

Report of a Laptop Program Pilot

**A Project for
Anytime Anywhere Learning by Microsoft Corporation
Notebooks for Schools by Toshiba America Information Systems**

Submitted by

ROCKMAN *ET AL*
San Francisco, CA

June, 1997

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Acknowledgments

This evaluation would not have been possible without the full cooperation and extensive assistance of the participating administrators, technology coordinators, teachers, parents, and students. We wish to thank them for their patience and cooperation in responding to the large number of questions we posed and their willingness to undertake the use of laptops in the classroom. We also want to thank the Microsoft staff, especially Karen Billings and Tammy Morrison, for their advice and support and to others at Microsoft for asking interesting questions.

We also want to thank some of the ROCKMAN *ET AL* staff and consultants for their efforts to gather and process the data and help create this report. Particular thanks to Sarah Cross, Kevin Campbell, Eileen Dunn, and Heather Hughes.

Laura Walker
Saul Rockman

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Executive Summary

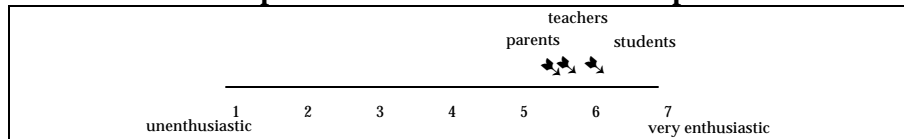
The pilot laptop program, sponsored jointly by Microsoft Corporation and Toshiba America, seeks to facilitate “anytime, anywhere” learning by helping schools acquire laptop computers and Microsoft Office software tools for every student. The pilot year implementation involved 26 sites, including both private schools and public school districts, for a total of 53 elementary, middle, and high schools. Participants ranged from schools with no previous computer experience to some of the most technologically advanced schools in the country.

ROCKMAN *ET AL*, an independent research group, undertook a study to explore the experiences of the schools during the pilot year. Using surveys, interviews, and site visit observations, ROCKMAN *ET AL* sought to document the range of school models for the program, explore the schools’ implementation processes, and investigate any impacts on teaching and learning. More than 400 teachers participated in the evaluation process.

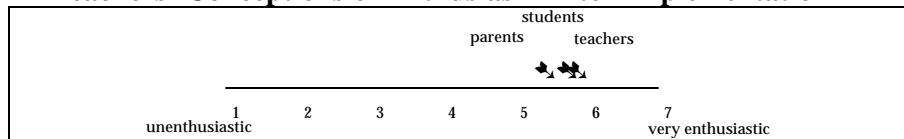
Below is a summary of the findings for the pilot year.

- Enthusiasm for the potential of the program started high and remained high throughout the pilot year, undiminished by the challenges schools faced.

Teachers’ Conceptions of Enthusiasm Before Implementation



Teachers’ Conceptions of Enthusiasm After Implementation



- The ways in which schools implemented the program depended on a variety of factors, including available planning time, financial and technical support resources, and concerns about providing equal access to students. Further, how the computers were perceived and appreciated also depended on several situational factors: the existing level of the school's technology program, the intensity of the implementation, the experience of the teachers, and the size of the classes.
- For some schools, especially many of the private schools, the laptops came on top of extensive computer labs, lots of desktop computers in the classrooms and, often, access to family computers at home. However, for other schools, particularly many of the public schools, the program's greatest impact was not on the nature of computer access, but the fact that they provided any access at all. Administrators said they saw the program as the first real opportunity they'd had to provide wide-scale computer access to their students.

Relationship Between Attributes of Laptops and Characteristics of Schools

Laptop Attribute (in concentrated model)	Impact on Group A Schools*	Impact on Group B Schools**
compact size	allows a 1-to-1 ratio in classrooms with large class size	allows work at desk, rather than work at stations
portability	allows access in each class the students attend	allows more even access from classroom to classroom
portability	enables computer access at home, often for the first time	allows easier (more compatible) access at home
individual ownership or control	changes from little or no access to at-will access	changes from relatively easy access to individual and at-will access

*Group A Schools: schools with very little or relatively small pre-existing technology programs; often class size is large and students do not have family computers at home

**Group B Schools: schools with often well-developed technology programs; often class size is small and students have access to family computers at home

- While all administrators agreed that a full time, one-to-one ratio, 100% inclusion model was their ideal, they cited various constraints which led many to adopt other implementation models. The five models we found are:

- a *concentrated* model, in which all students in a classroom have their own laptop, which they are free to take home;
- a *dispersed* model, in which students with laptops are dispersed throughout a grade or school, so that in any particular class there are both laptop and non-laptop students;
- a *class set* model, in which schools purchase a set of laptops that teachers can then check out as a set for specific time periods;
- a *desktop* model, in which district-purchased laptops are distributed a few to each classroom, with little opportunity to carry them home;
- and a *mixed* model, in which schools or districts combine two of the four approaches either within or between schools.

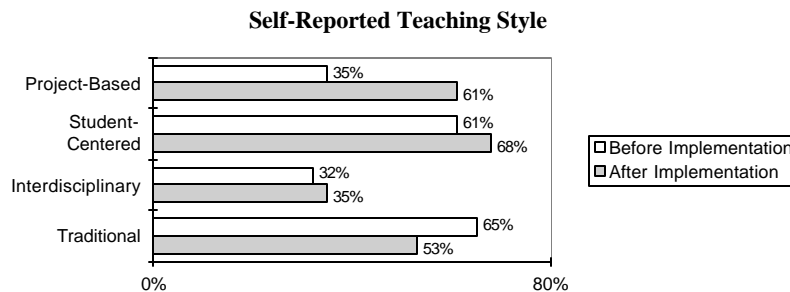
Distribution of Models

- Each of the differing approaches to implementation yielded encouraging outcomes that sustained the program and satisfied the schools. However, models which provided one-to-one and continuous access elicited the most praise and allowed the most time for developing integrated curriculum uses.
- The underlying vision appealed to teachers, administrators and parents in a wide range of school settings and can be sustained in some fashion by each school that chooses to participate. Even the schools that began the project late in the school year saw outcomes that portend or demonstrate positive changes in teachers and students.
- Teachers are using the laptops inside classrooms in many ways, with different benefits for students. These variations are a product of many factors, including the implementation model, the school’s prior technology background, available staff development, varying class sizes, grade levels and subjects, and individual differences in approach to teaching.

Applications of Laptops Reported by Teachers

Uses of Laptops	Reported Percentages
Word processing	74% reports/ 60% note taking
Presentations	58%
Internet	52%
Spreadsheets	33%
Keyboarding	16%
Skill remediation (drill)	12%
Learning software applications	43%
Databases	12%
Electronic portfolios /record keeping	18%
Games	20%
Doing homework	64%
Running models	6%
Other use	20%

- In schools which have had the laptops the longest, classroom applications seem to evolve in stages. First, many teachers and students must learn the very basics of computer and application use, and they often do so in tandem. Second, teachers move on to a stage of experimentation, in which they emphasize computer use, trying a variety of approaches and then gauging the results. Finally, once a range of uses have been explored, teachers tend to focus back again on the curriculum, and employ the laptops as tools when they seem most appropriate.
- Similarly, teachers report that student use evolves over time. Students begin with lots of exploration, and their work tends to have a lot of “bells and whistles”—various font styles in Word, for example, or extensive animation effects in PowerPoint. Later, as they acclimate to the laptops and software, they move towards more “substantive” uses.
- Many of the teachers who must engage classrooms full of laptop owners are still attempting to master the technology and software, yet they can usually relinquish the role of expert to students who have already progressed far beyond teachers’ abilities. The program encourages teacher risk taking.
- Teachers are taking on new roles as learners, often looking to both colleagues and students to assist them, while students are becoming the teachers of their faculty and of their peers. These new roles are a direct consequence of the intensity of the technology changes in the participating schools.
- Teachers can identify ways in which their participation in the program is beginning to modify their teaching styles and approaches to instruction.



- Changes in student attitude, motivation, and behavior are seen within a very short time for those students participating in the program. Teachers identify an array of benefits to student learning strategies and to learning outcomes. Among the benefits widely perceived are increased collaboration, movement towards independent learning, greater enthusiasm for schooling, and more engagement in problem solving.
- Teachers point out ways in which the availability of laptops and software tools can help individualize instruction for students with a range of needs—from special education to advanced students, from satisfying different learning styles to holding the attention of hard to reach students.

- Schools contended with a variety of barriers during the pilot year, including:

- Reliability of hardware given intensive student use;

- Meeting the needs for parent education;

- Providing sufficient training for curriculum integration;

- Working with less than the full, concentrated model;

- Improving students' keyboarding skills;

- Identifying strategies for financing and scaling up the program.

Yet, once the program was underway, problems were quickly forgotten and the potential of the program to improve teaching and learning become the focus of activity.

- The experience of the pilot year participants yields important information for schools and districts wanting to begin a laptop program. Schools planing to initiate or expand the laptop program need to consider:

- Establishing support at the school site and in the community

- Capitalizing on membership in a unique program

- Allowing sufficient time for integrating the new capabilities into the curriculum

- Growing the program in schools with limited technology access and experience

- Setting appropriate priorities for professional development

- Managing the amount of technology and solving technology problems

- Providing a means through which teachers can share successful lessons with others

- Providing sufficient opportunity to experiment with new instructional approaches

- Maintaining support from site and community leaders

- Establishing new and continuing assessment and evaluation strategies.

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Report of a Pilot Year

A Project for Anytime Anywhere Learning by Microsoft Corporation Notebooks for Schools by Toshiba America Information Systems

I. Setting the Context: Project Background

Background Information

LAPTOP PILOT PROGRAM

The laptop pilot program is a collaboration between Microsoft Corporation and Toshiba America Information Systems to demonstrate the educational value of having laptop computers available to every student in a classroom, a grade level, or a school. Toshiba notebook computers loaded with Microsoft Windows 95 and Microsoft Office software give students and teachers access to “real world” business tools and support learning anytime, anywhere. The pilot program, known in its first year as Learning with Laptops, involved both public and private schools in all parts of the United States. Microsoft introduced the concept to schools in the Learning with Laptops Summit in the Spring of 1996 and provided teacher training, consulting, a web site, and other implementation guidance. Toshiba offered a student notebook computer, financing and insurance bundles, and assisted the schools in establishing relationships with Toshiba resellers. This pilot program builds on demonstrations of effective integration of laptops in Australian schools, and has evolved to Anytime Anywhere Learning from Microsoft Corporation and Notebooks for Schools from Toshiba America Information Systems.

