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Implementing Reading and Mathematics Software

Prepared by:

Barbara Means
Robert Murphy
Linda Shear
Torie Gorges
Paul Hu
Willow Sussex

Center for Technology in Learning

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Abstract

Prior technology implementation research has identified school and classroom practices associated with more extensive use of technology. These practices have been promoted on the basis of a logic model that assumes that greater technology use will enhance student learning. Findings from the recent national randomized field trial of the Effectiveness of Educational Technology Interventions (EETI) call this logic model into question, at least for the kinds of reading and mathematics software included in that study and for the learning outcomes captured by standardized achievement tests. Further research is needed to understand the highly variable effects of software implementation and what constitutes *appropriate* software use in ways that support learning. This study explored software implementation issues through case study of a subset of the schools participating in the EETI experiment. Interviews and observations focusing on school and classroom implementation practices were conducted with staff from schools where teachers using reading or mathematics software with their students had attained above-average achievement gains and from schools where software-using teachers had below-average gains in their first year of software implementation. The qualitative data point to the importance of school practices in the areas of principal support and teacher collaboration around software use and of teacher practices concerning classroom management and use of software-generated student performance data. The issues of instructional coherence and competition for instructional time are highlighted as challenges to software implementation.

Contents

Exhibits

1. Introduction

During the last two decades, the United States has made a major investment in technology for elementary and secondary schools. In school year 2003-04, for example, the local, state, and federal investment in K-12 technology was estimated as $7.87 billion (Quality Education Data, 2004). By 2005, the federal government was funding more than a third of the costs of bringing technology to America's schools, a significantly higher share than the federally funded portion of elementary and secondary education costs generally.[1] Many of the individual states have also made significant technology investments in both infrastructure and teacher training for technology integration (Education Week, 2005).

Over the past five years, the use of educational technology in schools has been influenced strongly by the accountability environment created by No Child Left Behind (NCLB). NCLB's focus on year-to-year achievement gains in literacy and mathematics for all student groups has spurred many districts and schools to consider reading and mathematics software as potential tools for attaining adequate yearly progress. The effectiveness of this kind of software was evaluated in the congressionally mandated national experiment on the Effectiveness of Educational Technology Interventions (EETI), which examined the effects of reading software for students in grades 1 and 4 and of mathematics software for students in grade 6 and algebra classes (Dynarski et al., 2006). The present study is intended to complement that research by providing qualitative data on the way in which reading and mathematics software is implemented by teachers whose students made above-average achievement gains.

EETI data were used to identify schools that were above and below the mean in terms of achievement gains during teachers' first year of using mathematics or reading software. Follow-up interviews were conducted with staff at 13 schools continuing to use the software they had implemented as part of the EETI study, 7 schools that were above average in terms of achievement gains and 6 that were below average.

The collection and analysis of qualitative data were guided by two core research questions:

- What school-level practices are associated with higher achievement gains in classrooms using reading or math software?
- What classroom-level practices are associated with higher achievement gains in classrooms using reading or math software?

[1] Federal supports for technology use (including Internet connectivity) were roughly $2.8 billion in FY 2005 (SRI, 2006).

In addition, the following secondary question was addressed in the follow-up case study work:

- How do software implementation practices change over time?

The next section of this report describes the research basis for commonly recommended technology implementation practices. Section 3 describes the follow-up data collection in 13 schools. Section 4 presents the case study findings, highlighting the differences in implementation practices between those schools in the follow-up sample that had demonstrated above-average gains in Year 1 of the EETI study and those with below-average gains. The final section of the report recaps major themes emerging from the fieldwork and presents implications for practice.

2. Background Research

Prior research on technology implementation guided the development of data collection instruments for both the EETI study and the case study work described here. We briefly review prior research to provide the reader with a sense of (1) the implementation issues that those working in educational technology research and practice generally view as important and (2) the limitations of the empirical research base for what have become generally accepted “best practices” in technology implementation.

In addition to the principles for good practice in technology implementation found in the research and professional development literatures, we also drew on the recommendations that software vendors with products in the EETI study made concerning how their software products should be used. The 15 vendors distributing the software products included in the EETI experiments were asked to specify an implementation model for their software, and the elements of these models were documented as part of the national experiment. Exhibits 1 and 2 enumerate recommendations for what schools and classroom teachers, respectively, should do to implement instructional technology well. Examples of sources recommending each practice are noted in the second column of each exhibit.

