First Year Evaluation Report
Fullerton School District Laptop Program

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Summary

The Fullerton School District in Orange County, California launched a one-to-one laptop learning program at three schools in the 2004-2005 school year. In spite of the logistical challenges of the first-year implementation, the program has had important successes, especially in promoting the kind of learning skills required for the 21st century. The program is highly popular with participating teachers, students, and parents, who in their strong majority believe that it contributes positively to student learning. With some variation by school, grade level, and subject, students in the laptop program improved in test scores from the prior year at about the same rate as other students in the district.

The district's decision to expand the program, while continuing to evaluate the results, is merited. Important challenges the district faces include raising sufficient funding so that all families who wish to can participate and developing sufficient parental and community support for the program to expand.

Introduction

Laptop learning programs are expanding throughout the United States as school districts seek ways to make better use of new technologies to enhance student learning. A statewide laptop program has been organized in Maine, and a number of school districts throughout the country have initiated local programs. The Fullerton School District launched one of the largest pilot laptop programs in California in the 2004-2005 school year. As part of this program, more than 1,000 students at three district schools were provided with laptop computers. Participants in the program included all the seventh-grade students at Nicolas Junior High School (554 students), all the third to seventh grade students at Fisler K-8 School (395 students), and two classes of Gifted & Talented Education (GATE) and other high-achieving students at Hermosa Drive Elementary School (62 students, 53 of whom were district-designated as GATE students and 9 of whom filled school-based placements in the GATE classes based on high academic achievement). The laptop program has been financed by a combination of federal and parental funds, with Title I funding being used for lease of laptops at Nicolas and parental funding being used for lease of laptops at Fisler and Hermosa.

The program has included not only provision of Apple iBook computers to students and their teachers, but also provision of appropriate educational software, the establishment of wireless Internet access at the three schools, a substantial level of technical support to keep the equipment going, and a professional development program to prepare teachers to make use of the laptops.

This report constitutes an evaluation of the first-year implementation of the project. The remainder of the report will include a description of the evaluation methodology; a description of program implementation and laptop use at the three schools; a summary of teacher, student, and parent opinion of the laptop program; an examination of attendance, discipline, and test score data; an analysis of the benefits and challenges of the laptop program; and information about the research team.

Evaluation Methodology

In summer 2004, a team from the Department of Education at the University of California, Irvine (UCI), under the leadership of Dr. Mark Warschauer, was invited by the district to evaluate the laptop learning program. The evaluation team (listed at the end of this report) included two professors of education, four UCI doctoral students (including two who are employed in educational leadership positions in Southern California school districts) and two undergraduate researchers. Neither Dr. Warschauer nor any members of the team received any funding from the district or from Apple Computer to carry out the evaluation. Rather, they agreed to do so because of their broader research interests on the topic of technology in education.

The team was given full access to the laptop program, including the opportunity to observe any class in the program and interview any teacher or student (pending the permission of the teacher and of the student and parent, consent for which was almost always granted).

The following data was collected and analyzed in completion of the evaluation:

(1) *Surveys*: An anonymous online survey was conducted of all teachers and students in the laptop program containing both multiple choice and short answer questions. The survey asked 32 questions of teachers and 35 questions of students, with questions focusing on how the laptops were used and how they appeared to contribute to or distract from student learning. The response rate for the three surveys was 100% for teachers (35 out of 35) and 86.8% for students (878 out of 1011). In addition, the school district conducted its own survey of parents of children in the program and provided results of that parent survey to the evaluation team.

(2) *Observations:* A total of 157 hours of classes were observed at the three schools. Observations were generally conducted on a pre-arranged basis with individual instructors, but numerous drop-in visits were also conducted with teacher approval. Detailed field notes were taken during observations as to instructional procedures, laptop use, student and teacher attitudes, problems that occurred, and any other relevant matters.

(3) *Interviews*: Interviews were conducted with the district superintendent, the principals at each of the three schools, 28 classroom teachers, and 10 students. Interviews lasted from 15 to 60 minutes, and in most cases the individuals were interviewed two or more times during the school year. Interviewees were assured that their comments would be kept anonymous. All interviews were audio-recorded and transcribed. Interviews focused on assessment of the laptop program and its potential and problems. In addition to these formal interviews, informal discussions were held during observations at schools or at open house events. In some cases these brief discussions were also recorded with permission

of the participants, who included teachers and parents.

(4) *Documents and Records:* Teachers who were observed were asked to provide examples of rubrics, lesson plans, and instructional materials related to the laptop program, and most did so. A total of ten individual case study students were selected at the two largest schools in the program, and copies of their student work were collected with permission of their parents. District reports and presentations regarding the laptop program were collected. In addition, the district provided aggregate test score, attendance, and disciplinary records for the laptop program students for both the 2004-2005 academic year and, for comparative purposes, for the 2003-2004 academic year.

To carry out data analysis, all the interview transcripts and observation field notes were entered into a qualitative data analysis software program (HyperResearch), with data instances matched with one of 190 codes (e.g., "technical problems," "student engagement," "inappropriate content," "autonomous learning"). Codes were then aggregated into overall themes related to types of laptop use, response of participants, and benefits and drawbacks of the laptop program.

Program Implementation and Laptop Use

We found that laptops were used regularly at all three schools. Laptops were used, for the most part, on a daily basis in language arts, social studies, and science instruction. Laptop use in mathematics instruction was less frequent and, in some classes, rare.

Total amount of laptop use varied among the three schools, due to differences in context. Fisler, a new school with a science and technology focus, had hired teachers with a special interest in using technology and laptops in the classroom, and even the architecture of the school's building was designed to encourage collaboration among groups of teachers and students. Laptop use at Fisler was constant and extensive. At Hermosa, the laptop program took place in the school's gifted program, featuring two teachers who had a previous high interest in using technology in instruction. Again, laptop use was constant and extensive.

At Nicolas, teachers were neither hired nor selected based on their interest in technology; rather, all seventh-grade teachers were assigned to participate in the laptop program (with the option of transferring to another school if they did not want to teach with laptops). In addition, students at Nicolas had comparatively less access to computers and the Internet at home and thus less prior experience with computers than did students at the other two schools. In addition, Nicolas had the greatest percentage of English language learners (encompassing 25.3% of the school population) and students in Special Education (8.5%, compared to 4.2% at Fisler) among the three schools. The concentration of these special needs populations posed greater challenges to teachers in learning to integrate laptops into instruction. Finally, the Nicolas program was the largest of the three—the number of laptop students at Nicolas was 20% greater than at Fisler and Hermosa combined—which posed a number of administrative challenges. For all these reasons, the learning curves at

the school, teacher, and student level were steeper at Nicolas than at the other two schools. Implementation was slower, and total use was less.

Students' self-reported time using laptops for educational purposes in the four major subject areas at school and home in each of the three schools is seen below in Table 1.

Table 1: How often do you use your laptop for each of your classes, either in class or preparing homework for class?*

	I do not take this class	**Less than 1 hour per week**	**1-2 hours per week**	**3-4 hours per week**	**5-6 hours per week**	**7+ hours per week**
Language Arts						
Fisler	6%	23%	20%	23%	18%	11%
Hermosa	2%	16%	24%	29%	10%	19%
Nicolas	0%	24%	41%	18%	10%	8%
District**	3%	23%	30%	21%	13%	10%
Social Studies						
Fisler	7%	18%	34%	23%	12%	6%
Hermosa	3%	30%	33%	26%	7%	2%
Nicolas	1%	69%	19%	7%	2%	2%
District	4%	43%	27%	16%	7%	4%
Science						
Fisler	10%	29%	28%	13%	12%	9%
Hermosa	10%	34%	34%	15%	3%	3%
Nicolas	1%	40%	29%	18%	7%	5%
District	5%	34%	29%	16%	9%	7%
Math						
Fisler	9%	36%	24%	19%	8%	4%
Hermosa	6%	34%	27%	11%	13%	18%
Nicolas	1%	78%	16%	3%	2%	1%
District	5%	55%	21%	11%	6%	3%

* Numbers in this and other tables may not add up to 100% due to rounding
** District refers to all the students at the three schools who took the survey

Laptops were used in a wide range of diverse ways in the three schools, but, overall educational use can be summarized into seven overlapping categories: writing and revising, gathering online information, analyzing data, using multimedia, interacting with educational software, and individual study.

