Intel Teach to the Future:
Lessons learned from the evaluation of a large-scale technology-integration professional development program

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Abstract

This paper draws on findings from an evaluation of Intel Teach to the Future (http://www.intel.com/education), a professional development initiative focused on helping K-12 teachers integrate project-based technology use into their everyday curriculum. The initial U.S. implementation of Intel Teach to the Future was designed to be delivered on a very large scale, reaching over 100,000 teachers in three years. The goal of this paper is to outline some lessons learned from this evaluation about how "scalability," often cited as a desirable quality in effective educational interventions, can both advance and inhibit program impact within the individual school districts that participate in such a program. This paper presents information from two years (2000-2002) of external evaluation of Intel Teach to the Future, conducted by researchers from the Education Development Center's Center for Children and Technology (http://www2.edc.org/cct). This evaluation provided a rare opportunity to closely examine an ambitious, large-scale professional development initiative, and to study a diverse population of teachers and administrators as they experienced and implemented this program.

Introduction

This paper reviews findings from an evaluation 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 requiring participants to create 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.

Theoretical framework

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 as tools in project-based, student-centered 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 student 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 Carrigg, 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; NEGP Monthly, 2000; Wenglinski, 2000). Studies have shown that the most effective forms of professional development (ones that 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 present 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 should 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. As evaluators of this program, we explored the Intel Teach to the Future professional development experience for teachers and the extent of its effectiveness.

The directors of the Intel Teach to the Future program began with two equally weighted sets of goals, one related to the *type* of impact they wished to have, and one related to the *scale* of impact. The first set was: to improve the integration of technology into K-12 classrooms in general, and to improve mathematics and science education in particular. At the same time, program managers set out to cause meaningful impact at the classroom level for teachers across the country teaching in widely varying circumstances. More specifically, the second set of goals was: to train 100,000 teachers (in three years), to target teachers in low-SES schools, and to create "critical masses" of trained teachers within participating schools and districts, on the assumption that if a significant segment of a given teaching population was trained, this cohort of trained teachers would exert a strong influence on the overall school or district approach to technology.

To achieve both the type and scale of impact they desired, program managers created a highly structured implementation model that guided both the content and delivery of local versions of the program. The program infrastructure included a well-designed and extensively piloted curriculum, a train-the-trainer dissemination model (which required each trainer to train 60 teachers over three years), and a highly structured process of delivery and administration, in which tiered networks of regional and local coordinators administered the program in accordance with Intel's guidelines for recruitment of participants, distribution of incentives, and certification of program completion.

To evaluate the program's success in meeting both sets of goals, we paid careful attention to three topics in the first year of the evaluation: teachers' responses to the training; initial evidence of the impact of the program; and the efficacy of the implementation model. The second year of the evaluation has used a combination of surveys and case studies to look more closely at program impact on multiple levels of participating school districts: the classroom, school, and the district. Throughout our evaluation, we have investigated the interdependence of the program's two sets of goals. We have attempted to discern how the push to rapidly expand the program might be inhibiting or facilitating the program's effectiveness in influencing teachers' classroom practices.

In considering the consequences of a centrally controlled approach to implementing a professional development program in diverse geographical and socioeconomic contexts, we had reason to suspect that such an approach would hinder the program's impact. Existing research on technology-related reform efforts has shown that such efforts must be driven by local concerns and responsive to local conditions to be effective (Culp, Hawkins, Honey, 1999; Hawkins, Panush, Spielvogel, 1997). In addition, previous research has shown that for professional development opportunities focused on technology to have a sustained impact on teaching and learning, they need to connect with in-school, peer-driven follow-up and support; adequate technology infrastructure; administrative support at the local and district levels for innovation and experimentation, and further opportunities for more advanced training (Becker and Reil, 2000; Howard, McGee, Schwartz, and Purcell, 2000; McCannon & Crews, 2000; Norton & Gonzales, 1998). Intel Teach to the Future's dependence on a single implementation model, while

necessary to the rapid growth of the program, seemed likely to compromise the program's flexibility in responding to the particular needs of participating districts.

Methods

This evaluation has drawn on a range of methods to investigate both broad response to the program and the local complexities of program implementation and impact in individual districts, schools and classrooms. Methods employed have included the following:

- ***End-of-training surveys:*** conducted with all teachers completing this professional development program, collected information on satisfaction with the training and perceptions of training goals. This survey was completed by 39,960 Master and Participant Teachers.

- ***Impact survey:*** conducted annually with all teachers completing this professional development program. A wide-ranging survey collecting data on topics including teachers' use of technology, their use of the materials they created during their training, their instructional practices, and the collegiality of their workplace. This survey was completed by 4,717 Master and Participant Teachers.

- ***Observations and site visits:*** In the first year of research, we traveled to 11 participating districts, where we attended trainings, observed participating teachers' classrooms, and interviewed district technology coordinators, local program coordinators, trainers, and participants.