For each of these recommendations, we examined research citations used to justify the implementation practices in articles that recommended them and solicited relevant research articles from several researchers in the field. In addition, we conducted a formal search of peer-reviewed journal articles published from 1991 to 2006. The formal literature search used two major educational databases (ERIC and PsychInfo) to identify empirical studies with a control group design that tested effects of the recommended implementation practices. The database searches used three types of search terms: (1) technology terms (e.g., computer, technology, software, educational technology), (2) implementation terms (e.g., implementation, adoption, use, context, contextual factors), and (3) study design terms (e.g., empirical, experiment, experimental, quasi-experimental, control group, treatment).

As we reviewed research citations from the database searches, it became clear that experimental and quasi-experimental studies of educational technology implementation are scarce within peer-reviewed journals. When controlled studies of educational technology are published, they are generally comparisons of conditions with and without technology, rather than comparisons of different implementation practices.

Whether identified through the formal search, citation, or expert recommendation, all studies were classified in terms of their dependent variable (amount of technology use or student learning outcome) and the nature of their design. (Case studies and surveys were classified as correlational; quasi-experiments and true experiments were classified as "controlled studies.") The third and fourth columns of Exhibits 1 and 2 list studies supporting each implementation practice on the basis of a correlation with the amount of technology use (column 3) or with student learning outcomes (column 4). Column 5 lists control group studies using an experimental or quasi-experimental design to test the effects of these practices on learning outcomes.

A review of the exhibits shows how few studies in this area have used a control group design to test the effects of a technology implementation practice. Only one such study, testing the effect of teacher facilitation of software use, was found in the literature (Powell, Aeby, & Carpenter-Aeby, 2003). An examination of the broader research base of survey and case study research on technology implementation identified a few correlational studies examining the relationship between a limited number of implementation variables and achievement outcomes (Cavalier & Klein, 1998; eMINTS Evaluation Team, 2003; Mann, Makeshaft, Becker, & Kottkamp, 1998; Wenglinsky, 1998). In general, however, it appears that the empirical basis for recommending technology implementation practices is the observed link between practices and more technology use, rather than demonstration that they improve student learning.

Prior Research on School-Level Implementation Practices

Both researchers and practitioners generally recommend a set of schoolwide implementation practices with respect to educational technology (Exhibit 1). These tend to fall into four categories:

- Coherence between technology uses and schoolwide vision and programs
- Teacher training in technology
- Technology access
- Support for technology use

Recommendations designed to make technology practices consistent with, and a key contributor to, a school's overall goals for instruction and improvement include (1) using a broad schoolwide vision of instruction, rather than technology capabilities, as the starting point for planning, (2) aligning the technology with the local curriculum, and (3) principal support for technology integration (in the form of supported time for teachers to learn to use technology, scheduling conducive to technology use, recognition for technology-using teachers, etc.). In a series of case studies of nine pioneering technology-intensive schools, Means and Olson (1995) found that establishing close connections between technology uses and broader instructional goals was a common theme. In today's accountability environment, integration of technology use with school goals is likely to be described as a need to align school instructional practices, including the use of technology, with content and performance standards. Principals have been identified as important players in fostering this integration and alignment. Surveys of teachers have found that teachers who

Exhibit 1. Recommended School-Level Instructional Technology Practices

Recommendation (1)	Recommended by (2)	Prior Research Support for Practice: Correlation with Technology Use (3)	Correlation with Learning Outcomes (4)	Controlled Studies on Technology Use (5)
Schoolwide Coherence				
Technology use integrated with a consistent schoolwide instructional vision	Barnett (2002) Means & Olson (1995) OTA (1995)	Means & Olson (1995)		
Technology aligned with local curriculum	Barnett (2002) Ertmer (1999) Sarama et al. (1998) Sweet et al. (2004)			
Principal demonstration of support for technology integration	Brand (1997) Coley et al. (1997) OTA (1995)	Mann et al. (1998) O'Dwyer et al. (2004, 2005) Zhao et al. (2002)		
Teacher Training				
Teachers trained on concepts of student-centered teaching and technology integration	Barnett (2002)	Becker (1994, 2000) Mann et al. (1998) O'Dwyer et al. (2004, 2005) Zhao et al. (2002)	eMINTS (2003) Wenglinsky (1998)	
Teachers trained on implementation of the specific software/innovation	EETI vendors	Becker (1994) Mann et al. (1998) U.S. Department of Education (2000)	Mann et al. (1998)	
Professional development is ongoing, not one-time	Brand (1997) Jones et al. (1995) OTA (1995)	Adelman et al. (2002) Becker (1994) U.S. Department of Education (2000)		
Technology Access				
Computers/Internet accessible in regular classrooms	Barnett (2002) Mann et al. (1998) OTA (1995)	Becker (2000)	Mann et al. (1998)	
Adequate access to technology for all students	Barnett (2002)	O'Dwyer et al. (2004, 2005)		
Support for Technology Use				
Technical support available at the school	Barnett (2002) Sweet et al. (2004)	Becker (1994) Zhao et al. (2002)		
Teachers collaborate around technology use	Brand (1997)	Becker (2000) Means & Olson (1995) Zhao et al. (2002)		

report that their principals encourage and support technology use are more likely to use technology in instruction (Mann et al., 1998; Zhao, Pugh, Sheldon, & Byers, 2002).