ROCKMAN *ET AL*, an independent research organization in San Francisco, CA, was contracted to explore and assess schools’ initial year efforts to implement laptop programs. The goals of this study are to:

- document the acquisition and use of the technology and software,
- assess the expectations and plans for instructional use,

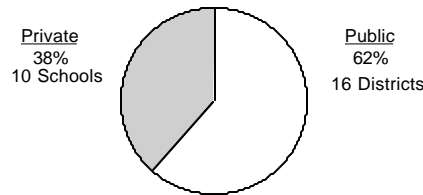
- explore the barriers to and facilitators of the implementation process,
- document the changes in teaching and learning, and
- identify strategies for effective implementation.

PARTICIPATING SITES

Schools

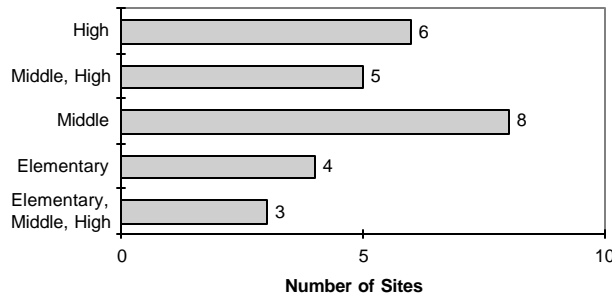
Twenty-nine private schools and public school districts planned to initiate a pilot laptop program in their sites during the 1996-97 school year. However, three of the original group of 29 pilot sites were unable to implement the program during the first year due to various constraints, including financial arrangements, parent concerns about equity, and organizational issues. By the end of the school year, 26 private schools and public school districts participated in the pilot program. Of these 26, 10 were private schools and 16 were public school districts that included 43 different schools, for a total of 53 different laptop pilot school sites.

Figure 1. Public vs. Private Sites



The participating schools spanned a broad range of grades, with middle school grades the most popular group for the program.

Figure 2. Sites by Grade Level



Scope

The number of students involved at each site ranged from 19 students in one school to all 510 students at another. The public school districts involved in the program ranged in size from one-school districts to those which serve over 39,000 students. Eleven of the sixteen public school districts operated the program district-wide, targeting an entire grade (all seventh graders in the district), a school level (all elementary schools), or even all the schools in the district.¹ Five of the sixteen districts targeted just one or two schools, and

¹These eleven who operated district wide include seven very small districts, in which there is only one elementary, middle, and high school in the district (and sometimes only one school for grades K-12).

often just one or two classes, for their pilot year implementation. All together, the pilot school sites represent a very broad range of settings, from rural to urban, affluent to impoverished, and small to large.

Teachers

Almost 400 different “laptop teachers” from 20 sites responded to our questionnaires. Laptop teachers, or teachers whose students possessed or had access to the notebook computers, were experienced: almost one-third (31%) of them had been teaching for more than twenty years. One fifth had been teaching less than five years, and the rest (50%) had been teaching between five and twenty years. While it is a common belief that younger teachers are more likely to engage technology in their classrooms because they may have learned it more recently in their pre-service preparation, the research literature suggests that teachers with seven to fifteen years or more of experience are most likely to learn and apply the new technologies, since they have mastered classroom management issues and can turn to new challenges. The age/experience distribution of the teachers participating in this program is also consistent with what we know about risk-takers in the classroom.

Schedule

The pilot programs were not uniformly implemented; schools around the country started the initiative at different points during the school year, some as early as September 1996 and some as late as April of 1997. Both fall and spring implementation schools are represented in this report. Private schools were more likely to implement the program in the fall, and public schools tended to begin later.

RESEARCH APPROACH AND METHODOLOGY

Research approach

ROCKMAN *ET AL* undertook a study of the initial year’s implementation, looking at the expectations held by teachers and others, documenting the adoption process, and examining changes in teaching and learning in the classroom and outside. This report is based on research conducted from October 1996 through May 1997 and builds on an interim report that focused on early adoption efforts. We used multiple approaches to gathering data to gain greater confidence in the findings. The methodology included surveys, interviews, and site visits, and during the course of our research we obtained information from students, teachers, school and district administrators, and parents.

Methodology

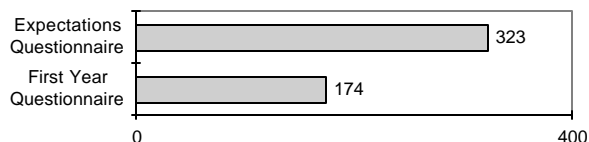
Surveys. We designed two surveys for teachers. The first, called the Teacher Expectations Questionnaire, was administered during the very early stages of implementation at each participating school, and gathered data on teachers’ expectations for the program. Teachers from nineteen schools returned this questionnaire at various points during the year, with a total of 323 teachers completing the survey.

The second survey, called A First Year Questionnaire, was administered in the early spring to those schools who had been implementing the program for at least six months. This

“follow-up” survey reflects teachers’ experiences in the pilot year. Eleven schools returned this survey, with 174 teachers responding. (See appendix for sample distributions.)

Note that those school sites that qualified for the second questionnaire included only the fall implementation schools, a group that contained a disproportionate number of private schools and high schools. Therefore, data gathered from this second round of questionnaires are not representative of all participating laptop schools. Also, note that not all school participants filled out both surveys; some filled out only the first, and some only the second.

Figure 3. Survey Response



Matched pair sample. Finally, of our total pool, 104 teachers filled out both the Expectations Questionnaire and the First Year Questionnaire approximately six months later. Because the responses to these questionnaires came from the same people, we were able to analyze in greater detail changes in these teachers’ perceptions over the six month time period. This “matched pairs” sample allows us more reliable data for examining changes in activities, attitudes, and expectations over the course of the year. Again, this sample of teachers reflects a group that contains a disproportionate number of private and high schools.

Telephone interviews. In addition to brief, fact-finding phone calls to each site, we conducted sixty-three 30-45 minute, in-depth phone interviews with teachers and administrators. These participants were randomly selected, and those who responded came from 19 different sites.²

Most of these interviews were conducted during the early stages of school implementation. Twelve of these interviews were “follow up” interviews with teachers and administrators who had been involved in the program for more than six months.

Site visits. Researchers spent five full days at four different sites, visiting eight schools and speaking with administrators, district personnel, teachers, parents, and students. While on site, we conducted an additional 71 interviews, including both small group and individual student interviews. We also spent approximately seven hours observing classroom uses of the laptops.

Both on the phone and in person, we conducted 134 interviews with various participants, described in greater detail in the table below. (See Appendix for interview forms.)

²Of the seven sites we did not speak with, four had not yet implemented at the time of our final round of interviews.

Table 1. Interviews Conducted

Telephone and Site Visit Interviews	Fall	Spring	Total
Teachers	33	28	61
Administrators	12	14	26
Students	0	34	34
Parents	3	10	13
Total	48	86	134

Approaches to Implementation

A VARIETY OF MODELS

In the initial pilot vision, students in a class, a grade, or a school would each have their own laptop computer loaded with Microsoft Office software, which they would carry with them between home and school and use both independently and when prompted by the teacher. However, many participating sites, especially the public school sites, were unable to implement this *concentrated* program model in their first, pilot year. While all administrators agreed that a full time, one-to-one ratio, 100% inclusion model was their ideal, they cited various constraints which led many to adopt other implementation models. These constraints included:

- building sufficient parent and community support for a wide scale implementation in the limited time between the original Laptop Summit meeting in March, 1996 and the start of the 96-97 school year;
- financing a one-to-one laptop ratio;
- addressing concerns about equity, if laptop students were concentrated only in one class or grade;
- and (for private schools) concerns about requiring laptop purchase with only a short period of notification.

Consequently, many schools undertook other implementation strategies in order to address these constraints. The pilot sites are using four models in addition to a concentrated model; they are described in greater detail in the table below. In brief, the five models are:

- a *concentrated* model, in which all students in a classroom have their own laptop, which they are free to take home;
- a *dispersed* model, in which students with laptops are dispersed throughout a grade or school, so that in any particular class there are both laptop and non-laptop students;
- a *class set* model, in which schools purchase a set of laptops that teachers can then check out as a set for specific time periods;
- a *desktop* model, in which district-purchased laptops are distributed a few to each classroom, with little opportunity to carry them home;

- and a *mixed* model, in which schools or districts combine two of the four approaches either within or between schools.

While all the administrators we spoke with hoped to implement a concentrated model at some point in the future, these alternative models allowed them to begin a laptop program despite constraints. One administrator faced with financial obstacles spoke positively of the class set model:

Class sets were our way of addressing the equity issue.... and it allows the staff members to go ahead and try to do things with everyone in class participating, instead of just those [students] who can afford to buy them.

Table 2. The Five Implementation Models and Defining Characteristics

<p>concentrated model: <i>schools target specific grades and/or classes for laptops</i></p> <ul style="list-style-type: none"> • goal is 1 to 1 ratio • usually students can take home computers; laptops are “theirs” (whether owned, leased, rented, or borrowed)
<p>dispersed model: <i>laptop students are scattered among grades or classes</i></p> <ul style="list-style-type: none"> • not a 1 to 1 ratio • computers are sometimes shared by students, or used by small groups • usually students can take home computers; laptops are “theirs” (whether owned, leased, rented, or borrowed)
<p>class set model: <i>school owns a class set which can be checked out by teachers</i></p> <ul style="list-style-type: none"> • goal is 1 to 1 ratio • usually students cannot take the computers home • set is checked out by teacher and used in class for varying amounts of time
<p>desk top model: <i>laptops are distributed a few to a classroom</i></p> <ul style="list-style-type: none"> • not a 1 to 1 ratio • computers are often shared by students, or used by small groups at a time • usually students cannot take the computers home
<p>mixed models: <i>schools or districts which employ 2 or more of these models</i></p> <ul style="list-style-type: none"> • models may vary: <ul style="list-style-type: none"> – between schools within a district – between classrooms within a school – within classrooms

DISTRIBUTION OF MODELS

Many factors influenced schools’ choice of models. In the pilot year group, the private and public schools approached computer acquisition in different ways.

Private Schools

All ten of the private schools implemented either the concentrated model or the dispersed model. In the concentrated model, students were either required or “strongly encouraged” to own a computer. In the dispersed model, most schools let parents know that within a few years, ownership would be a requirement, and some parents went ahead and

purchased in the first year. All of the private schools also instituted some sort of financial aid for those who qualified.

Public Schools

The sixteen public school districts utilized all five of the implementation models. Schools with a concentrated model simply grouped together all those students who owned, leased, or rented a laptop computer. This also included a few small districts in which district group purchases of the laptops covered an entire class or grade in a school. Dispersed models did not allow laptop ownership to determine class groupings, so laptop students ended up scattered a few per classroom throughout the school or the grade. Schools which purchased class sets sometimes opened access to these sets to the whole school, and sometimes targeted a specific grade within the school, so that laptops were shared only by classrooms in that particular grade level. In schools with a desktop model, concerns about equity led schools to provide equal access to a limited number of computers by placing them in classrooms throughout the school. Finally, several districts experimented with a range of models, and in some cases are now assessing which worked best in their particular schools.

