding to the survey did not report that technology presented significant classroom management challenges. Eighty-two percent of respondents "disagreed" or "strongly disagreed" with the statement "I found it difficult to manage my students on the computers." However, specific issues related to classroom management did present problems. For example, about half the respondents agreed that "Time constraints prevented me from completing the entire lesson." Limited access to technology created scheduling obstacles that made it difficult for teachers to integrate complex technology lessons into their overall curriculum. Many teachers felt it was important for students in all their classes to be covering the same material at the same time. If they could not gain access to a computer lab for all their classes, some teachers were reluctant to implement multi-day technology lessons. As the technology coordinator in one school stated, "[Teachers] say, 'If I can't do this with all of my classes I don't want to do it with any.'" One teacher who taught two core classes and one elective class explained how access limitations determined her choices about implementing technology lessons.

> *I do more technology integration with the elective class because it's one class... it's much easier to [deal with] scheduling issues. If the lab is taken you'll figure something out. But if you have five classes it's harder. You can't keep the class hanging. If you need more than three days, which you often do, then work doesn't get done. I try to keep my classes at the same point in the curriculum.*

Few teachers were ready to take the pedagogical leap of staggering the content and lessons they did in their classes in order to make technology integration more feasible. Most found it more comfortable to cope with resource limitations by preparing as much as possible in the classroom before taking their students to the computer labs. In our observations we saw teachers explaining the assignment before the students left the classroom and providing detailed, written instructions to students in the lab. In some cases, students arrived in the computer lab with storyboards or outlines of their projects. One teacher observed that these time management techniques actually had an educational benefit for students: "Doing PowerPoints forces the kids to do two drafts because they compose on paper and then when they go into the lab and enter it into the PowerPoint, they see what doesn't make sense. So that's an improvement, but it's done first and foremost out of necessity, because the lab time is so precious. You'd never let them compose from their heads in the lab."

Another management aspect of technology use that presented both challenges and rewards arose from the fact that student work could be turned in virtually rather than in hard copy. "The school is networked and students can drop their work into class and subject folders on the server to hand in an assignment," said one teacher. Although in theory this technique could serve as a more efficient way of organizing student assignments, in practice we observed numerous problems associated with virtual student work. The most critical problem was students who were unable to access the folders on the network into which they were supposed to copy their assignments. The saving of files to teacher folders required a series of navigational steps that many students had not mastered. In some cases, teachers provided students with written instructions telling them how to save their work, but even with these supports some students would simply save their work to local hard drives, making it difficult for them to find their work again. Teachers needed to be vigilant about making sure at the end of each lab session that students followed the proper steps to save their work on the correct network locations.

Assessment

Many teachers we spoke to mentioned that they had either started using or increased their usage of assessment rubrics after participating in the training. Many teachers felt that not only had rubrics made assessment easier for them, but they also helped make the evaluation process more transparent for students. "I use a rubric with each [technology project], which I never did before Intel," one teacher reported. "I share [the rubrics] with the kids. It makes it easier to grade and the kids know what's expected from them…. I get better work from students when they know what's expected from them ahead of time." Some teachers had taken the use of rubrics one step further by involving their students in rubric development and assessment of their work. "One thing my kids have done is make their own rubrics; that's something I tried since the Intel [training]," said one teacher. "It's a learning experience for them."

When confronted with the task of assessing technology projects, teachers offered conflicting views on evaluating the technical and design elements of the work. Some used rubrics to focus their assessments on the project content. "Sometimes students get so caught up in sound and background colors that they may miss the objective of the assignment, so I try to monitor. The rubric comes in handy for that." Other teachers, however, recognized that the visual and technical elements of the work had value in their own right, and therefore designed assessments that gave credit for both the content and the design of student work. "[Students] need the freedom if they want to get fancy with [the technology project]," said one teacher. "I don't see how you can separate the two [the content and the design]. They should be dealt with separately on the scoring guide and then you can put down what they did for each…. If you're just stressing content they could end up just doing a book report on PowerPoint and you don't get a very good presentation because it doesn't use the technology enough. That's not what PowerPoint should be."

Moving beyond Integration

Moving beyond integrating technology into old ways of teaching to using technology to foster new kinds of learning requires seeing technology as affording unique learning opportunities. For most of the Intel-trained Participant Teachers we observed, this sense of technology was still developing. Indeed, teachers sometimes found the very qualities that make multimedia software unique to be distractions rather than contributors to an enhanced learning experience. "One of the problems we have with PowerPoint is getting the kids to understand that we need the information as opposed to focusing on the neat things they can do with bells and whistles," was a comment representative of teachers who held this point of view.

Faced with the possibility that their students might be distracted by the unique characteristics of multimedia work, many teachers opted to restrict students' opportunities to experiment with software. For example, teachers often required students working with PowerPoint to write out the text for their presentations in advance, then type that text into their PowerPoint slides during lab time, and then add visual aids or work on layout. This encouraged students to work efficiently in the lab (often a necessity if lab time was scarce) but supported the notion of visual or auditory communication as an add-on to reports that remained primarily text-based. Teachers "solved" the problem of multimedia distractions by narrowing students' options, keeping students' multimedia work very close to the traditional work they'd been doing before. In one classroom, we observed the following characteristic exchange:

> *Annie asks Ms. Jones if she can have sound in her presentation. "No," Ms. Jones tells her, "we don't need sound." Stephanie then asks, "What about backgrounds?" "Only if you get everything done that you need to," Ms Jones replies. "Then you can go back and do those fancy little things."*

By eliminating the "distractions" posed by multimedia, these teachers also lessened the technology's power to help students communicate in multiple ways. Yet this approach is consistent with teachers' typical need to first integrate technology tools into their familiar ways of teaching. Some teachers – often those who had considered themselves moderately tech-savvy before their training – took a more balanced approach to technology's opportunities and distractions. One teacher expressed her comfort with students' need to explore software's possibilities. "I see it like if they start playing, that's part of the learning process. Eventually they start making critical decisions about what's sensible and what is not."

In one of our observations, students in a science class gave PowerPoint presentations on experiments they had conducted. At the end of each class the teacher spent time going over the presentations, discussing the visual and technical features that made the presentations more or less successful. He spoke about design choices and aspects of oral presentation style. This feedback indicated that the teacher was cognizant that this form of student product had its own unique requirements. He wanted the students to understand that when they designed PowerPoints they had to think just as much about how they presented information as what they presented.

Teachers who already used constructivist pedagogical techniques were able to foster the gradual development of a critical approach to multimedia communication in their students. One Master Teacher who taught at a progressive school described how she and her web design students evolved together in their understanding of the medium. "We started the web page three years ago. Our first one was OK; it was decent. It had some good information, it wasn't exciting and wonderful. We said, 'OK we're kind of bored with this, not a lot of people are using it; why?'" At the beginning of the second year, she sat down with her students to figure out how the site could be improved. They decided to explore the communicative potential of visual and sound effects. "For the second round we added fancier graphics and more eye-catching pictures and it was too distracting. It was too fancy. You couldn't read the information. So we went from too boring to too fancy." Finally, she tried to guide students toward a more mature approach to the medium. "Now we're at the third stage where we're trying to meet halfway on that. You want the kids to take ownership of it and be proud of it. Chris [a student] was part of the group that made the home page [in the second year] that to me was nauseating, and [my task is] trying to get him to see why it's nauseating and how to make it better without just telling him, 'You have to do this, this and this.' These kids are ready to talk about that because they've had the foundation of getting to play."