The importance of teacher training and professional development for the use of technology to support instruction is also a prominent theme both in the educational technology literature and in state and federal policy. Analyses relating teacher professional development in the use of technology to National Assessment of Educational Progress (NAEP) scores in mathematics found positive associations between teachers' receipt of technology professional development and their students' math achievement (Wenglinsky, 1998). Beyond the need to train teachers on the specific technologies or pieces of software they are expected to use, there is considerable emphasis on training teachers on general concepts of instruction with technology.

A number of large-scale teacher surveys have suggested a relationship between teachers' belief in student-centered pedagogy and frequent use of technology in their classrooms (Becker, 2000; Mann et al., 1998; Zhao et al., 2002). The conventional wisdom is that when technology is brought into the classroom, students become actively engaged in working with it as opposed to passively listening to a teacher lecture. Teachers are encouraged to think of themselves in a new role as a coach or facilitator for student learning rather than as the "sage on the stage." In the survey conducted by Becker (2000) and his colleagues, teachers whose survey responses were indicative of constructivist beliefs were also more likely to report having students use the Internet. Mann et al. (1998) reported that constructivist ideas about teaching were more common among teachers who reported the highest confidence in their computer skills and the most time using computers in class. Similarly, O'Dwyer, Russell, and Bebell (2004, 2005) reported that teacher-directed student use of technology was more prevalent among teachers who believed in student-centered instruction. This relationship between teacher belief in constructivist pedagogy and frequency of technology use with students has stimulated the promotion of professional development stressing constructivist or student-centered approaches to technology implementation (Barnett, 2002). A technology integration program stressing professional development on the integration of technology and inquiry-oriented instruction in Missouri schools found a relationship between implementation of the trained practices and fourth graders' scores on standardized tests (eMINTS Evaluation Team, 2003).

Like the recommendations in the teacher professional development literature more generally (U.S. Department of Education, 2000), the educational technology literature calls also for professional development that is ongoing rather than a one-time teacher workshop. The survey results reported by Becker (1994) and Adelman, Donnelly, Dove, Tiffany-Morales, Wayne, et al. (2002) both suggest a relationship between receipt of ongoing professional development on technology use, especially through school-based informal interactions, and teachers' frequency of using technology with their students.

Access to hardware, software, and network connections is clearly a precondition for instructional use of technology. Many observers have pointed out that merely having the equipment or Internet connection in a school is insufficient if it is not easy for teachers and students to get to the technology when they want to use it. A number of technology advocates recommend having computers in regular instructional classrooms, as opposed to in computer laboratories, on the assumption that the greater ease of access will lead to more integration between computer-based and other instructional activities. Becker (1994, 2000) has reported survey data showing a strong relationship between the amount of technology equipment teachers have in their own classrooms and the frequency with which they have their students use technology.[2] In terms of the relationship with achievement, Mann et al. (1998) found greater gains in the West Virginia schools using basic-skills drill-and-practice software in regular classrooms rather than in computer labs.

The literature on school supports for technology use advocates both supports for the technical aspects of using hardware, software, and networks and supports for handling the instructional issues posed by technology integration. A number of observers have asserted that someone who can offer technical assistance needs to be on the school staff to be available when needed. In teacher surveys (Becker, 1994; Zhao et al., 2002) those teachers who reported making frequent use of technology were more likely than other teachers to report having technical support staff within their schools. Although the availability of on-site technical support appears to be important, teachers responding to surveys have indicated that the availability of someone who can help them with the pedagogical (as opposed to the strictly technological) aspects of technology integration is even more important (Adelman et al., 2002). A related practice—collaborating with one's teaching colleagues around technology implementation—has been associated with frequency of technology use in both case studies (Means & Olson, 1995) and surveys (Adelman et al., 2002; Becker, 2000; Zhao et al., 2002).

Prior Research on Classroom-Level Implementation Practices

In addition to the school-level practices supporting technology use described above, the research literature contains recommendations regarding how teachers should integrate software and other technology tools into instructional activities in the classroom. These are shown in Exhibit 2 along with supporting case study and correlational research.