Writing and Revising

Writing and revising school papers was one of the most common uses of laptops. A total of 98% of students indicated that they used laptops to write papers at school, with 59% reported that they did so several times a week or more. A total of 85% of students also used laptops to write papers at home.

Laptops were used in all stages of the writing process, including gathering background information on the Internet, planning writing using graphic organizers, writing first drafts, and revising. The use of laptops appeared to have several major advantages for the teaching of writing. First, many teachers reported that their students wrote more with laptops, either because they enjoyed writing on computer or because it was easier for them than to write by hand.

Second, students were able to revise their work much more readily. An important part of becoming a good writer is learning how to edit and revise one's work in multiple drafts, yet this is naturally hard to teach when papers are written by hand. Students revised their work more easily with laptops, sometimes submitting multiple drafts of the same paper.

Third, writing completed on a laptop was much easier to assess and provide feedback. Teachers reported that, due to easier readability, they could much more quickly read, assess, and reply to a paper written on computer than one written by hand. This allowed teachers to provide feedback on more writing than they ordinarily could do. In addition, the district made use of an automated writing evaluation software program, MY Access!, which compared students essays with hundreds of already-graded essays on the same prompt, and returned both numerical scores and editorial feedback. The combination of computer and teacher feedback proved especially helpful. Students could write multiple drafts and submit them to MY Access!, turning a final draft in to the teacher for more personal feedback.

Fourth, computers allowed students to write in a greater variety of formats and genres for authentic purposes. Students designed and wrote brochures about their school to present to incoming students; worked together to produce newspaper texts, either in response to particular pieces of literature or to analyze historical events; and wrote and mailed formal letters to colleges and employers seeking career information.

Of course the actual amount of writing and the approach to revision and correction varied from classroom to classroom. Though most teachers said their students were writing more, one indicated she assigned fewer essays this year due to the dual complexity of introducing laptops and focusing on preparation for state tests. In addition, how much students revised depended greatly on individual teacher approaches. Some teachers encouraged multiple revisions for greater mastery of an effective writing process. Other teachers encouraged more frequent one-time submissions, so that students could practice the kind of writing that takes place on standardized tests.

Finally, one factor that inhibited writing by computer in a number of cases was students' weak keyboarding skills. This was more commonly the case at Nicolas than at Fisler or Hermosa, presumably due in part to students' lesser amount of experience with technology in home environments. In addition, all Fisler sixth and seventh grade students studied keyboarding at the beginning of the year as part of a mandated technology course, whereas the course that teaches keyboarding at Nicolas was optional.

Accessing Online Information

A second major use of laptops was to access online information. A total of 63% of students indicated they used the laptops to browse or search the Internet several times a week or more at school. This was consistent with what teachers reported in their surveys and with what we observed in classrooms. We witnessed online information access by students for three main purposes: to provide background knowledge, to facilitate "just in time" learning, and to support research projects.

A major difficulty in completing challenging academic tasks is presented by insufficient background knowledge. Students who read a difficult author or engage a complex social studies topic have greater success if they have sufficient background knowlege on the selected author or topic. The Internet, with its array of textual, audio, and visual information, proved to be a frequent source of background information for students. In some cases, students systematically sought such background information prior to tackling topics through online search activities called Webquests. In other cases, teachers led their students to background information at the point of need, as illustrated in an example explained by a language arts teacher at Nicolas:

> We were going to read an Emily Dickinson poem, and they could just not grasp what was happening. It was just an eight-line poem, but they still weren't getting it. So we did a quick search and saw pictures about her and her dad, and read about how she lost her father and led this strange isolated life...and they grasped the poem.

This point is also an illustration of the second use of information we observed, which was to support "just-in-time" learning, in other words, the provision of information or instruction at the exact point of time that it is needed. People are much better able to make use of, and remember, information if they receive it at the point of need. In the laptop classes we observed, students frequently gathered information as they needed it in response to current events or topics that arose in lessons. For example, following the East Asian tsunami, students at Nicolas went to CNN.com to gather information about early warning systems.

The third use of online information was in the service of research projects. We witnessed students carrying out a broad range of research projects related to literature, social studies, history, current events, health, and science. For example, a social studies teacher at Fisler explained to us that in the past she would lecture about the bubonic plague, but with laptops students instead investigated the plague online using textual resources and

maps that indicated how the plague spread. They then integrated these online resources into a research presentation.

Similarly, health teachers at Nicolas had their students carry out research projects on tobacco advertising and on school violence. In both of these cases, students made use of a wealth of online information—such as examples of tobacco ads and current data on school violence—that would have been difficult to access through any other means. As the teacher explained to us:

> [Without laptops and the Internet] it would have been hard for students to research because most of that information is either recent or compiled through various agencies and it would have been really, really time consuming to do that research in any other way. I don't think there would have been a way, other than me researching it and printing it out for them.

A total of 82% of the teachers we surveyed agreed that students "get more involved with in-depth research" in the laptop classroom. Our observations confirm that view.

Analyzing Data

A third use of laptops was as a tool for collecting and analyzing data. This principally took place in science and math instruction, as students analyzed data with spreadsheets. It also occurred in social studies instruction, as students created timelines, maps, or charts based on data they found online.

The most interesting example we witnessed of data collection and analysis was at Fisler, which had purchased a set of scientific probes that can be attached to the laptops for gathering and uploading of data related to temperature, voltage, light, force, motion, and chemical composition. In one lesson we observed, students worked in groups to measure each other's heart rates in various states (sitting, standing, jumping) and upload the data to computers where it was plotted into graphs. In the process, they developed and tested hypotheses about the affect of various combinations of activity and rest on heart rate.

Using Multimedia

A fourth use of laptops, and one of the most significant in our minds, was for accessing and producing multimedia. Children in school today have grown up in an era in which they are surrounded by diverse media in their daily lives. They are also growing up in a society where many fields of work require competence with multiple media. Laptops were used frequently in the schools to provide students opportunity to learn from and with multimedia.

The three main ways that students used multimedia were for instruction, interpretation, and production of knowledge. Teachers used multimedia to help students understand difficult concepts, for example, through online access to maps, video, simulations, and audio (thus overlapping with some of the above categories, especially accessing online

information). For example, a science teacher of a sheltered course (in which students need extra English language support) used an online video of protein synthesis and mitosis to help students understand concepts they were having difficulty grasping from their textbooks.

Students in several classrooms used Apple's GarageBand software as an interpretive tool. They worked in teams to compose music that they felt reflected the meaning of a poem, short story, or other reading. Teachers we interviewed felt this was especially effective in helping students think more deeply about what they read. As a teacher at Hermosa explained:

> The laptops really help develop a lot of high thinking skills, more complex analysis. For example, in this GarageBand poetry project, they had to be very thoughtful and think rhetorically. It wasn't a matter of this was the answer to the question, but what was the emotion going on in the poem. Through the project, they thought more deeply about the poem.

The third and most frequent student use of multimedia was for project production. Students frequently used Apple's Keynote or iMovie software for research projects and other creative work, as seen in the following examples:

- Third-grade students at Fisler took a field trip to downtown Fullerton and then produced an iMovie based on the historic sites they visited and photographed. The project allowed them to personalize the historic information and thus better learn it.

- Seventh-grade language arts students at Nicolas created a music trailer in iMovie as an advertisement for a novel they had read. The project required them to interpret the significance and impact of the novel and consider how to communicate that to an audience.

- Fifth and sixth grade students at Hermosa created iMovies on the Bill of Rights. Students worked in groups assigned to one of the ten amendments, with each group creating an iMovie illustrating the underlying concept. This made the Bill of Rights much more meaningful to them than simply memorizing it.