Theme II: School-Level Impact

Critical Mass in Schools

In those schools where a large number of teachers had participated in Intel Teach to the Future, it seemed that the relatively sudden increase in teachers interested in integrating technology into their "everyday" practice sparked a change in the culture of the school. First of all, there was a new group of relatively tech-savvy teachers in the building, confident in their abilities to solve at least rudimentary technical problems, and able to share ideas and encourage one another. At the same time, and just as abruptly, there was increased demand on the school's technology resources; all at once, a large bloc of teachers was signing up for time in the computer lab, requesting tech support, and seeking more and better hardware and software in their classrooms.

Below, we discuss some important ways that "critical masses" of trained teachers seemed to be affecting their schools. It is important to note that schools with greater numbers of Participant Teachers were more likely to have high-SES populations. Forty percent of teachers in schools with more than 15 Participant Teachers were from schools where 25% or less of students were eligible for free/reduced-price lunch. In contrast, less than 15% of these teachers were from schools with 75% or more free/reduced-price lunch students.[2]

Master Teachers as Campus Leaders

Each of the schools we visited had an Intel Teach to the Future Master Teacher on the faculty. The presence of these Master Teachers augmented in concrete ways the influence of trained teachers on the campus culture.

The first consequence of an on-campus Master Teacher was that Master Teachers often recruited Participant Teachers most heavily on their own campuses, and so there were large numbers of trained Participant Teachers in those schools. In addition, these Master Teachers had recruited first on their home campuses, before looking farther afield to fill their second and third trainings.

2 We were able to match 2886 end-of-year survey respondents with the training/application data. Respondents were divided into quartiles based on how many teachers from their school had been trained. Those in the first quartile were at schools with 1 to 4 other teachers (N=747,26%). Those in the 2nd quartile were at schools with 5 to 9 teachers (N=720, 25%), the 3rd quartile teachers were in schools with 10 to 15 (N=605,21%) teachers trained and the 4th quartile teachers were in schools where 16 or more teachers had been trained (N=814,28%).

As a result, Master Teachers' home schools had a relatively experienced group of Participant Teachers, many of whom had had a full academic year to integrate what they had learned from their training.

In each of the campuses we visited in our case studies, a Master Teacher was the vital center of a group of trained teachers. Whether these Master Teachers provided informal tech support or held an official role as a school technology coordinator, all of them had taken on leadership roles assisting teachers in the use of technology in instruction. The on-campus Master Teachers we observed continued to provide technical and instructional support beyond the training, and often advocated for teachers seeking additional technology resources. On-campus Master Teachers knew the teachers, the curriculum, and the students and were able to provide tailored instructional support to teachers as they explored new ways of approaching technology. "I think more teachers are willing to take the risk of using technology because they [can] always ask me questions," one Master Teacher told us. In fact, on the end-of-year survey Participant Teachers with Master Teachers in their schools rated "lack of instructional support" and "lack of technical support" as less serious obstacles to integrating technology into their teaching than Participant Teachers without Master Teachers in their schools.

Master Teachers were often called upon for technology support and troubleshooting within their schools. One Master Teacher who was part of her school's tech-support team stated, "All three of us are available and it's seldom that one of us will walk down the hall without getting yanked into a classroom to help on something. We try to make ourselves available for any kind of support." This immediate availability is especially important when teachers experience technical difficulties during their lessons. Master Teachers in our case study sites had aided Participant Teachers by responding to crashed servers and Internet access issues that arose in the middle of technology-based units.

Since the training, the Master Teachers we interviewed, even those who were already technology coordinators, had altered their approach to supporting teachers, moving beyond basic tech support to provide instructional support as well. One school administrator explained that the Master Teacher in her school "has no classes; his job is tech support for the school, and he seems to be as involved with instructional technology as with the technical side of things."

Some Master Teacher tech coordinators that we spoke with spent time after school and during staff training periods helping teachers prepare for technology integration. This support was not limited to addressing unit plans created during the Intel Teach to the Future training, but built upon other lessons in which teachers wanted to incorporate technology. An administrator noted that she had seen the Master Teacher in her school "working with teachers during their conference time, after school, outside of Intel time ... she makes sure the teachers who have been trained continue to use what they've learned.... [She also works] with teachers who are out of the program, with teachers that need help."

The Intel Teach to the Future model provides an example to Master Teachers of how to align technology with what teachers are already teaching in the classroom. A Master Teacher we met with spoke to this. "I want to be able to go out there and say to teachers, 'What are you teaching? I can help you with that.' I've also learned a lot about what's out there, what curriculum teachers teach."

As Master Teachers emerge as technology leaders within their schools, some have also become increasingly involved in technology decision-making in schools that have the flexibility to modify technology plans to better meet the needs of teachers. As a result, Master Teachers have helped Participant Teachers get additional hardware and software to support their use of technology in the classroom. Some Master Teachers we spoke with were actively involved in deciding where to put new computers — to create a new lab, to put them in an existing lab, or to distribute them among teachers. With the emergence of large groups of trained teachers and a subsequent strain on resources, the Master Teachers' input into hardware allocation became increasingly important. As technology point people in the school, Master Teachers aided in decisions about how to distribute resources based on their knowledge of which teachers would use them most effectively. "My principal doesn't make the hardware allocation decisions herself," said one Master Teacher. "She calls me and [another tech support person] because we know what's going on."

Collegiality of Participant Teachers

The survey data suggest that Participant Teachers are also assuming new responsibilities by sharing their skills and experience with colleagues. Fifty-seven percent of survey participants agreed that, since the training, they "have taken on more of a troubleshooting role with regard to technology use in my school," and 57% agreed that they "have taken on more of a leadership role with regard to technology use" in their schools. This was especially true for participants who had few or no other Intel-trained colleagues at their schools.

When asked on the end-of-year survey whether they discuss computers, software, or the Internet with their fellow teachers at school, 19% of respondents said "almost daily," 36% replied "weekly," 27% said "monthly," and only 18% replied, "never/seldom." Sixty-three percent of respondents "agreed" or "strongly agreed" with the statement "I confer more with teachers who were in my Intel Teach to the Future class about technology-related issues," since their Intel training, and 67% "agreed" or "strongly agreed" that they "confer more with other teachers about technology-related issues, including those who did not participate in Intel Teach to the Future," since their training.