Figure 4. Distribution of Models

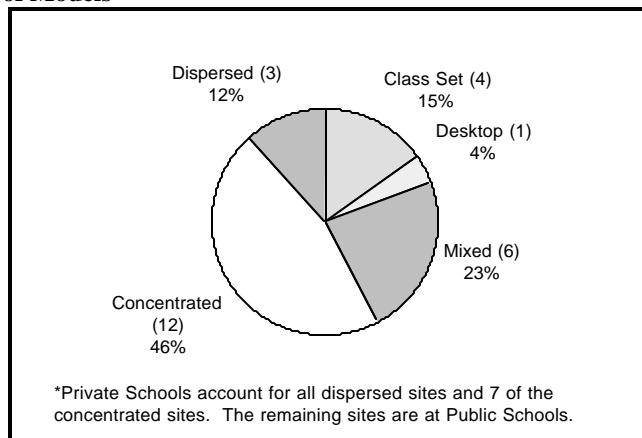


Table 3. Scope of Implementation Across Pilot Sites

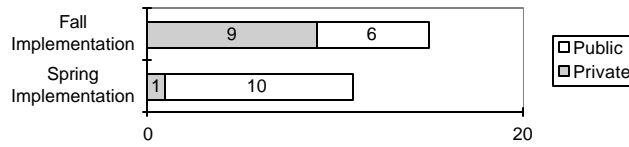
Model	Range
Concentrated	17 to 510 students
Dispersed	60 to 350 students
Class Set	1 to 16 class sets within a district
Desktop	5 to 7 computers per classroom
Mixed	4 of 6 sites include a concentrated group

IMPLEMENTATION SCHEDULE

As noted above, schools implemented the program at various points during an eight month period. In general, private schools were able to implement earlier than public schools. Ninety percent of the participating private schools implemented in the fall of 1996. Implementation schedules for the public schools varied more widely. Of the 19 public

schools participating in the pilot year, 6 started in the fall, 10 began in the spring, and 3 did not start the program at all during the 1996-97 school year.

Figure 5. Implementation Schedules



Schools that began later in the year cited a variety of reasons for their decision:

- planning took longer than expected (addressing concerns of equity, safety, distribution, etc.);
- gaining board approval and building public support took time;
- it took more time than expected to work out leasing and insurance arrangements, as well as legal issues (asking parents to share cost of public education); and
- the computers took longer to order and obtain than schools had hoped.

TEACHER PREPARATION

Teacher professional development is an important element of the laptop program. Each site was provided with a minimum of one day of software applications training and another full day on curriculum integration as part of the pilot program. In addition, the sites designed their own faculty education programs, which were more or less extensive depending on their teachers’ needs and available resources.

For some of the schools that started later, the extra lead time allowed them more opportunities to prepare. In general, teachers in spring implementation schools participated in more initial laptop preparation activities before their first month in the program than their counterparts in the fall implementation schools. Most common initial activities for all 323 teachers were:

- attending a software applications training (84%),
- attending a hardware orientation (72%), and
- developing a curriculum activity using the laptops (59%).

Table 4. Initial Activity Participation: Fall vs. Spring Schools

Initial Activity	fall 96 schools	spr 97 schools	all
Attended an applications training	79%	96%	84%
Attended a hardware orientation	67%	85%	72%
Developed a curriculum activity using the laptop computers	54%	70%	59%
Attended curriculum integration training	45%	69%	52%
Used/implemented a curriculum activity using the laptop computers	51%	55%	52%
Assigned homework requiring the use of the laptop computers	41%	29%	38%

Hosted/attended a Parent Night	18%	67%	33%
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CHALLENGES OF IMPLEMENTATION

Implementing a laptop program can be a huge and complex task, and many of the principals, superintendents, and other district personnel we spoke with described the various barriers they had encountered and the solutions they were finding.

Gaining support

For many schools, especially those beginning large-scale implementations, the laptop project represents a huge investment of time, money, and resources. Many administrators talked about how hard they had worked to gain support from school boards, parents, and the larger community.

Several administrators described their substantial efforts to lobby for board support, because boards were often reluctant to make such a large investment, especially if the program only benefited one grade or one school:

I was out on a limb... people can lose their jobs over something like that.

One superintendent said that his intense effort to get “100% support” from the board was a primary reason for the pilot’s success.

One school had to postpone implementation indefinitely in order to address parents’ concerns: how would the program benefit their child, and how would the computers be distributed? Many schools organized several parent meetings before implementation and presented student demonstrations on the computers afterwards, in order to illustrate the benefits of the laptop program to the parent community.

Several schools also attempted to draw on larger community support, especially as a way to finance the laptops. Some worked with local media to share stories about the impact of the laptops in their classrooms. In one area, community volunteers began a foundation that subsidizes a substantial percentage of parent leasing costs for the machines, and that also arranges computer hotlines and computer clubs for the laptop students.

Financial arrangements

Deciding how to finance the laptops was especially challenging for most sites, and providing for equitable access was a major concern. Private schools had to develop strategies for scholarship students and others who could not afford the initial expense. Public schools also had to address the complex issues which surround asking parents to share the cost of public education.

Most sites used a combination of approaches, including working with local financial institutions to set up small loans for parents, providing leasing or renting options, buying the computers outright (often using state grants), and working with local foundations and

institutions to help finance leases and rentals. Many schools set up sponsor programs in which volunteers could pay part or all of the costs for those who could not afford the fees.

Many of the public school administrators talked about the difficulties inherent in asking parents to pay for a public education tool. One superintendent warned,

The front person [for the program] will catch some heck because parents don't want to pay money for public education.

In another district, the program supervisors felt they had to pursue the legal issues, even though it meant they delayed their implementation for six months:

For us [the challenge was] the financial and legal issues in the state: asking parents to pay for something in public, state education. We went all the way to the attorney general to make sure it was legal, and that delayed our implementation.

Staff development

Most of the schools faced a monumental task with laptop training. In many cases, teachers received their computers only a short time before students did, and in very few places did teachers feel they had adequate preparation time for the pilot year implementation. Many teachers were unfamiliar with computers themselves, and others had no experience with the software. Many teachers felt they also had little time to prepare lesson plans that would incorporate the laptops into the year's curriculum. Because the schools were dealing with a wide range of teacher expertise with technology, they felt they had to move slowly so that teachers could master the basics:

One of the things we did well was going slowly with teacher training. We meet every Wednesday morning... Providing adequate time and preparation before and during has made a difference when little things came up.

One school felt the key to their successful teacher training had been to individualize the training, and to employ their own faculty as peer teachers. All the participating sites felt they needed to build beyond the initial teacher training that the pilot program provided.

Many schools also felt it was important to offer an initial computer orientation to parents; some required that parents attend an orientation session before students were allowed to take the computers home, and a few set up parent computer classes for those interested in learning more for their own benefit. In at least one site, parents requested that the school provide adult computer classes so that they could keep up with their children and take advantage of the laptop they had purchased when their children were not using it.

Safety and care of laptops

On the whole, most teachers and principals felt that computer security and care presented fewer problems than they had expected initially. They attributed this to careful planning. Schools struggled with how to protect the computers against theft: some required students to use locked cases when they were not using the computers, and used security devices to label the individual machines. Many teachers and technology coordinators also spent much time coaching their students on proper care of the computer, whether during use or during transport, and how to guard against theft.

Hardware issues

Sites had to work closely with a reseller or channel partner in order to assure timely delivery and quick repairs of the laptops. Many schools experienced problems either with delayed deliveries, incorrectly-configured laptops, or extensive repairs to individual machines. Those schools who had positive working relationships with their resellers talked about how lucky they felt, and how much they thought that relationship had eased the process of implementation.

Parental concerns

Schools had to gain parents' support for the project, work out acceptable financing plans, allay concerns about safety and theft, and find ways to provide support for computer problems that students might experience at home. The schools' staff often fielded parent questions about computers malfunctioning or breaking. In addition, schools had to plan ways to keep lines of communication open, so they could receive feedback on any problems that might be occurring as they implemented the program.

II. Inside the Classroom: Program's Impact on Teaching and Learning

This report reflects the experiences of schools involved in a pilot program, one that, as outlined above, required a substantial effort to implement and maintain. The participating schools were constrained by various barriers, which led them, in many cases, to begin the program later than expected, to adjust and adapt their implementation models, and to spend many hours trouble-shooting unexpected problems.

Even so, almost all participants felt that the program had already influenced teaching and learning in various ways. This section highlights some of the early indications of impact on teaching and learning, and it draws from the observations and comments of teachers, administrators, parents, and students.

In order to understand these observations, however, it is necessary to portray in more detail the ways in which schools incorporated the laptops. Particularly important are the participants' perceptions of the computers, and the ways computers were used.

Contextual Issues

PERCEPTIONS OF THE LAPTOPS

Part of the original intent of the pilot had to do not with access to computers but with access to portable computers, to laptops. In contrast to computers on student desks, laptops would lend themselves to "anyplace, anywhere" learning, enhancing opportunities for education both within and outside of school.

In reality, the laptops' major impact on a particular school depended to a great extent on several specific attributes of the school itself.

Benefits of the program: laptops vs. desktop computers

For some schools, especially many of the private schools, the laptops came on top of extensive computer labs, lots of desktop computers in the classrooms and, often, access to family computers at home. For these schools and their students, the laptops represented not so much a new computing capability, but easier access, greater mobility, and ease of transition either between school and home or school and dorm. These teachers and students tended to praise the laptop for these characteristics:

- It is portable, moving between school and home and among classrooms, and therefore allows an ease-of-use that desktops did not afford.

- With a one-to-one ratio, all students can be using computers at once if they so choose, without sharing.
- Students spoke of how much easier it is to complete homework assignments when they do not have to worry about transporting work between computers or between platforms at home and at school.
- Students also talked about doing assignments while they waited for rides home, or while their parents ran errands.
- After years of using a school's computer at school, and a family computer at home, students described how much they enjoyed owning their own computer, which they could organize and individualize in any way they chose.

However, for other schools, particularly many of the public schools, the program's greatest impact was not on the nature of computer access, but the fact that they provided any access at all. One administrator stated directly that:

The most important...rationale [for the laptop program] was to catapult our staff in their tech training.