In our prior research projects at non-laptop schools in California, we also witnessed a good deal of multimedia production, albeit usually with presentation software (e.g., PowerPoint) rather than video software (i.e., iMovie). However, since students at those schools only had occasional access to computers, the projects often overly focused on basic computer skills (e.g., how to operate the PowerPoint program). In contrast, in the Fullerton laptop classrooms, children learned the basic computer skills early in the year; in the remainder of the year the projects thus focused more on academic content and communication skills, rather than on learning the software. And when new students transferred into schools, other students assisted them until they caught up with the requisite computer skills.

Interacting with Educational Software

Our fifth category, interactive software to guide students in the development of new knowledge and skills, is one of the earliest educational applications of computers. Examples include science classes that used Cells Alive!, an interactive Website about cells and nuclei, and Froguts, a simulated frog dissection service. A number of classes likewise used BrainPOP, which has a wide variety of interactive instructional material in science, social studies, math, English, health, and technology. Perhaps the most novel interactive software we observed was MY Access!, mentioned in the section on Writing and Revising above, which uses artificial intelligence to grade essays and provide feedback for improvement.

Individual Study

The sixth main use of laptops we witnessed was for individual study. This took place in many ways. For example, students created digital flash cards using Keynote, recorded their homework assignments with the iCal calendar program, took notes with a word processor, and organized and transported their school-related material on their laptops. We will comment on these last two points because they represent important but not often recognized examples of the kinds of enhanced learning made possible in laptop schools.

Learning how to take notes is an important academic skill in preparation for college. In our previous research in traditional K-12 classrooms in California, we had witnessed little emphasis on note-taking in class. In contrast, many of the classes we observed in the current study placed a strong emphasis on note-taking. Laptops seem to facilitate note-taking for several reasons. First, many students prefer to type than write by hand. Second, typed notes are far more legible than handwritten notes. Third, it is much easier to work with typed notes than handwritten notes, for example to revise them or cut and paste them into other documents. Fourth, typed notes maintained on a computer and backed-up on a server are easier to store and access than handwritten notes that may get misplaced or crumpled.

In addition, students greatly valued the utility of their laptop for organizing and transporting their school-related work. A total of 65% of the teachers surveyed said that their students took more initiative outside of class time in the laptop program, and 75% of students said they did more homework since the laptop program started. Interestingly, almost all the students in our sample (some 92%) had at least one additional family computer at home besides the laptop. But they seemed to prefer having one dedicated portable laptop computer for all their schoolwork, and, in some ways, this helped provide a sense of home-school continuity and greater academic identity. As a Fisler parent explained to us in an interview:

> One of the best things about my daughter being involved in the laptop program was the degree of independence and ownership that she developed with her taking

> care of her own work. Traditionally, kids have the binders. They have the organizers that assigned. You sit down at the kitchen table and you do homework under the supervision of mom and dad checking on it. With her laptop, she's able to personalize some of her work, program her laptop. It's hers. She knows it inside and out. She's the one that logs onto the computer. She takes care of her work on her own. It hasn't left parents out of it because she has that desire to share with us, "look at what I've done, look at the project I'm working on." But it's her laptop. She's the one that carries it all. There's just a sense of personalization with her laptop where it's hers. The independence that I've seen in her and her work this year is much better than I thought.

Such individual and personalized study is an often-overlooked benefit of laptop programs, and one that is not easily replicable in other technology-intensive educational environments. Even the best array of shared-use computers, such as laptop carts, or desktop computers in classrooms or computer labs, will not allow students to have what one of our seventh-grade interviewees termed as her own "portable study guide."

Non-Educational Uses

Beyond these educational uses of laptops, there were in addition non-educational uses. These uses largely took place outside the classroom, either at lunch or recess during the school day or at home. For example, some 56% of students reported that they played games on their laptop at least once a week at home, and 57% reported that they listened to music at least once a week at home. To our knowledge, these activities were allowed as long as they did not conflict with any appropriate usage rules (e.g., by downloading music illegally or installing games.)

We sometimes witnessed non-educational uses in our classroom observations, as students took a few moments to visit a non-educational Website to read about their favorite entertainer or sports star or play a game. However, we didn't observe any classes in which this behavior was out of control. Rather, teachers were able to manage and stop this behavior similarly to the way they would stop any other inappropriate behavior by students, such as talking out of turn or passing notes. Altogether, only 12% of the teachers we surveyed agreed with the statement that "there are too many classroom management problems" in the laptop classroom. We should note, though, that a few students indicated in the open-ended questions on surveys that they felt there was too much game-playing taking place in class. That may indicate that, in at least some classes, more game-playing was occurring than we were aware of, perhaps because teachers and students controlled such matters more during our observations.

The main problems of inappropriate usage, though, related to accessing and sharing inappropriate material *outside* the classroom. Although the district had set up a firewall to block inappropriate content access, students' quickly discovered early in the school year that they could access pornography through viewing the "thumbnail" photographs resulting from Google Image searches. When the English-language Google Image site was placed behind the firewall, students demonstrated their creativity by then locating

Google Images in other languages; those too were then made inaccessible. In addition, at the beginning of the year students had the ability to quickly and easily share files with other students throughout the school through a shared folder system. This system was apparently abused once at Nicolas through sharing of pornographic material. Restrictions were then put in place to prevent further such occurrences.

In summary, inappropriate uses occurred but the teachers and administrators in the three schools were able to manage them such that they did not seriously disrupt the overall program.

Opinions of the Laptop Program

Survey and interview data indicate that the laptop program was very well regarded by teachers, students, and parents involved in the program. To the extent there was any dissatisfaction, it was mostly on behalf of students who wanted to see laptops used more often than they were. We will briefly address the opinions of each of the three groups.

Teachers

The overwhelming majority of participating teachers indicated their support for the laptop program. Fully 88% of respondents expressed agreement with the statement, "I recommend that the laptop program be continued at my school." A total of 9% teachers were neutral on this question, and only 3% (representing 1 out of 34 respondents to this question) disagreed. A total of 82% of teachers recommended that other schools adopt similar laptop programs. Teachers viewed numerous advantages to the laptop program, including the fact that it raises student interest in class (84%agreement), that it results in students helping each other more (84% agreement), and that students in the laptop program explore topics in more depth (90% agreement). Teachers also believe that students using laptops produce higher quality work (65% agreement), get more involved in in-depth research (85%), and work harder on laptops (79%). Their main frustration with the laptop program is due to technical problems, with some 59% agreeing that frequent technical problems hinder learning. Of this total, 50% of respondents (17 teachers) moderately agreed with this statement, while 9% of respondents (3 teachers) strongly agreed, suggesting that only a few teachers considered the impact of technical problems to be severe. A large number (79%) also felt that additional typing instruction would help students benefit more from the laptop program. Further details on teachers' beliefs of the advantages and disadvantages of the laptop program are seen in Tables 2 and 3.

Table 2: Teacher responses to "Compare teaching with laptops to your prior experience teaching without laptops."*

	Disagree	Neutral	Agree
Students spend more time giving presentations	10%	16%	74%
Students are more interested in class	6%	9%	84%
Students help other students more	6%	9%	84%
Students explore topics in more depth	3%	67%	90%
Students take more initiative outside of class time	15%	21%	65%
Students' writing quality is better	17%	27%	57%
Students' overall quality of work is better	6%	29%	65%
Students get more involved with in-depth research	6%	9%	85%
Students work harder at their assignments	3%	18%	79%
Students revise their work more	9%	13%	78%
I am better able to individualize instruction	15%	21%	65%
I feel my teaching is more effective	6%	6%	88%

*Non-responses and responses of "not applicable" are excluded from percentage calculations in this and other tables. Responses of "moderately" and "strongly" agree or disagree are added together.

Table 3: Teacher responses to "Do you agree or disagree with the following statements about teaching with laptops?"

	Disagree	Neutral	Agree
I recommend that the laptop program be continued at my school	3%	9%	88%
I recommend that other schools adopt one-to-one laptop programs	6%	12%	82%
Frequent technical problems hinder learning	30%	12%	59%
My students would benefit more from their laptops if they had more typing instruction.	3%	18%	79%
It is difficult to integrate computer activities into my lessons	58%	21%	21%
There are too many classroom management problems	65%	24%	12%
Class periods are too short to take full advantage of laptops	42%	9%	48%

Teachers also believe that the laptop program is beneficial to all groups of learners, whether they are English language learners, in Special Education programs, in gifted programs, considered at-risk learners, or in the general student population (see Table 4).