Although we saw a number of instances in which teachers provided instructional support to their colleagues, and in some cases collaborated with them on developing and implementing technology assignments, we did not see a substantial number of Participant Teachers in the case studies taking on leadership roles in their schools. Perhaps this is because in these schools there was already a strong technology leader (the resident Master Teacher) and because, as the survey suggests, when there are significant numbers of trained teachers in a school, no single Participant Teacher may feel it necessary to take on a leadership role herself.

Groups of Trained Teachers as a Change Force

In the schools we visited, the Intel Teach to the Future training had created a new sub-population of teachers actively pursuing technology integration, aided by a Master Teacher with advanced skills and experience as a teacher-leader, and supported by colleagues who had also gone through the training. This initial change in the teaching population catalyzed a second level of schoolwide changes that were neither complete nor unambiguously positive at the time of our study. In these cases, "critical masses" of Participant Teachers pursuing technology integration were making new demands on their schools and districts. These teachers had reached the stage of agitating for change in their schools, but not necessarily achieving it.

A new demand for computer lab time was a typical issue in campuses with large groups of newly trained teachers. In each of the case study sites we heard a remarkably similar story — demand for lab time, once limited, had become intense. Whereas the lab before had been the province of business classes and a few tech-savvy teachers, school tech coordinators now had to meet the demands of whole departments of core-subject teachers, all hoping to do significant units of work with their classes in the lab. There was simply not enough time or resources for teachers to have all the lab access they wanted. As a result, teachers found themselves unable to do all the things they now wished to do with technology. Over 50% of survey respondents "agreed" or "strongly agreed" that "not enough computers were available," when they tried to implement their unit plan or other technology-rich lesson. Over 47% "agreed" or "strongly agreed" that "it was difficult to schedule adequate time in my school computer lab." And nearly 20% of trained teachers who did not implement any part of their unit plan indicated that this was because the computers they needed were not available. As one principal indicated, the crunch in the lab was one side of a positive development — increased interest in technology integration. "All of the teachers would like more equipment and many would like more time in the lab."

Although trained teachers engaged in technology integration had raised this problem, they did not have the power to solve it. Acquiring more hardware and building a second or third lab would be ideal if school or district budgets allowed, but in most cases they did not. Teaching technology-rich lessons in the classroom instead of the lab might work for those teachers with small class sizes and three or four machines in their classrooms, but this was not considered a solution for those with, for example, thirty-five students and one classroom computer.

Partial solutions abounded, as teachers and administrators found creative ways to share classroom computers and free up lab time. In two of the case study schools, teachers chose to donate computers to common labs so they could be used by all the teachers and students in their school. A teacher in one of these schools stated:

> *The district gave each teacher a workstation for their classrooms, but the teachers at [our school] gave up their teacher workstations to the lab for students to use. Because we do so many group projects with kids, it made sense to have the computers in one place where kids could work on them. Teachers come to the lab to do administrative work. Each school has a site plan for technology distribution. The committee at our school decided where the machines should go.*

According to this teacher, the choice to pool resources reflected the teachers' recognition of their own instructional needs.

> *The lab is important. The alternative was two computers per classroom, which was the way [the district] wanted us to set it up but we want the lab. So the computers in the lab "belong" to the teachers and we've agreed to have them there. We'll keep it that way until [the district] tells us to change it.*

In another school we studied, teachers opted to turn the teachers lounge into a second computer lab, and those teachers who had participated in the training agreed to have the principal use their discount to purchase computers for the lab rather than have the computers in their own classrooms.

At a third school, teachers made their classroom computers available to their colleagues' students. They combined this strategy with a collaborative approach to scheduling lab time to allow each teacher access to the greatest number of computers possible at one time. In the words of one such teacher, "When you have 25 kids … three [computers] don't go far, so we work together. We have [lab] activities on different days. I have students from another class work on computers in my room." A colleague added, "We scatter [students] around and I'll have them go to six or seven classrooms of other teachers who are not using [computers]."

This strategy allowed teachers to leverage the resources of their colleagues, but it also conflicted with school policies. "We have an Internet policy where we have to monitor the kids, which is hard when they're in five different rooms," said a teacher in this school. "It's … a balancing act between school policy and what we actually do. We fight all the time with the administration about monitoring. We have them scattered so we're always walking to check on them but we can't be there every minute."

Large groups of trained teachers also began making more urgent demands for further professional development in technology. These teachers pressured schools and districts to provide follow-up trainings similar in format to Intel Teach to the Future. This demand spurred thought and action among school administrators on how to address these new needs. Schools responded by offering technology trainings as part of staff development time and in-service trainings. One administrator commented, "Now we have some dedicated staff training time for technology." Another said, "One of the things we're doing is always trying to show teachers how much information they can get, how they can utilize the technology appropriately so that the kids can get the most out of it. We dedicated some of our in-service time to technology. The Intel training has had some impact on our approach to in-services."

Administrative Responses to Critical Mass Groups

The quality of administrative support for trained teachers depended on a number of factors, such as the administrator's own interest in technology and the degree to which other priorities constrained or freed her to direct resources towards technology. Though many of these factors are local realities beyond the reach of Intel Teach to the Future's influence, some Master Teachers and Local Education Agency (LEA) coordinators used the training itself as a way to raise administrator awareness of the potential benefits of technology integration. One district LEA spoke of the need to provide training, not only to teachers, but also to administrators:

> *What I have found [is that] in a district this large there are pockets of teachers doing phenomenal things with technology, but there are few schools doing good things schoolwide, because we don't put an emphasis on administrative training and what a school looks like when technology is fully integrated. So an administrator can point to a great teacher example, but without training they don't know what it takes to create that great environment....*
>
> *We've had four principals participate in [Intel Teach to the Future]. [Involving administrators] was really pooh-poohed by Intel, but once the principals took it and saw how standards-based and curriculum-driven it was, they went to their teachers and told the staff how valuable [the training] was.*

The presence or absence of administrative support significantly affected teachers' abilities to pursue technology integration. Administrators are the ones who allocate financial and institutional resources to support teachers' efforts, and are the ones in charge of creating and enforcing the policies that influence what teachers can and must do in their classrooms. In our case studies we found two principal ways in which school administrations demonstrated their commitment to technology integration – by budgeting for resources and for technical support staff.

The difference between a supportive administration and an indifferent one was highlighted in one case study district that gave schools the option to designate a teacher within the school as full-time technical support staff. The option came at the price of larger class sizes: because the tech-support position would be counted as a full-time teacher, participating schools would have to distribute that teacher's allotment of pupils among the remaining teaching staff. We studied two schools in this district, "HiTech JHS," where the principal decided to have a full-time technical support person, and "SmallClass JHS," where the principal did not.

Administrative support for technology integration, and for Intel Teach to the Future, was strong at HiTech. Though the district offered no incentives for teachers to participate in the Intel Teach to the Future training, HiTech's principal found money in her budget to buy each Intel participant a discounted computer. She told us, "We brought in a full-time technology support person — at the expense of our FTE load — because we felt that was more important than having him in the classroom."