Developers of instructional software and integrated learning systems make the point that their product must be used to have an effect. Van Dusen and Worthen (1995) have argued that the small or negligible effects found in some implementations of integrated learning systems are unsurprising given the low level of use (with 15% to 30% of vendors' recommended use levels being typical). In both Wenglisky's (1998) analysis of NAEP math scores and the study of computer-assisted reading and mathematics instruction in West Virginia by Mann et al. (1998), higher levels of technology use were correlated with higher achievement outcomes. In the EETI study, greater usage levels were associated with

[2] Multiple interpretations of this relationship are possible. It could be that the teachers who want to use the technology more intensively with their students lobby to get the equipment in their classrooms.

Exhibit 2. Recommended Classroom-Level Instructional Technology Practices

Recommendation (1)	Recommended by (2)	Prior Research Support for Practice		
		Correlation with Technology Use (3)	Correlation with Learning Outcomes (4)	Controlled Studies on Learning Outcomes (5)
Integration of technology with learning goals and offline learning activities	EETI vendors	Becker (1994) Means & Olson (1995)	Wenglinsky (1998)	
Technology used frequently	EETI Vendors Van Dusen & Worthen (1995)		Mann et al. (1998) Wenglinsky (1998)	
Teacher present and facilitates learning when technology is used	EETI vendors	Sandholtz et al. (1997)		Powell et al. (2003)
Teacher reviews software reports	EETI vendors			Powell et al. (2003)
Efficient routines established for shifting in and out of technology use (classroom management)	Coley et al. (1997)	OTA (1995)		
Explicit motivational strategy to promote software use	Some EETI vendors			
Low student-to-computer ratio in classroom	Barnett (2002) Glennan & Melmed (1996) OTA (1995)	O'Dwyer et al. (2004, 2005)	Cavalier & Klein (1998)	

greater effectiveness in the Grade 4 reading experiment but not in the other three experiments (Dynarski et al., 2006).

Beyond sheer amount of use are issues concerning the way technology is used in the classroom. Teachers are encouraged to use technology not for its own sake but to support specific instructional goals, with a tight coupling between learning activities conducted with and without technology resources. Both Becker (1994) and Means and Olson (1995) reported that when this was done, teachers used technology with their classes more frequently. Wenglinsky (1998) reported that math teachers who used technology to support higher-order learning goals had students with higher math achievement.

Software vendors encourage teachers to be actively involved in the implementation of software with their students. Nearly all the vendors with products in the EETI experiments said that the regular teacher should be present when their software is used, even if it is being implemented in a computer laboratory, and that the teacher should be available to encourage students and offer assistance as they work with the software. Further, software vendors recommend that teachers regularly access the student performance reports generated by the software and use these reports to make decisions concerning students requiring extra assistance, needed modification of the software sequence, or other interventions to attain desired learning outcomes. A quasi-experimental study by Powell et al. (2003) compared conditions where software was implemented with and without strong teacher facilitation, which included frequent review of software reports. This study found higher end-of-course grades for students in the condition with teacher facilitation (but lacked a pretest measure of achievement to establish group equivalence).

A number of observers have noted the challenges that technology can raise for classroom management. Mann et al. (1998) found that 13% of teachers in their survey said that computers make classroom management more difficult. Sandholtz, Ringstaff, and Dwyer (1997) found that experienced teachers felt that their classrooms were significantly altered by the addition of computers in ways that raised new classroom management challenges. Teachers reported having to cope with new types of student behavior challenges (copying each other's work more easily, being more adept than the teacher on the computer), changes to their physical environment, and a new definition of their role in instruction, all of which necessitated reconfiguring their routines. Establishing strategies and routines for handling these challenges appears to be a correlate of extensive technology use (OTA, 1995).

Finally, technology access is a concern at the level of the classroom, as well as in the school as a whole. A rule of thumb arising out of practice is that there should be no more than five students per classroom computer to allow each student ample opportunity for technology use (Glennan & Melmed, 1996).

This brief review of the technology implementation literature provides a summary of the practices considered important by researchers and practitioners. Specific measures related to these constructs were collected in the EETI study and in the case studies of implementation reported in the next section of this report. This brief review is intended also to suggest that prior technology implementation research has been motivated by a logic model that assumes that greater technology use will lead to greater learning—thus making it worthwhile to identify practices associated with more extensive use of technology. The findings of the national EETI study call this fundamental assumption of the logic model into question, at least for the kinds of reading and mathematics software included in the study and the learning outcomes captured by standardized achievement tests.[3] For this class of software at least, technology use per se should not be expected to produce significant achievement effects, and further research is needed to understand what constitutes *appropriate* use of software in ways that support learning. The exploratory case studies presented in the next section provide a first step in this direction by

[3] It is not known what results would be found for different instructional uses of technology or with more instructionally sensitive measures of learning.

describing software implementation and integration in classrooms of teachers whose students made above-average achievement gains during their first year of software use as part of the EETI study.