Other administrators said they saw the program as the first real opportunity they'd had to provide wide-scale computer access to their students. And when asked about the impact of the laptop program, teachers and students at these schools tended to cite benefits of computers in general, and especially greater access to these benefits. Teachers praised how polished students' papers were now; students noted how easy it was to edit, to run statistical analyses, to access the Internet. Both teachers and students reported that before the program they had little to no exposure to computers, and this is what they seemed to appreciate the most.

I've always enjoyed using computers whenever possible, but we only had one computer lab, and it was often occupied, so access has been limited. I would take students maybe once a month before [the laptops]. And in relation to rest of school, that was a lot.

– Seventh grade teacher

Last year we had just one computer, and it was never used; now you use computers, and even if you don't have your own, you share. I like that.

– Fifth grade student

However, it would be a mistake to overlook the benefits that this second group of participants associated with their laptop programs as unrelated to laptops themselves. For, even though the participants are citing benefits of generic computer access, they were only able to gain this access because of the laptop program.

First, in many places, as part of the program, computer costs were carried by or shared with families, which allowed the schools' fiscal resources to stretch further than they ever could have otherwise.

Each student should have a computer; and there's no way we can have desktops for them. And parents can't; so the only realistic way to do it is with partnerships with parents.

Second, while some of the private schools have very small class sizes and sufficient space for desktop computers, these public schools often have 30 or more students in a classroom, and lack not only the resources for a computer for every student, but the space to fit 30 desktop computers in a single classroom. So, in schools employing the concentrated model, the laptops themselves allowed for one-to-one access that would not have been possible with desktops.

Finally, teachers stated that many of their students did not have access to computers at home. Since the laptops could be carried back and forth between home and school, their very mobility allowed for the greater computer access that participants praised. Additionally, some administrators saw the program as an opportunity to address inequities they saw in their student population—with the laptop program, all students could have a home computer.

Therefore, even when the program implementation model was the same—e.g., all of the schools using the concentrated model—the impact of the unique aspects of a laptop computer were directly related to various characteristics of the particular school site.

Table 5. Relationship Between Attributes of Laptops and Characteristics of Schools

Laptop Attribute (in concentrated model)	Impact on Group A Schools*	Impact on Group B Schools**
compact size	allows a 1-to-1 ratio in classrooms with large class size	allows work at desk, rather than work at stations
portability	allows access in each class the students attend	allows more even access from classroom to classroom
portability	enables computer access at home, often for the first time	allows easier (more compatible) access at home
individual ownership or control	changes from little or no access to at-will access	changes from relatively easy access to individual and at-will access

*Group A Schools: schools with very little or relatively small pre-existing technology programs; often class size is large and students do not have family computers at home

**Group B Schools: schools with often well-developed technology programs; often class size is small and students have access to family computers at home

The school context—the preexisting technology program, availability of computers at home, class size, etc.—shaped the ways in which the computers were perceived. In turn, these perceptions influenced the initial reasons that schools participated in the program, and the critical aspects of the laptops that they noted as they discuss the program's impact on teaching and learning.

USING THE LAPTOPS

The ways the laptops are used in the classroom also will affect any impact on teaching and learning. As a learning tool, the laptop has been adopted and utilized in a variety of ways across the 53 schools and hundreds of classrooms involved in the pilot project. Each

school named the same goal: that the computers be used to enhance the existing curriculum, rather than being used to teach software applications or computer literacy for its own sake. Beyond that, however, types of use, time on the machine, and scope and depth of projects varied tremendously.

This section outlines some of the differences in laptop use across classrooms and across participating sites. As with any educational project, myriad factors affect how the laptops are incorporated into classroom practice, including schools' technology capabilities, teacher expertise and preparation, and individual teaching methods and styles. The fact that the program includes a variety of approaches, methods, and uses is testimony not only to those individual and school differences, but also to the flexibility of the laptop program in reaching diverse people and settings.

Categories of use

During the initial stages of implementation, teachers expected to use the laptops in several very different ways. From the questionnaires, the most common projected uses were:

- word processing (90%),
- developing presentations (74%), and
- using the Internet (61%).

Six months into the project, however, teachers had scaled back their expectations. When asked how their students actually had used their laptops, while the top three areas remained the same, the percentages of teachers choosing each category decreased:

- (word processing) writing papers/reports (74%)
- (word processing) note taking (60%)
- developing presentations (58%)
- using the Internet (52%).

In fact, in all but one of the categories, teacher expectations of use vs. actual use decreased after teachers had had six months of experience. The only category in which teachers used the computers more than they had expected to was in learning how to use software applications, which went from 35% of respondents to 43%.

This trend seems to reflect a necessary narrowing of ambition and focus as teachers worked together with students to implement the laptop in their classrooms, and to train students about how to use the basic software tools on the computer.

Table 6. Applications of Laptops Reported by Teachers

Use of Laptops	Teachers at Initiation	Teachers after Six Months
Word processing	90%	74% reports/ 60% note taking
Presentations	74%	58%

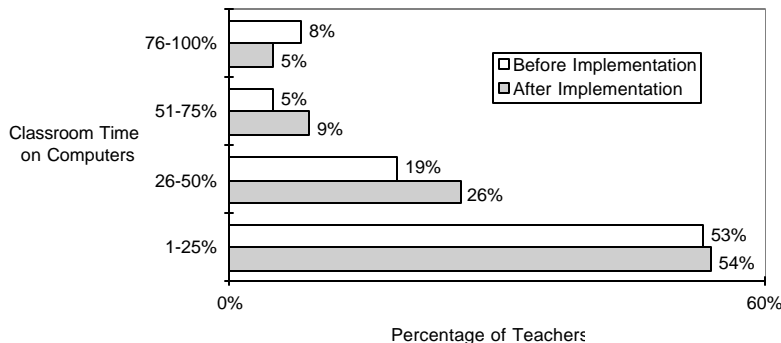
Internet	61%	52%
Spreadsheets	46%	33%
Keyboarding	41%	16%
Skill remediation (drill)	35%	12%
Learning software applications	35%	43%
Databases	29%	12%
Electronic portfolios /record keeping	29%	18%
Games	26%	20%
Doing homework	(new category)	64%
Running models	(new category)	6%
Other use	27%	20%

more than one answer permitted

Extent of Use

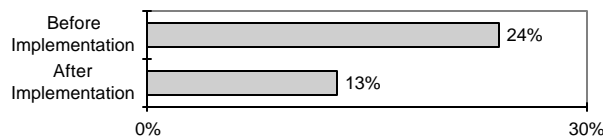
Class time on the laptop. Teachers predicted more accurately the amount of time they would use the computers in class. During the initial stages, approximately half the teachers said that they expected to work on the computers for 1-25% of classroom time each week. Only 14% thought they would use them more than 50% of class time. The group of teachers who responded to our questionnaire after six months again reflected these same patterns of use.

Figure 6. Classtime Laptop Use



Homework with the laptop. Interestingly, teachers ended up having their students use the computers for homework much more often than they had expected. In the initial stages of implementation, 24% of teachers thought they would not use the laptop at all for homework; after six months in the project, only 13% of the teachers stated they never used the laptop for homework.

Figure 7. Percentage of Teachers Not Expecting to Use Laptops for Homework



In our matched pairs sample, a full 40% of the teachers reported that they had assigned homework to be done on the laptop more frequently than they had initially expected to.

Uses vary

That the computers were used in classrooms in a great variety of ways was confirmed by interviews and on-site observations. Teachers adapted the computer and its tools to reflect the goals of their particular curriculum. One language arts teacher described how she used the software:

I found it easy to incorporate into language arts. We've used it for note taking, grammar, sentence composition, outlining; it lends itself very well to language arts.

And a physiology teacher described how he used the laptops:

I can have kids gather and format data, and massage the data itself: I can teach basic statistics real easily now; they can see a basic T test. It's made my job easier. It's nice to do graphs right there with Excel.

However, even teachers teaching the same subject to similar groups of students adapt the laptops in very different ways. For example, one foreign language teacher cataloged her extensive uses:

I use it in many ways. As a simple notebook; and, in Word, with tables for verb conjugations, etc. I also put together a database for French vocabulary into Access. We used Excel to set up a grade sheet so that students can track their own progress. We've used PowerPoint to make presentations to the class and to [another] class. We've also used Word Art to make pictures of vocabulary-- and also to make the word look like what it means: for example, to make the word for fork look like a fork. We've also done some word processing—for example, essays about our family in French...

Conversely, two foreign language teachers from another school said:

In the field of languages, I am not convinced that the laptop is a useful tool in the classroom... [Possible uses are] for homework assignments or individual drills....[and] it is difficult to use the laptop in foreign language class. The laptop will prevent a lot of interaction, communications which are the goals of the class.

Teachers report that as they and their students become more familiar and comfortable with the laptops, their range of use and the complexity of that use increases.

During our site visits, we also observed a great variety of lessons and uses of the laptops. Because we only visited classrooms for a limited period of time, and only visited four of the 26 sites, we do not feel the lessons we saw were necessarily representative; rather, they serve as illustrations of the myriad ways that the computers were being used during the first year of implementation.

Some examples of lessons we observed were:

- Ninth grade students writing papers on an aspect of 1920's history, doing basic editing of papers on the computer, responding to teacher feedback written into the text, and conferencing with other students who looked onto their screens.
- Fifth and sixth grade students brainstorming the best ways to display what they had recently learned about Native Canadians, each student then organizing that display in his or her own way: some creating Venn Diagrams using Draw, some designing charts of tribe characteristics in Excel, some describing similarities and differences in report format in Word, and some doing outlines with PowerPoint presentations; and some with magic marker and paper. Students conferred with each other about how to re-size text boxes, for example, or how to create a particular effect in PowerPoint, while the teacher assisted individual students who asked for advice.
- Sixth grade students creating a table of ratios in Excel, following directions written on a sideboard. The table records their measurements of ten body part ratios: circumference of the wrist to length of the arm, circumference of the head to height, etc. They create columns for each category for themselves, and for data from two of their friends. The directions are color coded: those which have to do with Excel itself are written in red chalk; those which pertain to the content of the lesson are written in blue. When students are finished creating a template, the teacher turns on her laptop, which is connected to a monitor, and shows them what their table should look like. After a brief discussion of ratios, the students use string to measure each other and begin to enter the data into the table. Later they will use Excel to compute the averages of these ratios and compare them.
- Sixth grade students in a social studies class creating "social pyramids" in Word Draw which depict social hierarchies of the Middle Ages. One student works on the teacher's laptop, which is hooked up to a projection screen; as he follows her directions, each child who has a laptop designs their own triangle, pointers, and labels. Those without laptops (five of the 24 students, whose machines are not functioning) draw the same illustration by hand. Afterwards, the teacher demonstrates how to create a flowchart on the laptop, using the steps involved in medieval apprenticeship to illustrate. She mentions these kinds of flowcharts might be helpful in studying for tests. Students build their own flowcharts as they watch her demonstration, often leaning over each other's screens to give advice on changing font size, arrow design, background color, etc.