Choosing to designate a full-time tech-support staffer enabled HiTech to initiate practices that required teachers to use technology. "We've just done things here that have required people to get up to speed," the principal continued. "For example, the other schools do attendance on paper. We started right away with attendance on computer. Most of our communication now is via email. I rarely write a memo that has a hard copy."

The school plans to require all social studies teachers to implement at least one technology project a year to ensure that all students experience technology as a part of the core curriculum. The principal has allotted time during staff meetings for teacher in-services on administrative software. The tech-support teacher – a Master Teacher who trained many of the teachers on his campus — also consults with teachers attempting technology integration on a lesson-by-lesson basis. "A teacher will come in and say 'I'm doing a lesson on China and I want my kids to do a PowerPoint,' and we'll walk them through that and maybe do it with them the first period they do it. Then they can take over from there."

Given the supportive and collegial environment this administrator has created at the school, it is not surprising that HiTech's teachers chose to donate their computers to the common lab, and opted to give up their teachers lounge so it could be used as a computer lab.

"SmallClass JHS" chose not to have a full-time technical support person, much to the chagrin of the school's technology coordinator, who now teaches computer classes most of the day while also maintaining the network and all of the instructional and administrative computers and providing instructional technology support for teachers in the school. Access to technology resources is limited. "Supposedly the lab is available for teachers who want to take classes in there," said one teacher. "But [the technology coordinator's] prep time is on a different schedule from teachers' block schedules, so they don't match up."

SmallClass teachers who participated in the Intel training did not receive computers. According to the technology coordinator, the school administration made no effort to pursue the discount, or any other large-scale purchase of hardware for Intel teachers.

One striking manifestation of the different administrative attitudes toward technology in these two schools was the hardware on each principal's desk. While interviewing the technology coordinator at SmallClass JHS, we noticed she was installing software on three brand new computers—the only new computers purchased by the school that year. These, she told us, were destined for the principal's office. The principal in HiTech, on the other hand, made sure that the newest computers went to teachers and the computer lab.

Theme III. Impact beyond the School

District Technology Leaders

The districts that we visited had varying levels of commitment to educational technology, but even those that had dedicated considerable funds for hardware and software still conceived of technology as an issue of infrastructure rather than instruction. A school technology coordinator attested that her "district has a tech plan but it's just for purchasing and equipment. The district runs the infrastructure side but nothing from the classroom out." This attitude toward technology influenced districts' approaches to professional development as well. The available training primarily addressed basic technology skills rather than the incorporation of skills into existing curricula and the addressing of standards. "Before Intel," said one teacher, "the technology professional development in the district consisted of short afternoon or weekend courses at the technology center in the district, which teachers had to pay for.... These were just a few hours long and would focus on an application."

As more and more school district leaders participate in Intel Teach to the Future, and as more and more trained teachers move into leadership positions, they will increasingly be able to bring their experience and knowledge to bear on district educational technology policies. Master Teachers who have taken on leadership roles within their schools have also become advocates for teachers at the district level. In one case study district, Master Teachers played a significant role in district hardware allocation so that computers were distributed to those teachers who the Master Teachers thought were most likely to use them. "[Another Master Teacher] and I worked really hard to convince the district that they're going to be spending money on technology anyway, so why not take that money and put the computers in front of the people who are trained to use them," said one of the Master Teachers. These same Master Teachers volunteered to sit on a committee that develop the district technology plan and helped write a staff development piece addressing the teachers' different levels of technical knowledge. "[The Master Teachers are] part of a voluntary group of tech coordinators in the district," said a teacher in one of the case study schools. "This year they created a tech plan for the district that focuses on professional development rather than purchasing." These particular Master Teachers were in technology leadership roles before their participation in Intel, but Intel Teach to the Future became a model of how to address professional development that they could draw on for district technology planning.

Survey data suggest that focusing professional development on curriculum integration rather than skills would be perceived positively by teachers, who often felt existing district offerings were less useful than the Intel Teach to the Future training. Nearly all survey respondents (95%) felt that the Intel Teach to the Future training was "very useful" or "quite useful," a higher rating than respondents gave for every other kind of technology professional development in which they had participated, including in-service workshops, conferences, informal tutoring, university/college courses, and online courses. One teacher explained that her district offers "little individual things, not on the level of Intel — doing a complete lesson plan. Nothing else was offered like that to my knowledge." A Master Teacher at one of the case study schools compared her district training experience with the Intel Teach to the Future training: "I did realize that the way our district has always offered trainings is wrong, and that we need to offer trainings that have a beginning and an end and a purpose. In the past I taught just a program to 10 to 15 teachers but we didn't train with a reason or a purpose, and I get to do that in the Intel class.... Teachers come up with a unit. They have a focus. It's not just pretend. Teaching programs in isolation is not effective. It would be neat to be able to have the control to do that in our whole district.... We need to develop this kind of curriculum and implement it district-wide."

Relevant and ongoing professional development experiences increase teachers' use of technology in the classroom, and the Intel Teach to the Future model is a starting point from which districts can begin to think about and provide more comprehensive professional development experiences for teachers. While not all districts are flexible enough to implement immediate change, some districts we visited were already responding to this shift in demand for technology-related professional development experiences that are appropriate and applicable to teacher instruction. Focusing on integration rather than basic skills, districts have started to think about what different types of professional development they can provide to better accommodate where teachers are in their abilities to successfully incorporate technology. For example, in response to the Intel Teach to the Future training, one district revised a summer institute it runs to provide technical training for teachers. In the past, the summer institute entailed learning discrete technology skills and software applications. However, the district staff member in charge of designing the institute reported, "This year it's, 'Come and let's see where you are in your curriculum and in your standards-based use of technology, and let's see how we can help you use the appropriate technology to help you move forward. I'm sure the Intel program was not the sole reason, but it really heightened our awareness and showed us that the emphasis needs to be on the curriculum, not just on the technology."

Experience with Intel Teach to the Future has also led to rethinking lines of communication and an increased focus on linking technology integration to state and local standards. A district administrator commented,"[My department] recently switched from reporting to the technology department to reporting to the instructional department. And that makes a difference in terms of how well the curriculum emphasizes integration and not just knowing how to use the software. It also has given us the ability to jump on that standards bandwagon in a focused effort — as opposed to just offering software classes."

As more teachers in the district have gone through the Intel training, there has been a push for similar professional development options. Teachers who have participated in Intel Teach to the Future are now no longer satisfied with inadequate professional development options previously offered by their districts. One district administrator noted, "[The district] had some classes that were more skill classes in MS Word and PowerPoint. They were eliminated. [Teachers] have said, 'I've taken Intel. What can you offer now for credit?'" Teachers are also now better able to assess their needs for subsequent training. In our case studies some teachers expressed a desire for follow-up training in additional, appropriate software programs, such as Excel.

Obstacles

As we discussed in our Year One Report, certain obstacles on the district level prevent the Intel Teach to the Future program from being fully realized and having a lasting effect on the way technology professional development is addressed. Many of these challenges are technical: for example, some districts use filtering software that hinders effective use of the Internet; districts may not support the latest software programs associated with the training; and some districts' overall technical support is inadequate.