- ***Phone interviews:*** We supplemented our site visits by interviewing 24 local program coordinators about Intel Teach to the Future and its role in the larger district approach to technology and professional development.

- ***Case studies:*** In the second year of research, we focused our observations on multiple visits to three participating districts representing a range of geographic and socioeconomic contexts. We conducted classroom observations, interviewed school and district personnel, trainers, participant teachers and students, and examined student work.

Findings

Our findings in the first year of research regarding teachers' responses to the training and initial evidence of the program's impact on their practices were highly positive. Teachers found the training relevant and of high quality, and more than half of them reported making use of the unit plan they had created during their training when they returned to their classrooms. Findings regarding contextual factors shaping these responses were consistent with the research cited above. Key findings from Year One include the following:

- ***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.

Our Year Two research suggests that in some cases the large scale of the program may be indirectly leading to improvements in these facilitating conditions. We found that in many cases, cohorts of trained teachers changed their classrooms, schools and districts, in order to improve their own opportunities to make good use of technology in their classrooms. We found that one of the key qualities of the program that is catalyzing these actions on the part of teachers is the *scale* of implementation within individual school districts. That is, because teachers have developed cohorts of fellow Intel Teach to the Future participants within their schools who share a common current interest and new set of needs, they are making the effort to push for more resources, to take on new responsibilities within their buildings, and to coach and support one another in their classrooms. Further, the size of the cohort of teachers within individual districts who have gone through this training has spurred districts to re-examine and modify their sequence of technology-related professional development offerings, not only adding more advanced courses to their sequences but in some cases reframing trainings to focus on concepts that are now familiar to these cohorts of teachers, such as student-centered use of the technology, assessing technology-rich student work products, and enhancing existing unit plans with student use of presentation tools such as PowerPoint and web page builders.

Teaching Content with Technology

Data from both our survey and case studies reveal that teachers who had gone through the Intel Teach to the Future training 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 developed in 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 developed in the training 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 element 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.

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 (Figures 1 and 2). These responses suggest that many teachers are beginning to make use of more project-oriented teaching strategies than they had previously. 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 1: How frequently teachers use teaching strategies

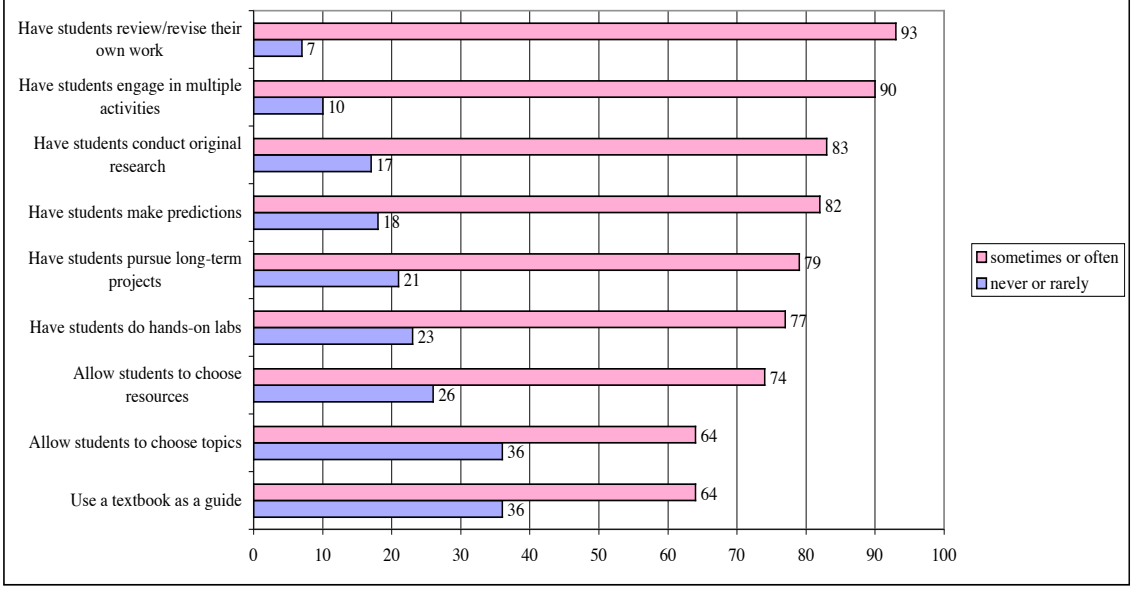
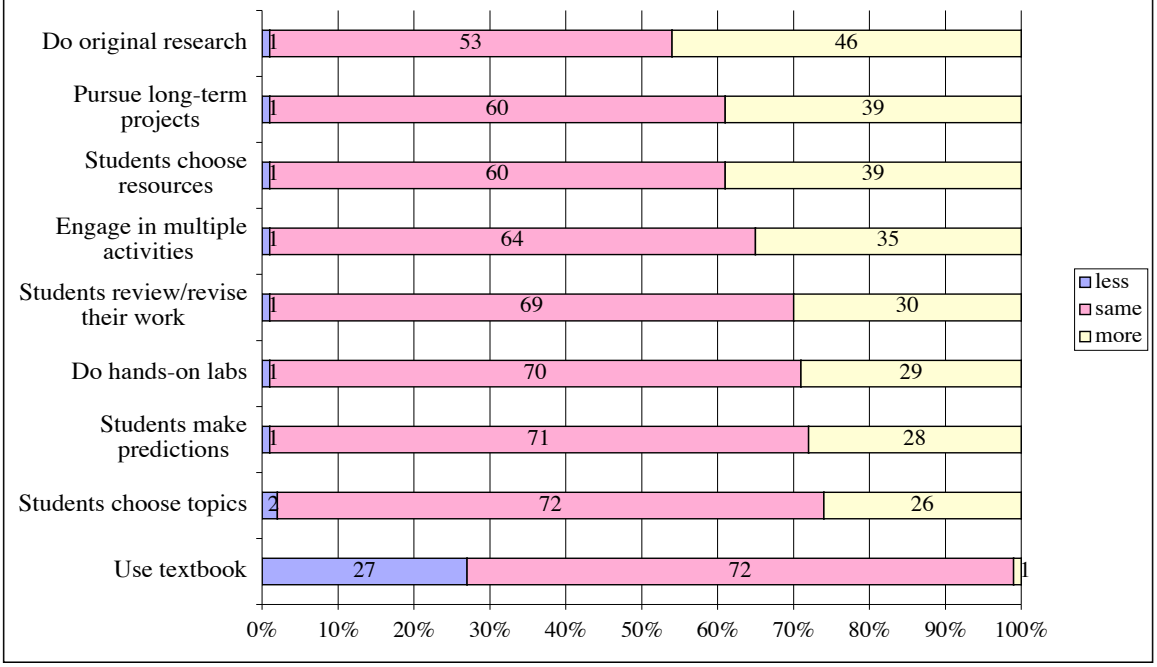