Site visit observations confirm that uses of the laptop tools varied from school to school and teacher to teacher. In fact, the laptop uses we observed varied so much that it is not possible to generalize about them. As teachers grappled to incorporate and take full advantage of this new tool, they often employed the laptops in ways that were directly opposite those of their colleagues in the next room or in the next building. While these practices reveal that the laptops are certainly not used in any uniform way at this point, the variety of uses reveal a willingness to experiment, and is also a testimony to the flexibility of the laptop program as it was implemented. Table 7, on the following page, outlines a few of the contrasting uses we observed on site visits, and teachers' rationale for each.

Evolving uses

Because the project is in its pilot year, it is expected that both classroom and home uses for the laptops will change over time. Teachers spoke with us about their own learning

curve: they had started slowly, with a few simple projects, and now were in the process of moving on to more extensive uses. Teachers reported that their own comfort levels grew as they gained experience on the machines. When they were asked what they hoped they could do in the future that hadn't been possible yet, teachers spoke most often of greater and deeper integration into the curriculum.

Implementation models such as the concentrated model, which gave both teachers and students extensive access, allowed more time for this familiarization and experimentation. Teachers in these settings report that students also gradually moved on to more "intense" and discriminatory uses:

Our students were very drawn to PowerPoint, and the first wave had mostly bells and whistles. Now there's more substance. They're much quicker now to know when the laptop is an appropriate tool. At first it was in constant use; now it's more critical use.

Table 7. Contrasting Applications of Laptops

Practice and Rationale	vs.	Practice and Rationale
<p>Direct instruction in software applications</p> <ul style="list-style-type: none"> • students need to be taught explicitly to use the tools before they can be expected to employ them 	<p>vs.</p>	<p>Teachers avoiding direct instruction in software applications</p> <ul style="list-style-type: none"> • direct instruction takes time away from the curriculum • students will pick up all beyond basic facility on their own or from other students
<p>Students encouraged to share laptops</p> <ul style="list-style-type: none"> • facilitates collaboration and group work • students can help each other 	<p>vs.</p>	<p>Students told not to let anyone else touch their laptops</p> <ul style="list-style-type: none"> • the laptop is an expensive tool and only the owner should handle it
<p>Students required to use the laptop for every assignment</p> <ul style="list-style-type: none"> • parents paid for an expensive tool that students should use whenever possible • the more they use it, the more comfortable they'll become 	<p>vs.</p>	<p>Students encouraged to chose it only as one tool of many</p> <ul style="list-style-type: none"> • the laptops are just one of many classroom tools, and students should be encouraged to make choices about what tool best fits the work at hand.
<p>Students typing paragraphs out of books</p> <ul style="list-style-type: none"> • students can internalize information and improve keyboarding skills by sometimes copying from texts 	<p>vs.</p>	<p>Students composing directly on the computer</p> <ul style="list-style-type: none"> • students should be encouraged to compose and edit text directly on a computer
<p>Loading worksheets onto the computer for laptop students</p> <ul style="list-style-type: none"> • in dispersed model classrooms, this allows laptop and non-laptop students to do the same work • students can become more familiar with manipulating text, entering data, etc., if worksheets are on the computer 	<p>vs.</p>	<p>Never allowing worksheets on the computer</p> <ul style="list-style-type: none"> • the laptop should never be used as a replacement for pencil and paper; it should only be utilized for the unique capabilities it possesses

Program Impacts: Perspectives from Teachers, Administrators, Parents, and Students

Students bringing laptops and business software tools into the classroom impacts teaching and learning in many different ways. Some of these impacts are unique to the individual classrooms or even individual students, but much is also illustrative of the ways that teaching and learning have changed and will change with widely available, personal and portable computing.

Schools experience the program from a wide range of perspectives. First, the implementation models that schools employ influence how much time students and teachers have to become familiar with the tools, whether they share access with others, and whether they can use the laptops outside of school. Second, the participating schools started their program at different times between September and April, and so, by year's end, some had used the laptop computers for nine months, and some for two. Third, the school's prior experience with technology shaped how the laptops were perceived—whether as an initial computer program or as an enhancement of previous technology efforts—and consequently, how they were used in the initial stages of the project. And fourth, as teachers across the sites experiment with integrating the computers into their classrooms, students approached and used the laptops in very different ways.

Nevertheless, some common elements emerge across sites and strategies. In the section below, we describe the following emerging themes:

- Enthusiasm
- Changing roles
- Individualized instruction
- Increased collaboration
- Changes in teaching
- Impact on student learning
- Improving technological competence

The data we collected from questionnaires, interviews, and site visits were strong and consistent. The indicators of student, teacher, and classroom impact that we cite below are based on repeated and consistent portrayals in interviews, observations, and questionnaires from the hundreds of teachers who communicated with us. The quotes are illustrative, and represent perspectives that are shared across sites, schools, and participants.

ENTHUSIASM

As a group, participants are extremely enthusiastic about the changes underway in their schools and classrooms. While a few individuals had negative experiences with their program, overall each of our data collection methods reflected extremely high levels of engagement and excitement about the project. For busy teachers accustomed to waves of reform projects, this is indeed a significant finding.

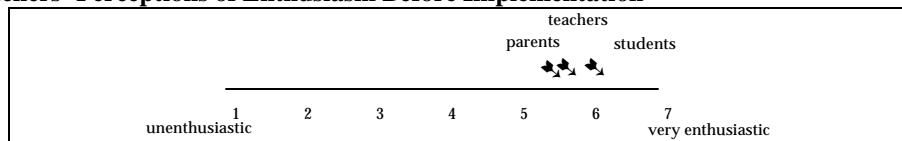
High levels of enthusiasm as the project began

The participants started the program with high expectations about the potential of the laptop pilot project to engage them and their students. We asked teachers just beginning the program to rate their own enthusiasm for the laptop program. On a seven point scale, with one being negative and 7 positive, 69% of the teachers chose six or seven, with an overall average of 5.8.

We also asked teachers to rate their students' enthusiasm in the beginning stages of the project. Seventy-five percent of the teachers chose a six or seven, with an average of 6.1.

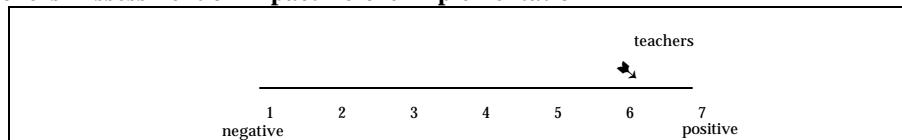
When we asked teachers to rate their perceptions of parents' enthusiasm, again the numbers were high: 53% of those responding estimated parents enthusiasm at a six or seven, with the overall average of 5.6.

Figure 8. Teachers' Perceptions of Enthusiasm Before Implementation



Finally, we asked teachers how positive an impact they thought the program would have on their classroom practices. Again on a seven point scale, with 1 being negative and 7 being positive, 70% of the teachers chose either a six or seven, with an overall average of 6.1.

Figure 9. Teachers' Assessment of Impact Before Implementation



Enthusiasm remains high during the year

This consistent, high level of enthusiasm presents a set of expectations that is difficult to sustain. Usually, when school personnel implement a complex program that requires great amounts of training, troubleshooting, and change in practice, initial enthusiasm drops as problems are encountered. Therefore, even more impressive than the initial high levels of enthusiasm is the fact that this enthusiasm did not wane after the first six months of project implementation. While laptop program participants did report various types of barriers, challenges, and frustrations, their high levels of enthusiasm showed no significant decrease.

On our follow up questionnaire, we again asked teachers to rate their own enthusiasm, that of their students and students' parents, and how positive they felt the program impact on their classroom was. Averages were again extremely high and not substantially different.

Figure 10. Teachers' Perceptions of Enthusiasm After Implementation

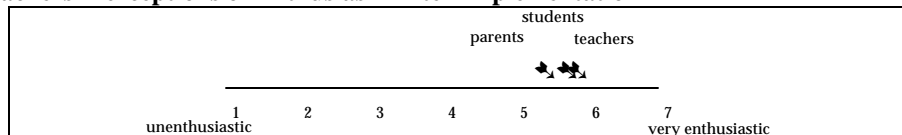
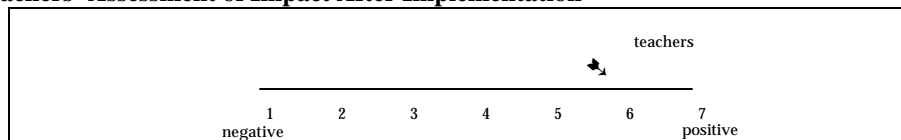


Figure 11. Teachers' Assessment of Impact After Implementation



Finally, in order to test the validity of our findings, we used our “matched pair” sample to compare only the very same teachers at the point of program introduction and then six months later. When we applied a statistical analysis to the responses, we found that there was no significant change in teachers’ very high ratings of their own enthusiasm, students and parents enthusiasm, and positive impact on their teaching practices over the course of the year.

These high levels of enthusiasm and excitement were also reflected in written comments and in our interviews with various participants. Teachers continued to report that they were convinced that this project was a truly significant innovation. For some, it was even more positive than they had hoped:

I’ve been teaching 30 years. First it was the overhead projector, then tape recorders, then filmstrips, then slide projectors....The laptops have far exceeded my expectations...At first I thought: just what I don’t need, one more thing to do... [now] I wouldn’t trade this year for anything.

It’s been better than what I expected—they’re easy to use, they’re flexible, kids are excited working on them, they love them... everything about them is great.

The significance of student enthusiasm

Across all of the sites, teachers, parents, and students themselves also discussed how excited students were to have the laptops. Further, they felt students’ enthusiasm had direct effects on their motivation and engagement, time on task, and sharing of work.

The amount of student enthusiasm often surprised the adults.

I didn’t expect the kids to be as excited by the process as they are; I thought they’d like it, but I didn’t realize how much.

Some teachers felt that this excitement increased motivation for school itself:

They are real motivated. The parents tell me they love going to school. Last year there were students who did not want to go to school and now they love it. It’s true.

Others felt it increased student engagement, especially for those who had not been enthusiastic about school before:

The students who were not engaged are more so now....Kids get into the curriculum who would not necessarily do so. It has provided a highway into the curriculum for kids who may have behavioral issues.

The kids have been transformed; they aren't the same students we taught first semester. Discipline, cohesiveness as a group, motivation to come to school have all improved drastically. Teachers have said to me: are these the same kids I taught last semester?