District use of filtering software can sometime be overly restrictive and thus discourages teachers from using the Internet as a resource when designing and implementing lessons. Some district filtering software prevents students from looking up relevant information on the Internet for assignments. Contacting and working with the district around this issue is time-consuming and cumbersome. One Master Teacher explained, "We have filters and web access is hard; all access to religion is denied. [Things like chat rooms, religious websites, and games are all inaccessible.] You're supposed to talk with [the district] and tell them you need access [for a blocked website] but it's not worth it to go through all the steps."

Teachers also noted their frustration when software programs obtained through the training are incompatible with the technical resources available in their schools and districts. "Every year that Intel is with us they put out the new Encarta and that has been a struggle," said one Master Teacher. "The software people have to change the image for each new version. We don't have the manpower to upgrade the labs." A district administrator added, "A new issue is the Office XP. The next Intel teaching modules insist that we use XP, but [the district] won't support that." Many districts lack the technical capacity to run the latest versions of software. Individual teachers have no control over what software can be installed in computer labs. In some districts, particularly the larger ones, they have no control even over what can be installed on their classroom computers. This means that teachers end up being trained on software they cannot use with their students.

Another district obstacle is a lack of technology support. Some districts do not provide adequate technical support personnel in schools, and do not service hardware received through the Intel Teach the Future program. One administrator complained, "We have a chronic frustration with [district] technology support people" when the teachers are faced with technical difficulties. A Master Teacher stated that she has not been able to use the laptop she received through Intel for over a year because neither Intel nor her district support staff will take responsibility for fixing it.

A supportive environment is essential if teachers are going to adopt new ideas and approaches to incorporating technology. Districts that are not flexible with technology planning cannot be responsive to the needs and requests of schools and educators. There is evidence that, at the very least, districts are becoming more aware of different ways to develop technology plans and provide appropriate supports for teachers. Although some districts are not at the stage of implementing different approaches, they are becoming more aware of the need for everyone involved to be in agreement about the importance of supporting schools with appropriate technologies. One district administrator commented, "The problem is, administrators have been the last to come on board in the district... In the district it's hurt us that our administration is not tech savvy. Slowly that's changing. Training for administrators is becoming more popular. If administrators are in the know they help to support the teachers."

DISCUSSION

In this second year of evaluation of Intel Teach to the Future, both survey and case study data continue to show that teachers who have participated as either Master Teachers or Participant Teachers are consistently positive about their experience. Ninety-six percent of survey respondents believed that the ideas and skills they learned from the Intel Teach to the Future training would “probably” or “definitely” help them successfully integrate technology into their students’ activities, and 88% of survey respondents felt “moderately” or “very well” prepared to integrated technology into their curriculum after completing their training.

The study also shows that teachers are applying what they learned from Intel Teach to the Future:

- Nearly 80% of survey respondents had implemented some or all of the unit plan they developed.
- In many cases teachers are beginning to experiment with a broader range of software applications. For instance, 50% of survey respondents tried using PowerPoint for the first time with their students after their training.
- Teachers are also beginning to experiment with, or expand their use of, pedagogical strategies consistent with those supported in the Intel Teach to the Future curriculum. Forty-six percent of respondents report that their students are doing independent research more frequently in their classrooms since their training, and 36% are more frequently having students pursue multiple, simultaneous activities in the classroom.

Bringing a Strong Curriculum to a Broad Audience

Intel Teach to the Future took on a challenge few other organizations have tackled—creating an adequate infrastructure to deliver and support a high-quality professional development opportunity to a large but focused population of teachers. This challenge was well matched to Intel’s corporate strengths, and throughout the life of the program, Intel Teach to the Future has built upon Intel’s expertise and experience and successfully met its targets for number of teachers trained.

The centerpiece of this program, however, is a curriculum that teachers are learning from and that is influencing their practice. The most important reason that Intel Teach to the Future consistently receives such positive feedback from teachers is the quality of the curriculum it delivers and the opportunities that curriculum provides for a skilled Master Teacher to speak to the immediate concerns, interests, and priorities of his or her colleagues. This curriculum places the teacher and her own curriculum at the center of the training experience. It has emphasized, in a flexible and non-dogmatic way, student-centered, question-driven teaching and learning. It has also encouraged teachers to learn technical skills only in the context of some larger teaching-related task. These qualities of the curriculum, and the quality of the Senior and Master Teachers leading the trainings, are responsible for the impact of this program on individual teachers.

In turn, the scale of Intel Teach to the Future has made it possible for participating districts to achieve a "critical mass" of similarly trained, technology-using teachers who are able to work in concert to advocate for better resources and professional development in their schools and districts. The five schools represented in this year's case studies, selected because of their optimal conditions for positive program impact, had reached a state of critical mass in which a large number of teachers in the school have participated in the training and a Master Teacher was included in the staff.

We hypothesize that the construct "critical mass" is not solely a function of the number or percentage of trained teachers in a school. For example, a school can have many trained teachers, but with no administrative support their impact on the school culture can be limited. Likewise, a few trained teachers who assume leadership roles can have a significant influence on a school environment.

We have developed a set of indicators of "critical mass" at the school level:

- Increasing teacher demand for previously underused technology resources
- Teachers and administrators describing technology integration as a common, shared practice
- Administrators requiring teachers to use a computer to complete administrative tasks (e.g., attendance, grading, internal communication)
- Technology training as a regular part of staff development
- Technology plans focused on instruction rather than infrastructure.

Making a Difference in the Long Run: Sustainability and Institutionalization

Critical mass is an important stage in a process of institutionalizing the practices and perspectives emphasized by Intel Teach to the Future. In order to have a lasting impact on the quality of technology-rich teaching and learning, these practices and perspectives need to become part of the fabric of the classroom, the school, and the district. This report has described some of the ways that this is happening in some of the districts that have participated in this program.

In the first phase of this research, we examined teachers' responses to the training, gathered initial evidence of how and whether teachers were bringing what they learned back to their classrooms, and identified factors that influenced how the program was implemented in a range of contexts. This year, we looked in depth at the impact of Intel Teach to the Future on schools and districts that were well positioned to take advantage of the program. In the coming year we will further explore critical mass within participating school districts by using a critical mass index, based on the indicators listed above, to study systematically a larger range of schools with varying degrees of participation in Intel Teach to the Future. We will examine the relationship between these indicators and the number and percentage of trained teachers in the school, whether or not there is a Master Teacher in the school, and the positions (e.g., subject area specialist, technology coordinator, computer teacher, teacher-leader) of the trained teachers in the school. In this way we hope not only to build a more solid theory about the relationship between program scale and school-level impact, but also to provide Intel with information about the best way to leverage its existing cadre of trained educators in future educational efforts.