Table 4: Teacher responses to "For each category of students, please indicate whether you think the laptop program assists their learning."

	Negative: It hinders their learning	**Neutral**	**Positive: It helps their learning**
English Language Learners	6%	22%	72%
Special Education	9%	26%	65%
Gifted	0%	3%	97%
At-Risk	10%	23%	67%
General students: No special needs	0%	10%	90%

Our personal interviews with teachers confirmed this overall positive sentiment, though there was a good deal of variation among individuals. Nearly all teachers we spoke with expressed a positive regard for the program and a belief that it was a good programs for the students, the school, and the district. Some teachers also expressed frustration at the difficulties involved in overcoming technical problems and in learning to integrate laptops into instruction in the face of many other educational challenges.

Students

Data from surveys, interviews, and observations all indicated that students at the three schools' shared teachers' positive evaluations of the laptop program. A total of 74% of students agreed that "schoolwork has been more interesting since we got our laptops" and only 11% agreed with "I would rather not use my laptop." More information on student opinions of the laptop program is included in Table 5.

Table 5: Student responses to "Do you agree or disagree with the following statements?"

	Disagree	**Neutral**	**Agree**
Having a laptop helps me keep organized	7%	18%	75%
I would rather not use my laptop	78%	11%	11%
Schoolwork has been more interesting since we got our laptops	10%	17%	74%
I understand my schoolwork better when we use our laptops	19%	35%	46%
I prefer to write assignments by hand instead of typing them on my laptop	70%	16%	14%
I am more involved in school when I use my laptop	15%	29%	56%
I am more likely to revise/edit my work when I do it on my laptop	9%	17%	73%
I do more school work when I use my laptop	17%	31%	52%
The quality of my school work has improved since I received my laptop	16%	37%	47%

Students' open-ended responses to survey questions about the best aspects of the laptop program and those aspects worthy of improvement provided further detail about their opinions of the program.

When asked about the best things about the laptop program, a considerable number of students commented on the laptop as a study tool. One, for example, said, "The best thing about the laptop program is that I do better in school because I have somewhere to write my notes." Another added, "It helps you be more organized and focused to do your work." A third explained, "The best thing about the laptop program is that all our files are saved and organized."

Other students commented on the value of the online information and research. As one said, "The best thing about the laptop program is that you can go on the Internet to find information." Another added, "The best thing about the laptop program is that we get to do more research…unlike in regular elementary classes, [where] you have to share so many computers and there are not enough."

Other students commented on the value of computer-based project work; their interest in digital audio, photography, and video; the importance to their future of getting experience with technology, and the sheer joy of working with new digital media. This last point was put forth very succinctly by a fifth-grade student at Hermosa who simply said, "Hey, it's a laptop. Doesn't get better than that."

As for their suggestions for improvement, students had very diverse views, ranging from less administrative control (so they could play more games), to more administrative control (so their classmates would not play games), to provision of Internet access at home, and to a desire for lighter-weight laptops.

Parents

We have much less information about parents' views than we do of teachers' and students' views. We did not observe parents in the same way we observed teachers and students at school, nor did we systematically interview parents. We encountered a relatively small number of parents who volunteered at school, attended open house meetings, or took classes at the university. When encountering parents, if time permitted and the parents consented, we sometimes conducted brief impromptu interviews. We cannot consider these parent interviews representative since they were carried out with a relatively select group, and the impromptu nature of the interviews may have led to perfunctory remarks. Nevertheless, the parents that we did speak to were all positive in their remarks about the laptop program.

In addition, we did not conduct our own survey of parents. The school district did conduct a survey, but we do not feel we can draw firm conclusions from it, since it had a relatively low return rate (15.6%) and it was not translated into Spanish or Korean, the main home languages of 24.1% and 20.3% respectfully of the students in the laptop program.

While requiring further confirmation through additional follow-up, the sentiments expressed by parents in both the limited interviews and survey were very positive and closely matched the positive views of teachers and students. For example, on the survey, some 94% of parents agreed that "The laptop has been a benefit to my child," 91% agreed that "My child is able to do more in-depth study with the laptop," and 76% agreed that "Having a laptop has helped my child to be better organized."

A total of 77% who completed the survey also agreed that "I believe the cost of the laptop was worth it to my child" (see Table 6). Support for this point was consistent at the three schools, whether the laptops were paid for by the parents (as at Fisler and Hermosa) or by the district (as at Nicolas). Interestingly, a slightly higher percentage of parents at Nicolas agreed with the worthiness of the cost, but the very low return rate at Nicolas (less than 5%) makes it difficult to make any interpretations of that point.

Table 6: Parent responses to "I believe the cost of the laptop was worth it to my child."

	Disagree	**Neutral**	**Agree**
Fisler (85 respondents)	3%	17%	80%
Hermosa (45 respondents)	11%	14%	75%
Nicolas (27 respondents)	19%	18%	73%
District total (157 respondents)	9%	14%	77%

In summary, the amount of direct data we have available as to parents' views is limited, but what we have suggests that parents share the positive assessment of the program provided by teachers and students.

Attendance, Discipline, and Test Score Data

We now turn to examining quantitative data that may shed light on how participation in the laptop program affected students' behavior and academic performance.

Attendance

Fisler School had a daily seat rate of 98.3%, well over the already-high district average of 96.7% (see Table 7) and highest of any school in the entire district. This is especially impressive in that Fisler was a K-7 school during the 2004-2005 school year (it has since become a K-8 school). Attendance is usually lower in seventh grade than in elementary grades, thus making it difficult for a K-7 school to exceed K-6 schools in attendance rates. This fact, plus the fact that Fisler attendance exceeded that of even demographically similar schools in the district, indicates that high attendance at Fisler is likely due not only to the demographics of the school, but also to other factors, which may include the laptop program. As a new school, no comparative attendance data for Fisler are available for the previous year. In addition, the Fisler attendance data are for the entire school (Grades K-7), rather than just for the laptop program (Grades 4-7), but since the laptop program encompasses the majority of the students in the school, and since no major discrepancies were noted between attendance in the laptop and non-laptop grades, we will assume that attendance of laptop students was also very high.

The Hermosa laptop program encompassed only two classes at the school, and separate attendance records were not made available to us. As attendance is almost always extremely high in the GATE program, we do not expect that there was much room for improvement due to the laptop program.

At Nicolas, seat attendance for the 2004-2005 year was 95.7%, a number that is 1.0% below the overall district attendance rate, but nevertheless .4% higher than seventh grade attendance in the previous year. This represents a small but significant improvement from the previous year, and a slightly greater improvement than that achieved in the district overall.

Table 7: Seat Attendance Rate

	2003-2004	**2004-2005**
Fisler	n/a	98.3%
Nicolas, grade 7	95.3%	95.7%
Entire FSD	96.4%	96.7%

Discipline

Fisler had one of the lowest suspension rates in the district, but comparable data to the prior year are not available, as it is a new school.

Data on suspensions for the laptop program at Hermosa are not available, as the program took place in only two classes.

Nicolas Junior High has two levels of suspension, an in-school suspension to an all-day study hall for minor infractions and an at-home suspension for more serious offenses. The number of seventh-grade students who received each of these types of suspensions fell sharply from 2003-2004 to 2004-2005 (see Table 8).

Table 8: Grade 7 Suspensions, Nicolas

	2003-2004	**2004-2005**
Number of In-School Suspensions	90	76
Number of Out-of-School Suspensions	47	14

Though there may be additional reasons for the fall-off in suspensions, the reduction is great enough, especially in out-of-school suspensions, that we think it reasonable to assume that there is some relationship to the laptop program. Our interviews and observations at Nicolas suggested that students there, as at the other schools, found laptop use very engaging, and we are thus not surprised that students attended more frequently and tended to avoid behaviors that would force them to stay home through suspension.