Teachers also reported that students' enthusiasm led them to spend more time on a task, and to go beyond what teachers had asked of them, writing 180 word foreign language essays when 30 words were assigned, for example, or doing an extremely complex PowerPoint presentation when the teacher had only requested four slides:

Kids show a lot of creativity; they go beyond the assignment.

Several parents commented that their children were now spending more time on school work at home, because they found it more interesting:

I don't have a problem getting him to start his homework, but stopping.

Some teachers reported that high levels of excitement also led students to share their work with others:

The kids really love it. Some of the things they are doing in their classes get them very excited. They will show you their presentation that they saved. Before they would tell you about it, but they are so proud now.

Students themselves described their own excitement at the project. In each of our interviews, students stressed again and again how happy they were to be a part of the program, and how lucky they felt. They also described how this excitement influenced their schoolwork. A fifth grader said,

I write stories in Word—I just wrote one last night on my own, because I like it. I write a lot more than I used to. I never had a computer before, but it's really fun.

A sixth grader described how his new tools had transformed book reports from dull tasks to exciting work:

[My favorite thing is] PowerPoint presentations book reports because they have all the cool pictures and backgrounds you can make, and a lot of graphics; and when you present it you can come in from any direction, with different settings... It's a lot more exciting than handing in a paper.

Because such high and widespread enthusiasm is rare for many reform efforts, its presence and influence in the pilot project is important to note.

CHANGING ROLES

One of the themes we often heard repeated was that the laptop project facilitated a change of roles for teachers and for students. Teachers were becoming learners and facilitators, and students were taking more of a teaching role.

Teachers as learners

Many teachers discussed how the laptop program required them to become learners again. Several had very little prior experience with computers, and many schools were not able to give their teachers extensive training before students received their own laptops. Teachers, then, spoke about how they had had to let go of the idea they were the experts, to admit they didn't have all the answers, and to learn to rely in part on their own students' knowledge:

You're so used to being in control in a teaching situation; this asks you to step back, be there with [the students], rely a bit on what they know....The minute I was able to say: I cannot absorb this, and I'm learning WITH the kids: one thing at a time—that worked; things have grown from that. You can't know everything about it ahead of time. And it's a much more positive thing than I thought it would be.

Teachers have to be real honest that kids will know the technology better than they do. Kids work on it more than I do- you have to be willing to let that go, to accept that kids are going to know it better than you do.. and that's good. That might be hard for some people.

Students as teachers

Our observations on site confirm that students were helping their teachers learn about the laptops. Many times we saw teachers turning to students with questions about the best way to compress a PowerPoint document so it would fit on a disk, for example, or how to create two text columns in Word for a newsletter in an English class. Students would gather with the teacher around a computer and demonstrate.

Students noticed these changes as well. Several students described how fun it was to be able to teach their teachers an easier way to do something in Word or Excel:

It's my first computer. It's exciting because sometimes I experiment; sometimes I can tell [the teacher] there's just one step and he can do that instead. I find out all the cool shortcut ways to do stuff, instead of the slow ways; I figure it out at home.

Other students were surprised at how much teacher and student roles had shifted:

It's something we didn't predict: the line between teachers and students is becoming blurred. We're teaching each other.

One district administrator felt that teachers' struggles with learning technology had led to increased empathy for their students, who struggled to learn fields that were familiar to teachers but new to them. Another administrator echoed this idea, saying that teachers' new awareness of themselves as learners led to insights into classroom practice:

[Through the laptop program], teachers are reflecting on the best environment for them as learners. Having them articulate all that learning observation has led to renewed conversations about classroom dynamics. They're viewing themselves as learners more than as teachers.

Teachers as facilitators

In schools in which the laptops facilitated greater Internet access, teachers also reflected on their changing role. With the Internet, they said, students are now able to tap into sources that go beyond the teachers' own knowledge; participants spoke about students taking charge of their own learning while teachers moved from being the source of knowledge to being more of a guide.

In a traditional classroom, the teacher is the key to general knowledge; he or she knows the sources, controls the access, controls everything. ...That changes with access to technology, because [the student] is not restricted to library books—you can have any book, any writing, any reference. Now teachers need to steer people through, not toward, information. The teacher is more important now as a guide to what is worthwhile.

INDIVIDUALIZED INSTRUCTION

When asked about the program's greatest impact, many teachers and administrators described how the Microsoft tools on the laptop allowed students to access the curriculum in ways that reflected their individual needs. They felt that the tools created more of an even playing field for all their students. Many teachers felt that the laptop allowed them to reach more effectively those students who had difficulty in a traditional classroom environment, and that it allowed students to pursue individualized learning paths.

Different learning approaches

Some educators felt that the laptops helped them address students' different learning modalities, reaching those who required more of a tactile approach:

It's always been a challenge for language teachers to reach tactile learners; this is a great way to do that.

The same students who struggle with pen and paper get very excited about [laptop] projects, and all uses of the laptops. Tactile learners can learn and show learning in different ways than with pen and paper tests.

Some teachers felt the laptop had helped students with shorter attention spans in regular classroom environments:

It's difficult to deal with attention span differences....[the laptop] seems to expand their attention span, because they receive instant feedback on what's right and wrong, and instant results for their efforts. They see it right in front of them.

Addressing special needs students

Many teachers felt that the laptop allowed special needs students to achieve a new level of accomplishment. One teacher spoke about its impact on writing for learning disabled students:

Having a portable tactile instrument has helped [learning disabled students] enormously... the ability to move text around, to revise quickly, to be able to do a spell check, and to do a lot of quick additional mechanical corrections has really helped those who normally wouldn't have done that.

Some parents of special education children echoed this idea. One felt that her son had spent most of his energy on mechanics and presentation in his school work, but now felt more on a par with other students:

My son is in special ed.. [it used to take him] all day to write something that may take someone else ten minutes. With the computer he feels more assured; he knows it; and he can go to town. He doesn't mind you telling him to change stuff, because he doesn't have to write the whole thing over again—that's very important.... it has been a godsend, a freedom for him.

Another parent described how it helped her daughter, who was diagnosed with Attention Deficit Disorder (ADD):

A big positive is the motivation [it's given] my daughter. She's ADD; [the laptop program] motivates her and keeps her organized. Now she finishes her homework—that's a big deal for someone who's ADD...Also it address her particular learning style—visual—rather than just script; she can add flavor, visualness to [her work].

Advanced students

One teacher felt that it also enhanced learning for her more advanced students, by allowing them to work at their own pace:

[One of the best things about the program is] students' ability to work at different paces, both from a technological and from a content ability point of view. It's more private somehow on the laptop, and they can go further.... more advanced students can be more creative.

Average students

Several teachers said that the new technology created a special place for students who did not stand out in their regular subjects. With the laptops, these students found a place where they could shine:

I've seen some students blossom in this area where in other areas they have difficulty. With computer instruction, we can draw out some of their real strengths that might have gone unnoticed. For example, I have a student who knows HTML, unlike the staff, so he taught the class how to do a web page; I employed him as a teacher. And now a student who had a hard time staying in his seat has the status of doing a better web page than the director of technology.

Some of the students who weren't traditionally good students are now computer whizzes. It adds a new dimension to their self esteem.

INCREASED COLLABORATION

Teacher collaboration

Traditionally, teachers work in isolation; due to various constraints, many find it difficult to consult even with those teaching the same grade or subject. As teachers shift from being the expert to being a learner, they often find themselves talking with and consulting with others, in their departments and out. Other research supports the notion that teachers learning to use computers will confer with and learn from other teachers in their schools.³

In the laptop project many teachers reported that they were working together more often with their colleagues. One-fourth of all our questionnaire respondents wrote that "increased networking with colleagues" was one of the top three professional benefits of the program.

Because the program was so new, teachers reported that they had to turn to one another to find answers to common problems or challenges.

Those of us who are more skilled are helping others who are less skilled; that's excellent—we're all in this together. It's helped us to become more cohesive as a faculty.

Teacher collaboration is enhanced: social studies and English have become closer... it caused us to work together.

Student collaboration

Likewise, teachers reported that students also turned to one another when faced with problems that neither they nor their teachers could resolve. Many teachers described how students would immediately gather around a computer on which one student was experiencing difficulties; one teacher said that it reminded him of group problem solving in professional settings. Another teacher felt that it was a waste of time to teach specific software applications, because once one student learned how to import a table from Excel into Word, for example, all the students would know within a few days.

While on site, several times we observed students conferring with each other, most often around particular uses of software applications. Students would assist each other in making tables in Excel, for instance, or in converting their information into a particular type of graph.

³Rockman, S., Pershing, J., and Ware, W. (1992) *Productivity, professionalism, and empowerment: Given a computer for every teacher*. Indianapolis: Indiana Department of Education.

Rockman, S. (1994) Bellvue School District. In Mergendoller, J.R., Johnston, J., Rockman, S., and Willis, J. *Exemplary Approaches to Training Teachers to Use Technology: Case Studies*. Prepared under contract for US Congress, Office of Technology Assessment.

During class discussions, when one student would mention a problem they were having with their computer, many others would volunteer ideas or solutions.

Students themselves spoke about how they would turn to their peers for help, or would find ways to help others when they were stuck. One sixth grader gave an example of the times he worked with friends:

You can put graphs on [PowerPoint]; I figured out how to do that on our planet report. [A classmate] wanted to copy me and I taught him, and then we both figured out how to do it.

One student saw this collaborative process continuing to grow in the future:

There are some people who know every which way around the computer; you can ask them [for help]. Next year we'll all know what we're doing and we can help the new kids.

One teacher had worried that individual computers would decrease communication among students, but had found that it did not have that effect:

There's maybe a little more interaction with peers now, such as when they're sharing an exciting idea. I worried that there would be less, with each child buried behind his or her own screen, but it's not true.

CHANGES IN TEACHING

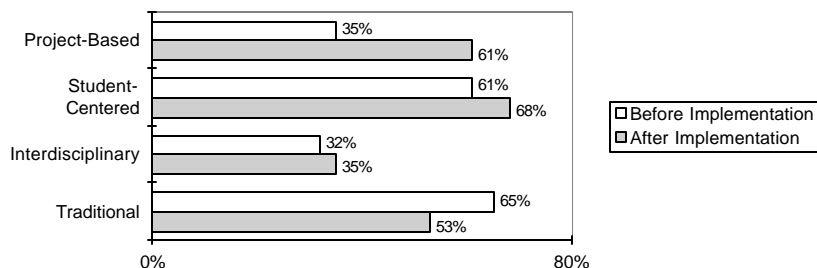
Given the increased access to computer tools and laptops, teachers have new opportunities to try teaching strategies that differ from their traditional methods. We found some initial indications of the impact the project might have on teachers' pedagogy and instruction. At this point, we rely most upon teachers' own descriptions of their classroom practices.