This evaluation suggests that trained teachers are integrating technology into familiar teaching practices and in many cases are experimenting with new teaching practices. These teachers are exploring pedagogical techniques encouraged in the Intel Teach to the Future curriculum, such as the use of rubrics, group work and student research, and are struggling with questions about what it means to design, implement and evaluate technology-rich lessons. This is an important stage in the developmental path from traditional low-tech pedagogy to pedagogy that capitalizes on the potential of technology to enhance teacher practice and student learning.

However, teachers' transition through successive stages of technological and pedagogical transformation is not guaranteed simply because they have reached this point or even through continued use of technology. This evaluation does not suggest that technology use in and of itself is driving change in teacher practices – rather, it suggests that teachers are responding to both the technology-related and pedagogy-related messages of this curriculum. By employing a curriculum that focuses on the needs of teachers, enables teachers to participate meaningfully in the training, and provides them with a product they can readily implement in their classrooms, Intel Teach to the Future helps to ensure that the knowledge teachers gain in the training is transferred to the classroom. In order for teachers to make a sustained investment in both classroom technology integration and inquiry- or project-based learning, they will need continued support, increased technical resources, and further professional development.

CONCLUSIONS AND RECOMMENDATIONS

In addition to demonstrating whether and how Intel Teach to the Future achieved its programmatic goals, this evaluation provides further validation of other research on key qualities of successful professional development programs. Elements such as the train-the-trainer dissemination strategy, the structuring of the curriculum around the construction of a "make-and-take" unit plan, and the intertwining of technical and pedagogical issues all played central roles in creating the impact on teachers, schools and school districts described in this report.

This evaluation also raises some further questions to be addressed in future research, particularly about the process of building capacity in individual schools and about the supports necessary to ensure that teachers continue to enhance their use of technology with their students. This research will be of interest not only to the Intel Teach to the Future community, but to educational researchers and program developers seeking to understand how scalability, quality and local relevance can be balanced in large-scale school improvement initiatives.

In addition to being an important case for further research, Intel Teach to the Future is also an invaluable testbed for future investments in growing the technological preparedness of K-12 teachers in the U.S. To date, 60,000 teachers across the country have been exposed to, and have adopted to varying degrees, a coherent, relevant set of ideas and practices about using technology with students in pedagogically sound ways. However, even this large group represents only about 2% of the current U.S. teaching population, and even the most skilled teachers within this pool have much more that they would like to learn in order to enhance their teaching. Therefore, we offer three recommendations that reflect our sense of the enormous opportunity represented by this group of teachers and their positive response to Intel Teach to the Future.

- *Leverage this population of teachers in future efforts to expand the program and disseminate relevant information and resources.* This population of teachers has a higher-than-average level of knowledge about technology integration; a shared language for describing how technology can best be used with students; and a familiarity with Intel as a provider of training and resources that are worth paying attention to. This makes them an invaluable resource for both the dissemination of new resources, ideas, and opportunities that Intel might offer, and for continuing to grow a cohort of educational technology leaders who work across grade levels, content areas, and types of schools.

- *Create future offerings that build on teachers' developing expertise with educational applications of technology*. Teachers invested in integrating technology into their teaching go through an incremental process of experimentation, revision, and mastery, moving through several distinct stages of understanding of how best to make use of technology in their teaching. Intel should make explicit connections between future offerings for teachers and the various issues regarding pedagogy, classroom management, and capacity building that are likely to arise among teachers who participated in Intel Teach to the Future. Doing this will maximize the likelihood that teachers will continue to maintain a relationship with and interest in Intel's Innovation in

Education programs, and that they will be able to draw on these resources (whether further training, curriculum resources, or other programs) in ways that will have a real impact on their teaching.

- *Give teachers assessment frameworks specifically designed to evaluate students' technology work.* Assessment is an essential component of any educational initiative for two reasons: it provides an accountability mechanism for stakeholders and it helps to shape instruction. For years inappropriate forms of assessment have been employed to measure the impact of technology integration on student learning. The result has been a lack of understanding about technology's unique educational affordances. By providing teachers with an assessment framework that assigns value to the skills and knowledge associated with effective technology use as well as more traditional skills and knowledge, educators will not only be better equipped to demonstrate what students are learning, but they will also have a tool that can guide instruction toward desirable technology integration practices.

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APPENDIX A

Descriptions of Case Study Schools and Districts

Large City, School 1

This school is located in a large city in the southwest that has a population of over 700,000 people. The district is made up of 74 elementary schools, 20 middle schools, and 11 high schools that accommodate over 61,000 students. The middle school is an extension of a pre-K-5 program in the building, which has an open enrollment policy so that students come from all over the district. Some students come to the school specifically for their special education program for children with deafness or hearing impairments. There are 306 pre-K-8 students in the school of which 30% have a physical or learning disability. Under half of the student population receives free or reduced price lunch (43%) and average spending per pupil is $6,450 compared to $5,502 district-wide. The school has an ethnically diverse student population; 50% white, 36 % Hispanic, 8% African-American, 4% Native American, and 3% Asian.

With a significant percentage of students with deafness and hearing impairments, the school's academic program is designed to support those students, who attend all of their classes with hearing students. All middle school students study American Sign Language (ASL) as their Foreign Language requirement. The school offers bilingual programs in ASL so that deaf and hard-of-hearing kids are fully immersed. Classes in the school are multi-grade. In the middle school, 6th-8th graders are in the same classes. In addition, there are 3 self-contained, multi-grade classes for 25 autistic students (K-8). There are 20 classroom teachers and 6 resources teachers who have an average of 12 years of teaching experience. Teachers team-teach so that the student/teacher ratio is 14:1 and average class size is 26.

Students in the 8th grade take state tests in Math, Reading, and Writing. In 2001, student scores on standardized tests were higher than state averages. Twenty-four percent of 8th graders met or exceeded standards in Math compared to 18% statewide. In addition, 65% met or exceeded standards in Reading compared to 56% statewide and 76% met or exceeded standards in Writing compared to 42% in the state.

Parents are very involved in and informed about the school. There is a site council, made up of parents and teachers, which meets on a monthly basis to address school issues, and district policy. In addition to fundraising and event planning, parents volunteer in classrooms, the school office, community garden, and library.

There are 63 computers in the school that have an average age of 2 years. The district provides a workstation computer for each teacher, which the site council decided to put in computer labs. Forty-five PCs and 18 Macs are distributed throughout the school's computer lab, mini-lab, media center, and classrooms. All computers are networked and have Internet access.

There are no technology professional development requirements in the district and all technology services and materials are available to teachers for a fee. Services include technology workshops, a 2-week Summer Institute for technology training, and site support. Professional development provided by the school addresses administrative needs such as Internet training, collecting student data from the district Web site, and using self-assessment software. There is one lab technician (30-hour/wk) in the school, and the district tech support comes once a week. The school also has one Master Teacher who is an informal tech support. Nearly all teachers in the school have gone through the Intel Teach to the Future training (90%, n=18).