Test Scores

In general, laptop programs have not been shown to raise standardized test scores. For example, in Maine, even though there was broad public satisfaction with the Middle School program, and the state legislature and Department of Education decided to encourage extension of the program to the high school level, the middle school test scores did not increase following the first two years' implementation. The reasons for this were analyzed by Dr. David Silvernail of the University of Southern Maine, who demonstrated through analysis of curricula and examinations that the kinds of critical thinking, research skills, and in-depth analysis that are promoted in laptop programs are not evaluated by the kinds of questions asked on standardized tests.[1] Writing might be the one subject area in which improved test scores are expected, yet even here there is a conflict, as essay examinations conducted with paper and pencil (as all California state tests are) have been shown to systematically underestimate the writing ability of people who have studied essay writing with computers.

In addition, even if in the long run laptop programs might contribute to raising test scores, it is not likely that would happen in the first year of a program, as teachers, students, and schools go through a learning curve. In the Fullerton School District, for example, the hardware, software, and Internet connections for the laptop program were not fully in place until November 2004, and state tests were conducted in April 2005, leaving only five months for teachers and students to adapt to the new technology. A useful parallel here is the business world, which achieved substantial increases in productivity through introduction of technology, but only after a process of adaptation and organizational learning.

Thus while we would not expect the 2004-2005 laptop program to raise the 2005 test scores in the district, it is nevertheless valuable to examine test scores at the three laptop schools to see if any possible trends can be identified in the relationship of laptop use to test scores.

The most carefully scrutinized test results for California schools are the CST (California State Tests), administered every spring. In order to best approximate the effect of the laptop program on test score performance, we chose to examine CST scores on a "matched cohort basis." In other words, we have compared on a school-by-school basis the CST English Language Arts and Math scores in spring 2005 to the CST scores on the same two tests in spring 2004 for all the students who were in the school district in both years. That allowed us to see how much test scores rose or fell for students in the laptop classrooms compared to how much they rose or fell for students in non-laptop schools or in the district overall. [2]

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[1] Silvernail, D. L. (2005). *Does Maine's middle school laptop program improve learning? A review of evidence to date*. Portland, ME: University of Southern Maine Center for Education Policy, Applied Research, & Evaluation.

[2] In analyzing CST results, we have used what are called "scaled scores," as these provide the clearest numerical way to compare matched cohorts. We note, though, that CST

We have divided this analysis up into two categories, one for grades 3 to 6 and one for grades 7, since most elementary schools in the district go up to sixth grade. The results of this analysis are seen in Tables 9-12, which are included in the Appendix due to their length.

Overall, Fisler had outstanding test scores, especially impressive for a new school. At both the Grade 3-6 and Grade 7 levels, its English language arts and mathematics scores were substantially above district levels and comparable to other top-performing schools in the district. Fisler's grade 3-6 students ranked fifth best (out of 18 programs) in the district in English language arts and second best in mathematics. Fisler's grade 7 students ranked second best (out of 4 programs) in both English language arts and mathematics.

Examining the matched cohort results, Fisler students in grades 3-6 and grade 7 performed better on this year's English language arts and mathematics tests than they did in the previous year. At the grade 3-6 level, their improvement was slightly less than the average improvement in the district. At the grade 7 level, their improvement was greater than the average improvement in the district. We believe that the grade 7 comparison is a fairer one, because the grade 7 students at each of the four junior high schools were new to the school. In contrast, in grades 3-6, the other schools had the advantage of teaching for the most part the same students they had previously, whereas Fisler, as a new school, had to address the needs of students who had previously attended a variety of other schools.

We conducted two analyses for the Hermosa students, one for all 62 students in the laptop classes and a separate analysis for the 53 GATE students in the same classes, for purposes of comparison with other GATE students elsewhere in the district. Both the 62 laptop students and the 53 GATE students had outstanding scores that were comparable to the GATE students overall in the district. Interestingly, the 62 Hermosa laptop students outperformed the district average for grade 3-6 GATE students in English language arts, even though 15% of the Hermosa laptop students did not qualify for the GATE program. As for the GATE students in the Hermosa laptop program, their scores were slightly higher in both English language arts and math than the already high average GATE scores for grades 3-6 in the district.

The matched cohort analyses indicated that the Hermosa laptop students (both in their entirety and the GATE subset) improved in their English language arts scores from the previous year, though not as much as the average improvement of all GATE students in

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scores can also be expressed in terms of five levels of performance standards that are derived from the scaled scores. In particular, the No Child Left Behind Act of 2001 emphasizes the percentage of students who achieve a proficient level of performance or above (equivalent to a scaled score on the CST of 350 or greater), so California schools generally focus their attention on that percentage rather than on the underlying scaled scores.

the district. Hermosa students' scores in mathematics fell from the previous year, both absolutely and in comparison to the district GATE average. Because of the small size of the cohort at Hermosa (62 students), the matched cohort analysis at the school was not found to be statistically significant. In other words, the changes in scores from the previous year may have been due to chance variation, rather than to any instructional effect. (And the percent of matched cohort students who scored at a level of proficient or above in mathematics remained the same in 2004-2005 as in 2003-2004: 98.4%.) Further analysis suggests that the fall in mathematics scores was largely due to one grade level that included only 13 students in the matched cohort group. Interpreting test scores from such a small group with just one teacher is difficult, as the test scores could be due not only to chance variation, but also to learner or teacher behavior that is unrelated to use of the laptops. The scores do highlight, however, the broader point, discussed later in this report, that the district has not yet found the most effective ways to integrate laptops into mathematics instruction.

Consistent with prior years and the school's demographics, test scores at Nicolas were the lowest of the four junior high schools in the district in both English language arts (ELA) and mathematics. Scores for Nicolas seventh graders in English language arts (ELA) fell slightly, while they rose in other junior high schools. In math, Nicolas seventh graders achieved the same average score as they did the year before as sixth graders. At the same time, math scores for their counterparts in the two non-laptop junior high schools fell.

Some attention has been given to the fact that Nicolas's overall Academic Performance Index—based on a combination of CST scores and other scores at both the seventh and eighth grade levels for the school—fell slightly from 2003-2004 to 2004-2005, representing the only school in the district with falling scores. However, API is not the most accurate measure for evaluating the laptop program for at least two reasons. First, API also includes eighth grade test scores, though those students did not participate in the laptop program. Second, almost all the students at any particular grade level change from year to year; the relative strengths and weakness of each incoming wave of students may lead to fluctuations in scores from one year to the next. The matched cohort method eliminates the impact of such variation in cohorts by comparing the performance of this year's seventh graders to the performance of the same students when they were at other schools in sixth grade. The combined results of English language arts and mathematics among the matched cohort indicate that overall performance change for Nicolas seventh graders was on a par with their peers elsewhere in the district.

At the same time, Nicolas students scored a little lower in English language arts when compared to the prior year's seventh-grade cohort. In contrast, Fisler and Hermosa laptop students scored higher in English language arts test scores when compared to the previous year. The slight fall in scores at Nicolas may well be due to many of the implementation challenges there discussed earlier in this report. Analysis of Nicolas test scores in the next one-to-two years, as teachers develop more experience with instructional use of laptops and students gain greater familiarity with computers and keyboarding, will provide a more reliable analysis of the impact of laptop use on student achievement beyond the early implementation stage.

In summary, laptop use was consistent with both high English language arts and mathematics test scores (at Fisler and Hermosa) and relatively low scores (at Nicolas). When comparing how much laptop students improved from the prior year as compared to non-laptop students, no clear pattern emerges, with laptop students improving more than the district average in some combinations of school, grade level, and subject, and improving less than the district average in other combinations. Further evaluation of test scores on a multi-year basis will be necessary to more fully and precisely understand the relationship between laptop use and measurable academic performance.

Finally, we should point out that the district has its own benchmark assessments in addition to the CST. Analysis of the results from those district assessments was beyond what we were able to carry out in this evaluation, but we note that such analysis might shed additional light on the relationship of the laptop program to academic achievement.

Benefits

Finally, we address the overall educational impact of the laptop program in the district. Taking into account our observations, interviews, and surveys, as well as analysis of attendance, discipline, and test score data, we have identified five major benefits of the laptop program and five important challenges for the district to consider as it continues the program. In this section we will discuss the benefits: 21st century learning skills, engagement through multimedia, quantity and quality of writing, deeper learning, and easier integration of technology in teaching and learning.