Figure 2: Changes in use of teaching strategies



Critical Mass in Schools

In those schools where a large number of teachers have participated in Intel Teach to the Future, it seems that the relatively sudden increase in teachers interested in integrating technology into their "everyday" practice sparks a change in the culture of the school. First of all, there is 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 encouragement with one another. At the same time, and just as abruptly, there is increased demand on the school's technology resources; all at once, a large bloc of teachers is 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 seem to be affecting their schools. It is important to note that schools with greater numbers of Participant Teachers are more likely to 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.[1]

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 recruit 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. Therefore, 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-school-year survey, Participant Teachers with Master Teachers in their schools rated "lack of instructional support" and "lack of

[1] We were able to match 2,886 end of school 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 (814, 28%).

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 providing 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 is not limited to addressing unit plans created during the Intel Teach to the Future training, but builds upon other lessons in which teachers would like to incorporate technology. An administrator noted that she has 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."

As Master Teachers emerge as technology leaders within their schools, some have also become increasingly involved in school technology decision-making within schools that have the flexibility to modify school 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."

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 school-wide 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."

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 it," said one of the Master Teachers. These same Master Teachers volunteered to sit on a committee that develops the district technology plan and helped write a staff development piece addressing the teachers' different levels of technology 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 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 in your use of technology.' 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.

Conclusion

The Intel Teach to the Future program's emphasis on scale produced a number of predictable difficulties for participating districts. Because they were obligated to train certain quotas of teachers within a short time frame, many districts resorted to recruiting and training teachers who were not in fact prepared for the level of technology integration that the training promotes. In many cases, the pace of training outstripped districts' ability to provide trained teachers with adequate hardware to use what they had learned. Further, many district-level program coordinators became frustrated when the program's centralized implementation model stymied their efforts to adapt Intel Teach to the Future to better suit their district's particular needs.

However, we have also found that in many districts with little preexisting programming aimed at helping teachers integrate technology into their everyday teaching practice, this large, structured intervention had an impact beyond training individual teachers in specific skills. Trained teachers are undergoing new experiences in the classroom, and are finding value in the opportunity to consult and collaborate with other trained teachers having similar experiences. At the same time, cohorts of trained teachers are making new demands on their schools and districts for access to adequate hardware, software, and technical support, and when those demands are not met, teachers are devising creative strategies for leveraging their existing resources, such as making their classroom computers available to their colleagues' students and donating the computers they receive through the program to common labs. Furthermore, as the program matures and there are more teachers at different grade levels within a school who have implemented technology-enhanced lessons, teachers find that students are gaining the experience they need over successive years to make more effective use of technology in new classroom activities. The size and relative uniformity of these teacher cohorts and their perspectives on technology use makes them more effective catalysts for change, and can create the kinds of support networks within schools that teachers often need to support their sustained experimentation with new teaching practices.

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. And it has 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 majority of teachers in the school had 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.

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