Large City, School 2

This middle school is located in a large city in the southwest. There are over 61,000 students in the district where there are 72 elementary schools, 20 middle schools, 11 high schools, and 18 alternative programs. Of the 660 students in the school, a majority is white (69%), 18% is Hispanic, 8% is African American, and there are smaller percentages of Asian (4%) and Native American (1%) students. For the most part, students are from a middle class background; 28% of students receive free or reduced price lunch compared to 58% in the district. Spending per pupil at the school is $4500.

There are 27 teachers in the school that have an average of 10 years of teaching experience. With a student/teacher ratio of 32:1, average class size is 32. In addition to major subjects, a computer skills class is offered to 6th-8th graders and a technology foundations class will be offered starting next year. This year the school implemented a series of programmatic reforms including the addition of 2 classes (Folklorico/Spanish and Service Learning), an in-house suspension program, and tutoring services offered before school. Fifteen percent of the student body has physical or learning disabilities and special education programs are designed to address the specific needs of these students.

Compared to other schools in the state, this middle school performs from slightly below average to slightly above average on standardized tests. Students take tests in Math, Reading, and Writing in the 8th grade. In 2001, 14% of 8th graders met or exceeded state standards in Math compared to 18% in the state. Sixty-three percent met or exceeded standards in Reading compared to 56% in the state.

Parents have the option of joining the Parent Teacher Student Organization (PTSO), which is a shared decision-making body made up of teaches, administrators, parents and students. The school also supports a School Community Partnership Council (SCPC).

There are 190 computers in the school, with 105 PCs and 85 Macs (70 SE, LC, I, II, III; 15 power Macs). Two years ago the district had schools switch from Macs to PCs so the PCs in tend to be newer (average age of 2) than the Macs (average age of 6). The school has one computer lab with 35 PCs. Six PCs are in the school library and 64 PCs are distributed as stand alones in classrooms. There are 32 Macs in a classroom lab that is used by students in the Gifted and Talented Education (GATE) program. The remaining 38 Macs are distributed throughout classrooms as stand alones.

Not all computers are networked but there are network drops throughout the school. All computers in the computer lab are networked and connected to the Internet, while the classroom lab has 6 (out of 35) computers that are networked. The remaining networked computers are in 23 classrooms with one computer located in each, and 5 classrooms with more than one network drop in each.

Technology-related professional development is not required of teachers by the district and all trainings and services offered by the district are provided for a fee. The district offers a basic tech skills class and a 2-week Summer Institute for technology training, while the school provides small tech trainings and in-services for teachers. There is one on-site network technician and 2 teachers that provide tech support for the school, who are consulted to make school tech-related decisions. With a Master Teacher in the school, a majority of the staff has gone through the Intel Teach to the Future training.

Small City, School 1

This middle school is located in a mid-size city in the Northwest. With over 35,000 students, it is the 2nd largest district in the state and supports a total of 59 schools: 43 elementary schools, 10 middle schools, and 6 high schools. The middle school draws its 1,009 students from 4 large and one small elementary school. Over half of the student body is white (67%), 20% is Hispanic, and there are smaller percentages of Black (3%), Asian/Pacific (3%) and Indian/Alaskan students (2%). About half of the students at the school (52%) receive free or reduced price lunch compared to 35% district-wide. The school spends $3,535 per pupil compared to $5,365 in the district.

There are 50 FTE teachers in the school that have an average of 13 years of experience. The student/teacher ratio is 29:1 and average class size is about 28. Required courses cover the major disciplines such as Math, Literature/Reading, Science, and Social Studies. Sixth graders have the option of taking a Music or Drama elective, while 7th and 8th graders have the additional options of Art, Foreign Language and Computer/ Technology classes. Sixteen-percent of students have a physical or learning disability.

Students take state tests in the 8th grade in Math, Reading and Literature, Science, and Writing. There is also a state speaking proficiency. Overall school performance on standardized tests is similar to other schools in the district, and lower than state averages. In 2001, 59% of 8th graders met or exceeded standards on the Reading and Literature test compared to 58% in the district and 62% in the state. On the state Math test, 51% of students scored higher than the district (48%) but lower than the state (57%).

To promote parent involvement, the district runs a Community Involvement Advisory Committee, and parent and citizen committees. The school has a Parent Involvement Council and Site Council lead by teachers, administrators, and parents.

There are 282 computers in the school: 174 PCs, and 108 Macs. The district is moving towards having all computers be PCs so the Macs tend to be older with an average age of 6 years, while the

PCs are newer and have an average age of 2.5 years (excluding donated PCs). After converting a staff dining area into a computer lab, the school now supports 3 labs that have a total of 85 computers. There are 119 computers distributed throughout 28 classroom mini labs and 54 computers are reserved as "teacher stations" in each classroom. An additional 16 computers are used for administrative purposes in the school office, and 8 computers are used as servers for the network. All computers are networked and have Internet connectivity.

Although recently hired teachers at the school are better trained in the use of technology, short technology classes are offered after school for those who are interested. The school also dedicates time during staff meetings on a monthly basis to hold technology trainings and the district provides small trainings for a fee at the district technology Training Center. Since the position of tech coordinator is voluntary in the district, the school decided to bring in a full-time School Technology Coordinator (STC) at the expense of their FTE teacher load. The STC, who is a Master Teacher, provides all tech support, related staff development, and web site development for the school. Nearly all teachers (about 35-40/70-80%) in the school have gone through the Intel Teach to the Future training.

Small City, School 2

This middle school is located in a mid-size city in the Northwest. The 3rd largest city in the state, the school district serves a community of about 200,000 people. It is the 2nd largest district in the state and has 43 elementary schools, 10 middle schools and 6 high schools that accommodate over 35,000 students. A majority of the 870 students enrolled at the middle school are white (71%), and Hispanic students represent the largest minority group in the school at 15%. Just under half (46%, n=400) of the student population receives free or reduced price lunch compared to 35% in the district and spending per student is $5,365 district-wide.

There are 54 licensed teachers in the school with an average of 15 years of teaching experience. The school runs on a 7 period schedule that allows for a student/teacher ratio of 29:1. All major subject areas are full-year courses with the exception of Science which is a semester long course for 6th and 7th graders. Although Computer Literacy is not a required class, it is offered as an elective. Twenty-two percent of the student body has physical or learning disabilities and the school has 2 self-contained special education classes.

Students are required to take benchmark tests in the 8th grade to fulfill state standards in Math, Reading and Literature, Science, Speaking, and Writing. Student test scores for the school are usually slightly higher than the district and consistent with statewide scores. In the 2000-01 school year 60% of students met or exceeded standards for Reading and Literature compared to 58% in the district and, 62% in the state. Fifty-five percent of students met or exceeded Math standards, which is the same as the state average and slightly higher than the district (49%). In conjunction with standardized tests, students must also submit student work samples for Math, Science, and Writing, while Speaking is exclusively assessed by student work samples.

Parent involvement is exercised through parent and citizen committees, which serve as a liaison between the school community, the school principal, the school site council, and the Board. There is also a local school Community Involvement Advisory Committee and a school Site Council made up of parents and staff members.