21st Century Learning Skills

A major goal of the laptop program, and in our view its greatest success, was in promoting "21st century learning skills." These are the types of skills required for success in the information era that we currently live in, and which are quite different than the types of skills needed a generation or two ago. A national coalition of business, educational, and governmental groups has categorized these 21st century learning skills as falling in three areas.[3] *Information and communication skills* include the ability to analyze, access, manage, integrate, evaluate and create information in a variety of forms and media, and the ability to create effective oral, written, and multimedia communication in a variety of forms and contexts, all using today's real-world tools. *Thinking and problem-solving skills* include the curiosity, creativity, and ability to frame, analyze, and solve problems; to make complex and well-reasoned choices; to understand the interconnection among systems; and to investigate, develop, implement and communicate new ideas. *Interpersonal and self-directional skills* include the autonomy and ability to monitor one's own understanding and learning needs, locate and use appropriate resources as necessary, and demonstrate teamwork and leadership in working productively with others.

[3] Partnership for 21st Century Skills. (2004). *Learning for the 21st century: A report and mile guide for 21st century skills.* Available at http://www.21stcenturyskills.org

We found the laptop program, even in its first year, to be successful in promoting each of these types of skills for participating students. In our observations, we frequently witnessed students taking a great deal of initiative, either alone or in collaboration with classmates, to identify problems and tasks and work to solve them, making use of a diverse range of online information and digital media. They then developed high-quality products of the types frequently used in academic and business worlds today, ranging from reports to presentations to video and brochures. From our interviews with teachers and students, it was clear that activities like these were more common in laptop classrooms than non-laptop classrooms. Students were learning valuable new skills in the process.

A project in a third/fourth grade class of mostly GATE students at Hermosa was one of many we witnessed that facilitated the development of 21st century learning skills. As part of the school's focus on service learning, the teacher presented the class with the challenge of helping their second-grade peers prepare for the state math tests. The students used the Internet to investigate the California math standards for second grade. With the assistance of text editing, digital photography, and spreadsheet software, they created games for the second-graders to play to meet these standards. They then used iMovie to produce a video of themselves explaining how to play the game, paying careful attention to craft their message in a way that the younger children could understand.

These types of projects develop a much broader range of self-directional, interpersonal, thinking, problem-solving, information, and communication skills than does the all-too-typical school assignment of reading a passage and being quizzed on it. Such projects are also much more difficult to carry out in a non-laptop classroom.

Students and teachers at all three schools spoke often about the value of new learning. As a Nicolas student commented on the survey,

> The laptop program…gets me more into and interested in technology at an early age, and that is a must because in this high technology world, we cannot survive in the world without knowing how to navigate a computer.

A teacher at Fisler explained it this way in an interview:

> A lot of people say it's the wave of the future. So, I think it's a way to be dynamic. It's a way to offer something that is going to give these children so many opportunities for the future.… The jobs our children are going to grow up and have, have not even been created yet. Because the world is changing so quickly, and we need to get them ready. I think this is a great way to do it.

Engagement through Multimedia

A major problem in today's schools is disengagement, with unsuccessful students tuning out and dropping out. Successful students often pay the minimal attention they need to get good grades but still dislike school and prefer their richer interactions with new media at home.

Students in the laptop classes enjoyed constant access to the information available on the Internet. They thus got a great deal more practice finding, evaluating, and using such information than do students in the typical classroom. They also got a great deal more practice working with and understanding diverse forms of digital media. And they frequently used all this information and new media to create a wide range of quality products.

While there was variation from classroom to classroom and student to student, for the most part we witnessed students who were more engaged with the learning process than in the typical classroom. This undoubtedly had to do with the excitement of working with new media. One of the teachers we interviewed described students as "technology sponges." We found them to be "multimedia sponges," excitedly absorbing all sorts of instruction that involved a combination of texts, images, audio, and video. In some cases the engagement was affective and behavioral, affecting students' level of enthusiasm and their willingness to do schoolwork. We frequently saw students' eyes light up as they began to work on multimedia projects or shared their work with us. In other cases, the higher engagement was also cognitive, as students got more involved in considering or addressing complex learning issues, for example, by interpreting a poem, analyzing the spread of a disease, or critiquing tobacco advertising.

A teacher at Nicolas discussed the greater engagement of her students:

> Last year, I had kids who were very similar, similar attitudes, similar background. They'd come in with that same look on their face, "I don't want to be here. I'm bored. I'm tired of this. I'm only here because my mom, my dad, my counselor, whoever says I have to be here." Those were the kids that I fought with all year long last year. It was like pulling teeth to get them to do anything. But the same type of kid with the same attitude, so to speak, comes in this year and you give them a laptop and you give them enough that it's interesting and their faces changed. Their demeanor has changed in some way. They get very upset when I have a substitute and they can't use the laptops because that's about the only time they don't use it.

Quantity and Quality of Writing

In the information era, writing well is required by many more careers than ever before. And virtually all real-world writing is done on computers. Most of the teachers we interviewed said that most students wrote more than previously. In addition, in response to the statement "I prefer to write assignments by hand instead of typing them on my

laptop," 70% of the students disagreed, compared with only 14% who agreed, a ratio of five to one (see Table 5 above). Furthermore, language arts teachers indicated that feedback and revising were facilitated by the laptops.

A teacher at Hermosa explained the matter thus in an interview:

> They are writing more, it's better quality, it's produced faster. I think the laptops facilitates the writing because there is less fatigue involved with cursive or print, again they have the Internet right there to pull up graphics, they have Apple works drawings to illustrate their stories, so I think the laptop is a great facilitator of writing. I'll give my students prompts to write a short story, and usually before the stories were 2-3 pages, but this year, their short stories are 8-10 pages long.

Laptop use may not immediately result in higher test scores on writing for two reasons: first, there is a mismatch between real-world multiple revision computer-based writing and high-stakes tests of one-time writing by hand, and second, there is a learning curve when first using computer for writing, including learning how to keyboard. But we are convinced that over the long term laptops can play a key role in helping students to become better writers, and we expect that multiple forms of assessment, including writing tests conducted via computer and portfolio assessment, will demonstrate that.

Deeper Learning

Laptops allowed students multiple angles to investigate the same topic. It thus facilitated project-based work that allowed students to dig deeper into the subject matter.

A number of the teachers we interviewed reported a greater emphasis on in-depth research projects than before. The examples of project work we witnessed were impressive. Students and teachers proudly shared their creations with the community at open house events. In addition, students' work frequently crossed disciplinary boundaries, as teachers collaborated on research assignments or as students' own research projects took them in those directions.

An example of deeper learning is found in the many creative projects that language arts teachers did with the story, *Beowulf*, at both Fisler and Nicolas. Seventh-grade students at the schools went on the Internet to investigate what life was like at the time the story was first written. They read and listened to the audio of its Old English versions. They interpreted the story through literary newspapers and student-produced musical compositions. All of these things helped students explore the meaning and significance of *Beowulf* much more than they might have in a traditional classroom.

Easier Integration of Technology in Teaching and Learning

Finally, all of the above was facilitated by easier integration of technology into teaching and learning than in typical classrooms, even one with a good deal of access to technology. Teachers were able to flexibly use technology on a daily basis, without

worrying about having to schedule a computer lab or mobile laptop cart. A Fisler teacher explained to us the difference between teaching in a one-to-one laptop school and teaching in a school with shared laptops on a mobile cart that could be reserved on a weekly basis:

> The difference is huge. Before, if you look at your week, and my day for laptops was Wednesday, in that setting you had to throw everything else out on Wednesdays because I've got my laptops here today. If you don't start and finish something, it's going to be another week before you get the laptops back. And you don't know what happens to those computers during the rest of the week. There were cases where kids dumped files. Maybe you had a student that didn't finish something. The next week they get that computer, and their stuff is gone.
>
> [Now] being at this school and being equipped with laptops with the students, it really gives me an opportunity to allow them to do so much more than they could have if we were just sharing computers. They can write on computers every day, not just once a week. They're able to do the research on their own. Not only can they do it at home, a lot of them don't have the excuse that they don't have a computer at home. Being in the classroom you don't have to wait for one another, we just have our own computers. So in terms of using it to obtain my goals—they are given so much more opportunity to do so much more incorporating computers, using iMovies, Keynotes, all of that, and it makes learning really fun for them and exciting for them. So they really enjoy it as well as I do.