Overall, since teachers are exceptionally enthusiastic about the program, they tended to speak about benefits—to themselves, their students, and the school. In order to investigate teachers' statements about changes in teaching, more in-depth and school-level research would need to be undertaken in the project's second year.

Teaching style

We asked teachers on both of our questionnaires to describe their teaching styles, first before the laptop project, then again since they'd been teaching with laptops. Teachers could choose as many answers as they felt applied. Below are the results for our "matched set" of teachers, the group of 104 for whom we have both pre and post questionnaires.

Figure 12. Self-Reported Teaching Style



The greatest change seems to be in project-based instruction, an approach that allows students to manage their own learning by completing individual or small group projects; the projects often span various disciplines, require a diverse set of skills, and include numerous steps that lead to a final product. Roughly half the people who said they did not use project-based instruction in the initial stages of the project reported that they did use it by the ending months of the project.

This finding is confirmed by other data from follow-up questionnaires. When asked an open ended question regarding the laptop's impact on the way they teach, teachers' most frequently noted answer was an increase in project-based instruction.

Other responses to the question are captured in the table below. Many of these responses came from only one teacher; however, taken together they depict the wide range of effects teachers feel the program has had upon their teaching.

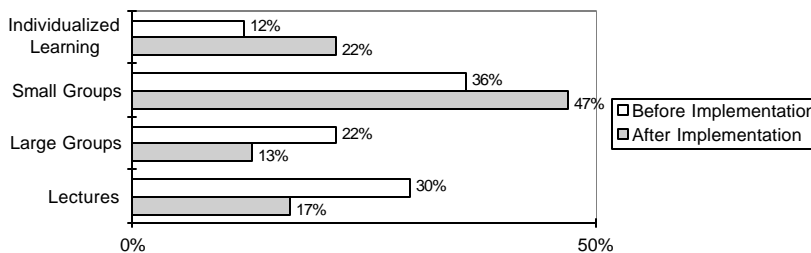
Table 8. Responses to “Do you feel the laptops have changed the way you teach?”

<p>Changing their lessons: More student teaching More small groups Multiple task assignments More computer presentations by teacher Teaches research more More projects</p> <p>Changing their expectations for students: Teachers request more editing More demanding (spelling) Require typed assignments Teachers focus more on student organization</p> <p>Changing their role in the classroom: More responsibility for learning lies with students More individual time with students More learning from each other, student to teacher, and vice versa</p>
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Teaching method

On the questionnaires, teachers were asked to choose the one teaching method they used most often. Their responses, summarized in the table below, reveal that the teachers at the schools implementing the longest were more likely to employ small group and individualized learning methods, and less likely to lecture or teach in large groups.

Figure 13. Self-Reported Teaching Methods



However, the two questionnaire groups reflect different segments of the entire group of schools. When we examine change over time in our matched pair sample, which only asks the same teachers each question at two different points in time, we find that many teachers changed the approach they used in teaching, thus confirming the changes we noted with the full group:

- 33% of those who initially indicated lecture style teaching chose small group teaching after six months of implementation.
- 43% of those who initially indicated they teach in large groups moved to small group or individualized learning after six months of the project.

These findings are reflected in the interviews we conducted with classroom teachers. Most felt that the program had enhanced their teaching. One teacher described the increase in small group learning:

This is the first year in 31 years when kids have not been in rows. I am not teaching the way that I have most of my career. Most of it is group learning. I have allowed the kids who learn fast to teach others.

Another teacher also felt the program had impacted his classroom practices in substantial ways:

Professionally: it's forced me to evaluate how I'm teaching: I'm doing less lecturing, more student centered activities. Also I'm now aware of amazing resources that I wasn't aware of or weren't there before...It's opened a whole new way of working with kids.... I have been teaching 24 years and the program's been great for me as a professional. It's forced me to look at what I do, how to do it better, and then to change it. It gets you out of ruts, and keeps you current.

Many teachers felt that the laptops simply facilitated the kind of teaching they had always aspired to:

[The laptops have] allowed me to do what I've always wanted to do: a lot of project based instruction and as individualized as possible. With paper and pencil, that's harder. This has facilitated that process of: where would you like to go, what would you like to learn today?

Participating in the laptop program seemed to encourage more small group, project-based, and individualized instruction. For some teachers, this was a refinement on what they were already doing; for others, the program inspired a change from more traditional approaches.

IMPACT ON STUDENT LEARNING

With professional software tools and portable computers at hand, students had more options to change how they went about learning. Teachers report that students' learning is being affected by the laptop project, and that this impact is increasing as they and their students grow more comfortable with the computer and the software.

The range of student impacts noted by teachers is impressive. Some impacts are related to curriculum and the tasks assigned to students as part of their instruction. Some applications change the way students write or organize materials for presentations. Other changes noticed by teachers relate to students taking on more responsibility and independent work as a consequence of having the tools available for it.

Student writing

One area of impact mentioned many times was students' writing. Teachers felt that the ease of editing that the software provided led students to create more rough drafts, spend more time on content rather than mechanics and presentation, and encouraged students to use teachers' comments and advice more readily, since often it was right there in the text. And, of course, teachers feel that the presentation and the mechanics of students writing were much more professional with the laptop.

Improvements in writing have been seen in other projects where computers are generally available at home and in school, and are usually associated with changes in teaching that accompany improved facility to revise and efforts to incorporate process writing approaches.⁴ At one school, teachers felt that the laptops allowed their students to finally carry out the process writing approach that the school emphasizes:

The approach to writing [has changed]. For example, the 7th graders, they're much more willing to go back and change things. It's enabled that writing process to be truly lived out-- they basically already knew how you go about doing that.

Several teachers commented that students now didn't mind making corrections:

Their writing is better. They don't mind going back and changing things. It makes them feel bad to erase, but it's better in the computer. They don't mind. I can make a long assignment and they don't mind it.

Another teacher listed the many ways he felt the laptop access had made an impact on his students' writing:

Kids are sending me more rough drafts to look over. It's more work but the papers are higher quality....papers in English are better mechanically because they're using grammar and spelling checks. Drafts are improved; with handwritten papers they might have skipped the draft stage.... kids will give me a rough draft on a disk and let me go through it for them or together on the computer. Then they can take the disk home and come up with a much better finished product. Technology has made that fun for them; red marks on paper would have been depressing.

Students also discussed the impact on their writing. They agreed that easier editing motivated them to undertake more drafts, and made them more willing to revise even up to the last minute.

We used to write out rough drafts; now we can do that on computer...you can cut and paste as you write. When you're writing by hand, you leave a section where it is even though it's better somewhere else. But when you can shift it easily, the process of editing is easier so you're more willing to do that editing.

⁴Rockman, S. and Sloan, K.R. (1995). *Assessing the growth: The Buddy Project Evaluation, 1994-5*. San Francisco: ROCKMAN ET AL.

You can get your first ideas down really quickly, more quickly than by hand. And easy corrections allow you to concentrate on what you're saying more.

Presentation and organization skills

Writing was not the only area where the availability of professional software tools and laptop computers seemed to have an impact. PowerPoint was thought by many teachers to have encouraged new student skills and abilities. For instance, in order to summarize a large body of information in a short presentation, students had to learn to isolate main points, outline, and condense.

[PowerPoint]'s a totally new way of processing information and then sharing it with others. The pride they have in what they've created is really unique.

Teachers also felt that the enthusiasm for creating PowerPoint presentations led students to absorb the material better:

I think that the PowerPoint is a really different way of thinking for them. For example, right now, they're taking a [French] grammar topic and explaining it in a PowerPoint presentation... I think some of them are taking it further than they would have before—learning it in a different way... Instead of memorizing the rule in rote fashion, they're trying to think of ways to show what they're learning. In the past, you'd ask them to study page 130 and all the uses of the verb "allez"—they would just study it. Now, they ask, can you look at my PowerPoint before it's due? They're asking for feedback and revisions and help.

A fifth grade student described the changes in her planning processes with the new tools on her laptop:

Now we can lay out a page; you don't just grab a piece of paper and start writing and drawing lines. You can lay it out and set it out just like you want it.

Making choices

Many laptop participants perceived that students with laptops and a collection of software tools took greater responsibility for their own learning process. Teachers felt the laptops required students to make choices and decisions that they had not had to make before. They felt this process of weighing the options and planning ahead was very beneficial for students.

It's a new way of putting out the same stuff; but the choices they have for production have opened up. For example, for a graph: what kind of graph will best show what you want? ...Some students think it out first; others jump in. The laptops help you become more organized, to plan ahead. What's going to be the most readable; highlight what; more are thinking about those things.

It's fun to see them pick up that: this is just a tool, sometimes not the right one; sometimes pen and paper is better; part of the challenge is learning when to use what.

Student-centered learning

Teachers also felt that the laptop allowed students to guide their own learning more of the time. They felt this enabled more of a student-centered approach to teaching, one in which students became active participants rather than passive learners:

The impact is on the level of students being able to acquire their own learning, to go out and do that, to be responsible for their own learning. For example, I tell kids to create a PowerPoint presentation—they're the ones going out there and doing it. It makes them more responsible for their learning.

With [the laptop program], it's very open-ended. Students have to be the ones inputting the information. They have to be analyzing and filling in things they're looking for. It makes them do a lot of searching with their learning, analyzing what's needed and what's not.

This increase in student responsibility was also reflected in the manner in which they cared for the laptops themselves. Many parents of elementary grade students said that they had feared students were too young to take care of such an expensive tool. Instead, they said, on the whole the children rose to the occasion and took primary responsibility for the care of their laptops. Teachers and parents alike felt this increased sense of responsibility was an important benefit of the laptop program.

IMPROVING TECHNOLOGICAL COMPETENCE

For many students and teachers, the laptops in this initiative provided their first significant access to computers. Many of the benefits that teachers and administrators cited had to do with the gains that both they and their students were making in computer literacy.

A year and a half ago I could barely turn on a computer and now I know every way, back and forth, in and out of a computer. It has been a wonderful experience for me as a person.

Teachers felt that using the Office software tools gave students experiences that matched real world computer uses. Others felt this was very important for preparing students for the work force. One teacher remarked that this was how she had eventually sold parents on the idea: these computers would be the same platform and the same software that parents themselves were using in their workplaces.

For the first time parents and students are seeing relevancy in education; a real world application to what's going on. Most days they struggle to see why these classes matter. Now it's an entirely different attitude.

III. Challenges During the Pilot

Even though teachers, administrators, parents and students on average were overwhelmingly positive about the project, there were several areas in which they identified challenges.