The school maintains over 200 computers that have an average age of 6 years. There are 2 labs that have 30 computers each. One lab is used for the Computer class, the other as a Media Center. In addition, there are 10 classroom mini-labs with 2-6 computers each, and one computer in every classroom for teachers to use at their desks. Most computers are PCs, although MACs are used in a Spanish Language lab. All computers in the schools are networked and have Internet access.

The district has a technology plan that focuses on purchasing and allocating equipment and there are no requirements for technology-related staff development. The district offers small courses for a fee at the district technology Training Center and the school offers mini in-service trainings during staff meetings or after school, which are not well attended. The position of tech coordinator is voluntary and there is one such person in the school who is also a Master Teacher. The tech coordinator in the school is a full-time teacher and is given 90 minutes a day to work on tech problems including computer maintenance, domain administration, web design, and instructional tech support. There are 9 Master Teachers in the district who provide support for each other. An estimated 35 teachers (65%) in the school participated in the Intel Teach to the Future training.

Middle Sized Town

This middle school serves a largely rural, working class population in the South. The district is comprised of 9 elementary schools, one middle school, and one high school and serves 8,019 students. The only middle school in the district, it is the largest in the state with a student body of 1,825. Minorities make up just over half of the student population; 34% African American, 22% Hispanic. The ethnic breakdown of the school shows a larger percentage of African American students than statewide (14%) and a smaller Hispanic population than the state (41%). Fifty-five percent of students receive free or reduced price lunch.

There is a staff of 125 teachers with an average of 14 years of teaching experience. The Student/Teacher ratio is 20:1 and the average class size is 20 students. The school is run on a block schedule; 90-minute classes with Language Arts and Math taught daily while Social Studies and Science are taught on alternating days. This schedule allows for teachers of each grade level and subject area to have common conference periods.

Major subject areas are divided into Advanced/Pre-AP and Regular classes and about 20% of the student population has a physical or learning disability. There is a mandatory Extended Day program designed for students in need of additional preparation for state tests. Overall, the school's performance on Math (95% passing) and Reading (91% passing) tests exceeds that of state levels (90% and 89% respectively). The school is preparing for the implementation of a new state exam that will replace the current exam in the 2002-2003 school year.

As a relatively new school (4 years old), a parent organization was formed in 2001 and has just begun to have an active role in the school. In addition, the district has a Campus Education Improvement Committee that enables teachers, parents, business members and community representatives to come together to review district educational goals and establish procedures to attain them.

The school is equipped with approximately 350 PCs with an average age of 2 years. All computers are connected to a district-wide network and have access to the Internet. The school has 6 computer labs with 22-30 computers in each lab. There are also a dozen computers in the school library and 1-5 computers in classrooms of those teachers who have the skill and desire to use them with their students. Students are required to take a Computer Literacy class in the 6th grade.

The average spending for each student is $3,865 and 1.2% of the school budget is designated for career and technology education. As a part of teacher professional development and the district technology plan, every teacher in the school is expected to complete a series of computer literacy competency modules; word processing, spreadsheets, multimedia, Internet, and database or desktop publishing. About 44% of teachers have gone through the Intel Teach to the Future training for which teachers fulfill 3 of the district's required modules (word processing, internet, and multimedia). There is one Master Teacher in the school (2 in the district) who is a full-time tech support person and who is fully integrated into school planning and development meetings with the principal and faculty members. In addition to the Master Teacher, there is one part-time teacher who also provides tech support in the school. There are 6 technology staff members in the district to help support technology use.

APPENDIX B

Methods

This evaluation is based primarily on three data sources:

- Case studies of five schools in three school districts participating in Intel Teach to the Future;
- Surveys administered to all teachers completing Intel Teach to the Future trainings at the end of their training, which focused on perceptions of and satisfaction with the training;
- A survey conducted in April, 2002, focused on teachers' classroom practice, technology use, and the impact of the training on their professional lives.

Additional data collected through teachers' applications to the program were also used to support our analysis.

Case Studies

Over the 2001-02 school year, EDC/CCT evaluators made three visits a piece to five different middle schools in three school districts. These school districts were located in three separate charter RTAs. All of the selected schools were chosen on the recommendation of the LEA liaison, who was asked to identify middle schools within their district that had a substantial number of trained teachers. During the site visits, EDC/CCT evaluators interviewed Participant Teachers, Master Teachers, school and district administrators and students. We observed classes in which students were using technology, and collected relevant paper and electronic documents, such as student work and teachers lesson plans for review.

End-of-Training Survey

This survey was administered over the World Wide Web via Intel's intranet that supports the Intel Teach to the Future program. Data reported on in this survey were current as of September 2, 2002, and reflect the responses of 39,960 teachers, collected since July, 2000.

This survey collected information about teachers' perceptions of the goals of the course and of the quality of their trainer; how prepared they feel to make use of what they have learned in the classroom and what obstacles they anticipate encountering; and how favorably they viewed the curriculum and the overall training experience. Responses to this survey have been highly positive and highly consistent over the life of the survey, with few significant differences arising among teachers by state, area of specialization, or grade taught.

End-of-Year Survey

This survey was administered over the World Wide Web via Education Development Center's own-website. All teachers who had completed an Intel Teach to the Future training (both Participant and Master teachers) by April 1, 2002 were sent an email inviting them to take the survey. This survey covered the following areas:

- The nature of the classes in which Intel Teach to the Future unit plans are being used (grade, size, discipline, etc.);
- Whether and how teachers are using what they did and learned in their training, including their unit plan;
- How teachers are using technology with their students;
- Teachers' goals for using technology with their students;
- The environment in which teachers are working;

The survey also included several questions about the Intel education website.

A total of 4,580 people responded to the end-of-year survey. Almost all survey respondents teach in public schools. They are evenly distributed across grade levels, and across teaching areas. Approximately 1/3 of respondents teach in elementary (K-6), 1/3 in middle (6-8), and 1/3 in high school (9-12), and 1/3 are generalists, 1/3 teach in core content areas (math, science, language arts and social studies) and 1/3 teach in other areas, including business, computer science, the arts, and special education. Two thirds of respondents are from "charter" RTAs, the first five areas that participated in Intel Teach to the Future: north and south Texas, northern California, Arizona, and Oregon.

Data Analysis

All field notes and interview notes from case studies were coded (using the software Atlas TI) using a coding scheme that built on codes used in analysis of our Year One qualitative data. Coding focused on a variety of sub-themes associated with the three levels of impact (classroom, school and district) and allowed us to test out and refine the main themes that structure this report.

All survey data were analyzed (using the statistical analysis software SPSS) in response to a series of questions derived from several sources, including the Year One evaluation findings, the themes emerging from the case studies, and hypotheses raised in other key pieces of research (Becker, 2001; NCES, 2000).

Case study findings and survey findings were tested and refined in relation to one another, generating the discussion presented in this report.