Laptops also provided much greater opportunity to individualize instruction, as students had a wider range of learning material to choose from for more individualized assignments. For example, a third grade teacher at Fisler regularly developed a "Tic Tac Toe" worksheet of nine learning activities to follow up on reading assignments. The learning activities made use of educational Websites and software to address a range of reading, writing, and language skills required by California state standards. Students worked at their own pace on these activities in a way that could only be carried out with an Internet-connected computer for each child.

Students gained a great deal from having their own personal computer as opposed to sharing computers in the classroom or laboratory. They could keep their own notes on their laptop and refer back to them as necessary, create study materials and access them, and keep and organize all their files for ongoing work at school and home. One Nicolas student explained the benefits in this manner:

> I think that the best thing about the laptop program is that you can take your laptop home and use it there. I think that it makes it a lot easier to do your homework and to do either the project or to do research. It has made most of my schoolwork and homework a lot easier to do and to complete. It describes clearly how and what to do. I love the laptops, I really do.

Before leaving the topic of benefits, we want to make clear that we did not find the laptops to be a panacea. The above advantages reflect general trends that we noted in the laptop classes, but the actual benefits varied from classroom to classroom and student to student. The laptops in and of themselves did not bring about any miraculous transformations, but they did prove to be an effective tool for facilitating improved teaching and learning in the ways described above.

Challenges

Though our overall evaluation of the laptop program is positive, we also note five important challenges the district faces as it continues and expands the laptop program. These involve technical support, scheduling and implementation, teacher development and collaboration, mathematics instruction, and financing and community support.

Technical Support

The strong majority (80%) of teachers indicated that the technical support they receive is either excellent (37%) or good (43%). Nevertheless, a number of teachers, especially at Nicolas, pointed to technical problems as hindering implementation of the laptop program. These included hardware, software, and network malfunctions. As a teacher at Nicolas told us,

> Breaking down [is a big problem]. They don't have enough loaners. They don't have enough quick support... I'm learning a lot on how to fix some of the things for the kids. I can do a lot, but then there are certain things that I cannot do, so I have to send them over to get [help]. The kid's gone all period long and comes back at the end and they still don't have their computer back. Now, they've missed one class time and they will not have a computer for probably four to seven days. That's consistently happening and we're seeing more towards the end of the year than at the start of the year.

The involvement of student interns in technical support is one way to address this problem. Nicolas, for example, has an excellent "SWAT" program (Students Willing to Assist with Technology), and the expansion of this and similar programs at Nicolas and elsewhere can help address technical problems, while also providing technical training in computer trouble-shooting to interested students. Beyond this, additional loaner computers would probably be helpful to minimize the disruption from breakdowns. As teachers and students become more familiar with the laptops, it is expected that they will be able to solve more problems directly in the classroom and thus require less technical support. However, increased self-sufficiency in the ability to resolve technical difficulties within the classroom may be offset by increasing rates of hardware failure as equipment ages.

Scheduling and Implementation

A number of teachers commented on the difficulty of integrating laptops in instruction during short junior high school periods. As a teacher at Nicolas told us, commenting on the time pressures faced regardless of presence of absence of laptops, "In a 44-minute period, by the time I've taken role, collected homework, talked to them about yesterday's lesson, you're only looking at maybe 25, 30 minutes of a lesson," which leaves little time for the kinds of autonomous and integrative project work and research activities that work well with laptops. In response to this challenge, both Fisler and Nicolas decided to implement block scheduling this year in part of their educational program. This is an excellent idea and is consistent with effective use of laptops in Maine, which features statewide use of laptops, test scores among the highest in the country, and highly flexible block scheduling arrangements.

For the same reason, the district's decision to pursue further implementation of the laptop program at the sixth-grade level is sound. Many educational technology specialists used to consider junior high the ideal level for integration of laptops. But with children becoming much more technology-savvy and software becoming much more user friendly, elementary school students can now make effective use of laptops, as evidenced at both Fisler and Hermosa this past year. (Indeed, at Fisler, where the program was carried out from grade 3 last year, there was agreement among the administration, teachers, and parents that it should be started even earlier, and the program was thus launched in the school's second grade classes this year, as well as one combined first-second grade class.) Implementation at the sixth-grade level will be facilitated by the more flexible scheduling at that grade than in junior high.

In addition, implementation at the sixth-grade level will help avoid some of the problems that occurred this year at Nicolas, where a single school had to integrate a new laptop program for more than 500 students. Implementation at elementary schools should go more smoothly, due to the small size of the sixth-grade cohorts at each school (and taking advantage of the learning experiences of the first three schools, as well as a lengthier lead time for planning). If the district later decides to implement at the remaining district junior highs after a sixth-grade implementation, such eventual junior high implementation will be facilitated by the fact that students will enter seventh grade with prior laptop experience.

Teacher Development and Collaboration

Teachers we spoke with greatly valued the training sessions they had and the majority (57%) indicated that the instructional support they receive is either excellent (14%) or good (43%). Most of those interviewed also commented positively on training sessions they attended. Not surprisingly, though, most indicated they would like to have even more instructional support in integrating laptops into instruction. One way of fulfilling the need for instructional support is through formal and informal collaboration among colleagues. At Fisler, for example, regular grade-level meetings proved very helpful in developing and addressing instructional challenges with laptops. At Nicolas, with a large

number of teachers at a single grade level, formal and informal interaction generally took place by subject matter rather than by grade. At both schools, architecture often facilitated collaboration, with teachers interacting most frequently with those nearby their room. The value of geographic proximity in sharing knowledge should be kept in mind as the laptop program expands.

New block scheduling arrangements such as those discussed above may also heighten such teacher collaboration, if they are used to create special programs within a school in which all the students share the same teachers. In addition, greater forms of collaboration across schools can be sought, with teachers at one school having additional opportunities to network with teachers from other schools. In general, follow-up professional development beyond the initial training needs to focus largely on how to integrate technology into instruction rather than on basic software operation.

Mathematics Instruction

In the classrooms we observed, there seemed to be a natural match between use of laptops and instruction in language arts, social studies, and science. In each of these subjects laptop use supported well the kinds of writing and research required by the curriculum. In contrast, the fit with mathematics instruction was more difficult. The online math software program used by the district, Larson Math, was not particularly popular with teachers, and both teachers and students indicated that the laptops were infrequently used for math. The one exception to this pattern was in a third/fourth grade class at Hermosa, where laptops were used in supplementary math projects, such as the one involving developing a game to teach basic math to second graders (described above). But such projects were sometimes focused more on developing broader skill sets, such as self-directed learning, project planning, communication, critical thinking, technological proficiency, and the ability to apply knowledge to everyday life, than on mathematical knowledge itself. Project work thus needs to be balanced with instruction that prepares students for the kinds of proficiencies required on high-stakes math tests.

No easy solutions exist to this challenge, as researchers in the two largest laptop programs in the U.S., in the state of Maine and in Henrico County, Virginia, have also found that math is the subject in which laptops are least used. Part of this is due to the nature of mathematics instruction and assessment in the U.S., which emphasizes discrete calculations rather than broader problem solving. The district may want to pilot a couple of different software programs for teaching mathematics with laptops to better evaluate alternatives. Several such programs are under development at U.S. universities and are likely available for piloting. In addition, interdisciplinary math-science projects involving challenging numerical and problem-solving skills provide another possible use of laptops. In the interim, it should be recognized that integrating laptops into mathematics teaching is a complex task, and math teachers should be given latitude as to when, how, and how much they choose to use laptops.

Financing and Community Support

Probably the biggest challenge the district faces is in the area of finances. On the one hand, the laptop program is proving thus far to be successful and the district would like to extend it to as many students as possible. Unfortunately, California finances are such that a laptop program based entirely on public funding is not likely in the near term.