Hardware problems

The difficulty that all participants named most often was hardware problems. Teachers, parents, and students were frustrated by “glitches” such as frozen screens, broken latches and easily-damaged screens. Many teachers felt that the percentage of computers out of commission each day was way too high: estimations ranged from 5 to 30 percent. Further, some students’ computers seemed to be “lemons,” and their situations were especially frustrating; because their computers were so often in need of repair, they were not able to participate on equal footing with their classmates.

While some teachers reported that these problems decreased as students learned to handle the machines better, many others felt that students were doing a remarkable job of treating the laptops carefully, and that the problems were not due to students’ use.

10-30% of the computers are out on any given day; they’re just not robust enough. I’ve had no problems with mine-- but for kids lugging them around school, it’s harder.

Several other teachers mentioned that their laptops came configured incorrectly, and that that had led to unnecessary frustration for students and teachers alike.

Parent education

The parents we spoke with were extremely happy about the benefits they perceived their children were receiving from the program. However, they also wished that they had received more laptop information and training themselves. Sometimes they were at a loss as to how to support their child when he or she got stuck on a particular application. In several sites, parents were encouraged to take classes offered by the school, and these parents hoped even more classes would be offered:

Sometimes the word to parents about basic instruction and upkeep hasn't been what we've needed it to be. We only had a basic course; mostly what we did was immediate bugs, not applications. It would've been helpful to have more courses.

[Computer] training is a need for some parents. Some parents may have stayed away from the program because they felt inadequate.

Curriculum integration

While many teachers participated in training on how to use the hardware and software, they noted that it was insufficient to meet the demand they saw in their classrooms. When teachers were asked what further preparation they would like, the most frequent answer was training in integrating the computers into their particular curriculum area. One teacher said,

I think it's fairly easy to find ways to use the computer, and it's helpful to have the computer. But when they talk about seamless integration: that's a long way to happening.

Many teachers and administrators worried about the ways in which teachers were incorporating the computers into the curriculum. They feared that in some cases, the laptops might be used as a very expensive replacement for pen and paper. One teacher felt that extensive training was needed to ensure that others did not simply load study guides onto the hard drive:

We need to remember to utilize it not just as a sophisticated tool but as a tool for kids to increase higher thinking skills. I keep pressing on this issue but I totally believe it. Other teachers ask me how many study sheets I've put in the computer for kids to bring up on the screen—the answer is zero, because it's a waste of time. That's not what I do.

An administrator felt training was the key to making sure the laptops were used in a constructive manner.

Teacher training is absolutely crucial. This cannot turn out to be a \$2,000 typewriter.... that cannot happen and it's a great danger. Also there's a danger in seeing this as panacea... not every use is a good use of the computer.

Implementation models

At sites which did not yet employ the concentrated model, teachers felt their job was more difficult and they were not able to do all the things they hoped to do. While many remained positive overall, they still hoped that the program would soon become universal.

For those who were teaching in classrooms with less than full participation, many felt it was unfair to conduct lessons in which only the laptop students could participate, and therefore they were limited to instruction that mirrored what other students were doing with pen and paper. In turn, some noted, if they did not use the computers because not everyone had one, those who did often decided not to bring theirs to class.

I only have six laptops for a class of 36. This dramatically changes how they can be used in class.

Additionally, in schools which chose to use the class set and desktop models, a larger number of teachers were usually affected by the program, and often not all of them were able to receive the more intensive training that smaller programs were able to provide. Those teachers with class sets also did not have the time to experiment with various approaches and uses.

I have the classroom set of laptops only a limited number of weeks (2 weeks out of 10), and only one student has his own laptop. Therefore I am limited in what I can do.

Keyboarding skills

In many cases, students received no or very little direct keyboarding instruction, and instead were simply becoming faster as they spent more and more time on the computers. Some teachers felt that teaching software applications had already taken too much time from the curriculum, and they could not justify teaching keyboarding as well. Students stated that they felt they were picking up the skills, but many also added that it was slow going.

Several parents with whom we spoke also worried that their children's typing took so long, and that, by teaching themselves, students would pick up bad keyboarding habits. Parents felt that keyboarding classes in the younger grades might enhance students' use of the computer.

Student concerns

Because they are the primary users, students often perceived problems that others didn't mention, and they had a great deal of advice for refining the program. Many felt that the screens and the latches were too fragile: they felt they, personally, were very responsible, but often screens would be damaged by pressure inside their backpacks, and latches would melt in the heat. Given the potential problems with the screens, most students carried two backpacks: one for the laptop and one for everything else. Students often mentioned that carrying two backpacks was difficult, as was the extra weight of the laptop for some of the smaller students.

Some students had computers that seemed to break far more often than their classmates'. Accordingly, these students did not share their classmates' enthusiasm for the laptops. Students were also concerned about battery life; sometimes, they said, their battery indicator would suddenly change from two hours of time left to five minutes, and they would rush to find their cord in order to plug in. Some expressed fears that their work would be lost due to battery fluctuations. Many classrooms had just finished installing power strips that allowed students to plug in at their desks; before that modification, students said that having to plug in across the room could be frustrating.

Students also were obviously concerned about care and safety of the laptops. Some reported that students not in the program had threatened to steal their computers, but they added that nothing like that had occurred.

Expanding the program

Sites were first faced with the challenge of building support for the program; now many sites are facing a new challenge, born of the success of these efforts. In many places, the program has proven popular enough that scaling up is a major concern. Administrators must negotiate issues of training larger numbers of teachers, providing security for even more laptops, and continuing to seek financing for an even greater number of students. For many, moving from a small pilot implementation to a wider scale program means moving beyond the core of "true believers" and risk-takers to include teachers who may not be as excited or

invested in the program. Those sites that have found ways to subsidize student fees are now facing the possibility that even more students will want to participate than they can accommodate, and the accompanying issue of how they will choose the participating students.

IV. Looking to the Future

Among the issues that teachers, administrators and students identified as critical in building their programs over the first year—issues they felt that schools wishing to undertake a laptop program would need to know, as well as those they are faced with as they plan to increase the amount of student participation and expand the program—are the following:

Building support. Many staff from the pilot schools suggested that new schools start with a small program, so that early success would increase public support. If schools start small, they can begin with the most enthusiastic teachers and students, those willing to take risks with the program. As time goes on, these successful teachers and their students might influence the others in the school and broaden participation.

Credibility and support. Microsoft's and Toshiba's names lend credibility to the school program, allowing a level of public support and enthusiasm unusual for most reform efforts.

There is a Microsoft magic that offers a lot of credibility.

Additionally, schools gained support and confidence through membership in an elite pilot group. Many spoke about the importance of the Learning with Laptop Summits in providing opportunities for consultations with peers, access to new ideas, and confirmation of the importance of their efforts. As the program grows larger and includes more schools, this sense of group membership may decrease, along with these benefits.

The growth curve. Even in many of the more sophisticated sites, some teachers are not as fully prepared as others. Teachers and students must often learn in tandem, about when to use the computer and for what end, where it enhances things and where it doesn't. Later, there may be a shift back to the curriculum, and calling the computer into service when it will enhance the curriculum itself. Providing sufficient time for this growth curve will allow teachers and students to develop more fully their computer skills and uses.

Expansion issues. Laptop programs can enhance a school's technology program no matter where the school begins, from no previous technology initiatives to very advanced programs involving most teachers in a school. All the sites seemed to be able to use the program to scale up from where they were, and the program is flexible enough that it can be implemented no matter where a school starts. However, those schools that were able to implement a concentrated model with substantial teacher education and support experienced the most enthusiasm and growth. Schools should consider these factors as they plan their programs' expansion.

Training and professional development priorities. When first year students move up a grade, they will no longer be learning alongside the teachers; students will already know how to use the applications in appropriate ways. Teachers need to be in a position to leverage that knowledge. Often recommended was preparing the succeeding year's teachers early, and letting them be a part of the ongoing implementation. This preparation should

involve the first year's teaching staff and build on the experiences they have had. Also schools should consider starting parent classes on applications and keyboarding classes for students who need it.

Technical problem solving. When there is any large scale implementation of new technology, there are bound to be problems with making it work. Schools describe major problems with hardware. They suggest that new schools should develop a collaborative relationship with their resellers, load software and check laptops' configurations before distribution, work on technical troubleshooting with parents and students, and plan extra time for dealing with technical problems. Several sites felt that Toshiba has been responsive to their many concerns, implementing an 800-number, for example, and by making other necessary adjustments. By climbing the learning curve over the first year, Toshiba has a competitive advantage as the hardware supplier in the future.

Learning from others. Teachers are hungry for lesson plans that will permit greater integration of the technology into the curriculum. By sharing lesson materials across sites, using the program web pages for instance, teachers may be able to find the assignments that serve the curriculum and make use of the computers' unique capabilities. The web site is now under-utilized as a place to share these ongoing lessons, and many believe that increased future use will enhance the program.

Time to experiment. The initial participants tend to be the risk takers and are willing to put in the time necessary to make the initiative work. They can see the benefits and opportunities quickly. As additional teachers begin to engage the laptop program, they may need more time to learn and to experiment before they see the potential for major impact on both teaching and learning. Schools need to build in this time for the project to involve the new participants successfully.

Leadership support. Critical to each of the first year's successful efforts has been the support of the building and district leaders. The principals and heads of school have provided the motivation and leadership needed to carry their boards and parents into the program. Their involvement continues to be needed as they try to grow the initiative within the school and among schools throughout their system.

Ongoing assessment. Individual schools and the larger program need to develop ways to assess which of the many uses and approaches provide the most benefits for students. This pilot year evaluation focused mostly on the perspectives and experiences of the participants as they began their implementation. Both individual schools and the program itself could gain from an approach to assessment that would provide more extensive information on the program's impact on teaching and learning and the influence of technology on school change efforts.

About the Research Team

This research study was conducted by ROCKMAN *ET AL*, an independent research and consulting firm, specializing in technology and education. The company consults with corporations, state and federal agencies, and educational organizations on research, evaluation, and policy development that advance the application of technology to meet educational and business learning needs. Capabilities include print and media materials for learners, teachers, and corporations; research and evaluation; organizational development; long range planning; and projects involving technology, learning, and the change process. Saul Rockman established ROCKMAN *ET AL* in 1990 after leaving Apple Computer where he was Manager of Education Research.

Current and recent clients of ROCKMAN *ET AL* include: Ameritech's Vision Athena Project, Apple Computer, Children's Television Workshop, Congressional Office of Technology Assessment, Council of Chief State School Officers, Indiana's Buddy Project, Kaplan, Pacific Bell, Public Broadcasting Service, Scholastic, US West, WarnerActive, and several Department of Education, NSF, Department of Energy, and ARPA projects.

The offices of ROCKMAN *ET AL* are located in San Francisco, California and Bloomington, Indiana; the company has working relationships with contractors, university faculty, and consulting groups in all regions of the country.

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