In budgeting, the district needs to continue considering the total cost of ownership, which includes not only hardware but also software, network connections, maintenance, and training. Fortunately, year-by-year, the falling costs of laptops will gradually lessen the financial burden for hardware. Over time, cost savings may be generated through higher attendance rates, fewer disciplinary problems, a reduction of space and equipment needed for computer labs, and eventually a reduction in text book expenditures as more learning materials become available online.

In the meantime, the district is attempting to address the substantial financial challenge by relying on a combination of parent, district (e.g., via Title I), and community (e.g., local business) support for the laptop program. It seems to us that this approach is sound if the district is able to guarantee that all children can participate regardless of parental contribution. The program should be expanded at a rate consistent with this goal and no faster. In addition, whatever the source of financing, significant amounts of time and energy and are required to obtain and manage it, and the district needs to take this into account in its program planning.

The issue of financing is closely tied to the issue of community support. The success of the program to date, especially at the two schools where families paid for the laptops, has been made possible by broad parental support for the program. Close communication with parents, city officials, and local and county businesses will be essential for continuing to maintain and develop the community support necessary for expansion of the program. The district Website, parent meetings, newsletters, business and/or community advisory boards, and public events demonstrating how children learn with technology can all be used to further communication and collaboration.

Conclusion

In 2004-2005, the Fullerton School District launched a one-to-one laptop program at three of its schools. Implementation of the program was very smooth at two of the three schools and more challenging at the third. All three schools achieved important educational benefits, including better promotion of 21st century learning skills, greater student engagement through use of multimedia, greater quantity and quality of writing, deeper and more complex learning, and improved integration of technology in instruction. At the same time, the district faces a number of challenges as it continues to expand the program, including ensuring sufficient technical support, rethinking junior high single-period scheduling, seeking ways to better integrate laptops in mathematics instruction, assisting ongoing teacher professional development, securing sufficient

funding so that participation in the program is not an undue burden to any families, and continuing to develop support and collaboration from parents and the community.

The stakes involved are high, as they potentially affect not only the education of children currently in the district, but also future children in the district, and even children elsewhere in California as government, business, and educational leaders take note of this important and ambitious program. Parents, local businesses, community members, and school district officials are encouraged to work together to continue making the program a success.

About the Evaluators

Dr. Mark Warschauer is Associate Professor of Education and Informatics at the University of California, Irvine, and the Associate Director of the university's Ada Byron Research Center for Diversity in Computing & Information Technology. Dr. Warschauer is the author or editor of seven books on technology in education that have been published by MIT Press, Cambridge University Press, and other academic publishers. His books have been translated and published in Chinese, Japanese, and Portuguese. His more than 100 scholarly papers have appeared in a wide variety of outlets, including *Scientific American*. He is currently writing a book on laptops and learning to be published by Teachers College Press of Columbia University.

Douglas Grimes is a Ph.D. student in Information & Computer Science at the University of California, Irvine. His research on technology in education has been funded by the National Science Foundation and the U.S. Department of Education.

Dr. Warschauer and Mr. Grimes were assisted in this evaluation project by the following researchers:

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- *Kurt Suhr*, Principal, Newport-Mesa Unified School District, and Student in Doctorate of Education Program
- *Michelle Rousseau*: Ph.D. Candidate in Information & Computer Science
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Appendix: Test Score Data, California Standards Test

Table 9

Grades 3-6: English Language Arts					
School	**Scaled Score 04-05**		**Scaled Score 04-05, Matched Cohort Students**	**Scaled Score 03-04, Matched Cohort Students**	**Change for Matched Cohort Students from 03-04 to 04-05**
Acacia	378.6		379.2	371.1	+8.1
Beechwood	379.8		379.6	361.8	+17.8
Commonwealth	316.9		319.9	318.0	+1.9
Fern Drive	358.7		357.9	349.4	+8.5
Golden Hill	365.9		368.6	362.5	+6.1
Hermosa	367.8		374.0	362.0	+12.0
Laguna Road	402.8		405.9	396.8	+9.1
Maple	310.5		311.9	306.9	+5.0
Orangethorpe	321.8		322.7	316.1	+6.6
Pacific Drive	318.7		320.5	311.9	+8.6
Raymond	342.4		340.4	330.9	+9.5
Richman	309.8		309.4	304.7	+4.7
Robert C. Fisler	***371.5***		***374.3***	***370.1***	***+4.2***
Rolling Hills	354.2		358.1	349.8	+8.3
Sunset Lane	373.5		377.4	368.1	+9.3
Valencia Intermediate	320.4		322	311.4	+10.6
Valencia Primary	296.9		302.1	311.2	-9.1
Woodcrest	314.1		315.9	304.4	+11.5
District total (all grade 3-6 students in district)	***345.6***		***347.3***	***339.5***	***+7.8***
Hermosa (students in laptop classes)	***433.8***		***434.5***	***432.3***	***+2.2***
Hermosa (GATE students in laptop classes)	***434.1***		***435.2***	***433.0***	***+2.2***
District GATE total (all GATE students in grade 3-6 in district)	***429.6***		***429.5***	***423.3***	***+6.2***

Table 10

Grades 3-6: Mathematics					
School	**Scaled Score 04-05, Unmatched**		**Scaled Score 04-05, Matched Cohort Students**	**Scaled Score 03-04, Matched Cohort Students**	**Change for Matched Cohort Students from 03-04 to 04-05**
Acacia	408.6		409.0	398.0	11.0
Beechwood	408.7		407.8	377.0	+30.8
Commonwealth	331.3		334.2	327.2	+7.0
Fern Drive	378.3		374.5	356.5	+18.0
Golden Hill	373.5		376.3	370.4	+5.9
Hermosa	391.3		401.9	388.8	+13.1
Laguna Road	440.5		444.2	429.2	+15.0
Maple	327.9		329.3	312.6	+16.7
Orangethorpe	331.4		331.9	331.5	+0.4
Pacific Drive	330.3		331.1	311.6	+19.5
Raymond	363.8		363.7	344.7	+19.0
Richman	324.6		323.2	307.7	+15.5
Robert C. Fisler	***411.4***		***407.9***	***394.9***	***+13.0***
Rolling Hills	357.8		361.2	358.2	+3.0
Sunset Lane	400.0		401.9	389.5	+12.4
Valencia Intermed.	326.1		328.0	304.2	+23.8
Valencia Primary	335.4		341.6	325.7	+15.9
Woodcrest	318.9		335.2	313.4	+21.8
District total (all grade 3-6 students in district)	***364.8***		***365.8***	***351.9***	***+13.8***
Hermosa (students in laptop classes)	***474.6***		***473.2***	***483.9***	***-10.7***
Hermosa (GATE students in laptop classes)	***477.8***		***476.4***	***487.4***	***-11.0***
District GATE total (all GATE students in grade 3-6 in district)	***476.8***		***475.7***	***464.6***	***+11.1***

Table 11

Grade 7: English Language Arts					
School	**Scaled Score 04-05**		**Scaled Score 04-05, Matched Cohort Students**	**Scaled Score 03-04, Matched Cohort Students**	**Change for Matched Cohort Students from 03-04 to 04-05**
Ladera Vista	351.7		352.5	348.9	+3.6
Nicolas	***311.3***		***314.3***	***316.8***	-2.5
Robert C. Fisler	***373.5***		***373.0***	***365.2***	+7.8
Russell Parks	382.0		382.8	373.5	+9.3
District total (all grade 7 students in district)	***347.8***		***349.4***	***346.0***	+3.4

Table 12

Grade 7: Mathematics					
School	**Scaled Score 04-05**		**Scaled Score 04-05, Matched Cohort Students**	**Scaled Score 03-04, Matched Cohort Students**	**Change for Matched Cohort Students from 03-04 to 04-05**
Ladera Vista	338.4		340.0	349.3	-9.3
Nicolas	***312.7***		***314.8***	***314.8***	0.0
Robert C. Fisler	***378.0***		***372.2***	***368.2***	+4.0
Russell Parks	380.8		380.6	386.3	-5.7
District total (all grade 7 students in district)	***344.4***		***345.0***	***349.4***	***-4.5***