3. Case Study Sample and Data Collection

To examine software implementation in detail, the U.S. Department of Education asked SRI to select a subsample of EETI schools for a brief follow-up at the end of the 2005-06 school year. In this qualitative study, we identified teachers whose students had scored either above-average or below-average achievement gains in the first year of the EETI study and sought additional detail about the school and classroom practices that distinguished high-gain schools. In addition to examining data on their implementation during the first year of software use as part of EETI, we conducted follow-up work with these teachers and their schools to obtain a more integrated picture of how various aspects of software implementation fit with each other and within the broader contexts of schools and classrooms. Because this was also an opportunity to gain some information concerning how implementation changed in a teacher's second year of working with the software, we considered the subset of 101 EETI schools participating in the second year of that study as the best candidates for our follow-up sample.[4]

Follow-up Sample

For the 101 schools in the EETI Year 2 sample, researchers identified whether each had been above or below the mean in terms of the achievement gains that treatment students experienced in Year 1 and in terms of the extent to which the software had been used. For each product in the Year 2 EETI data collection, researchers looked for a pair of schools using the product, where one school had been above the mean in terms of achievement gain and the other had been below, making sure that the high-gain school had also had a positive effect size and was above the mean in terms of software use. Researchers attempted to find a high-gain and a low-gain school for each product in the same district, but this was not possible in most instances. As an alternative, researchers sought two schools that were as similar as possible in terms of percentage of students eligible for free or reduced-price lunch and in terms of pretest scores. In this manner, a pair of schools using the same product, one with above-average gains and one with below-average gains, was identified for 6 of the 10 software products in the Year 2 EETI data collection. To broaden product coverage, researchers also identified high-gain and low-gain schools using a seventh product that was not in the Year 2 EETI study for follow-up. Initial phone calls to

[4] The EETI study itself continued the collection of achievement data in the fall and spring of the 2005-06 school year for teachers who had been in the first year's data collection in cases where both the product vendor and an adequate number of schools using the vendor's product wanted to participate in a second round of data collection. Ten of the 15 products included in the first year of EETI remained in the study for a second year.

several of the schools that had implemented this product in Year 1 of the EETI study confirmed that the same teachers were still using the product. Two of these schools that met the criteria of having similarly disadvantaged student bodies but differing in terms of gains in the first year of the EETI data collection were added to the follow-up sample.

The resulting 14 case study schools were contacted in April 2006 to ascertain whether they would be willing to participate in this follow-up data collection by completing phone interviews or hosting a site visit. All the schools initially agreed to participate, but one of the low-gain schools, subsequently dropped out of the data collection, resulting in a follow-up sample of 13 schools as shown in Exhibit 3. The characteristics of the schools in the follow-up sample are summarized in Exhibit 4.

Exhibit 3. Follow-up Interview Sample

	Schools	Teachers	Other School Staff [a]
High-gain schools	7	14	13
Low-gain schools	6	13	12
Total	13	27	25

[a] Principals or vice principals and technology coordinators

By virtue of the selection process, the two groups differed in average class achievement gain (0.77 for the high-gain group versus –0.70 for the low-gain group, $p < .05$). As intended, they were very similar in terms of variables related to their staff and student populations. The high-gain and low-gain schools selected for follow-up were very similar in the proportions of students eligible for free or reduced-price lunch (57% vs. 56%) and in their student-to-teacher ratios (18- vs. 16-to-1). The two sets of schools varied somewhat in terms of urbanicity and proportion of Hispanic students, but the only statistically significant difference between the demographics of the two groups was the higher proportion of special education students in the high-gain schools ($p < .05$).

Exhibit 4. Characteristics of High- and Low-Gain Schools in the Follow-up Sample

Variable	High-Gain Schools (n = 7)	Low-Gain Schools (n = 6)
Teacher experience level (years)	8.8	12.7
Teacher certification (percent)	79	83
Urban schools (percent)	71	50
Free/reduced-price lunch (percent)	57	56
African American (percent)	32	36
Hispanic (percent)	16	31
Special education (percent)	10*	3
Student-to-teacher ratio	18.0	16.0
Pretest score (standardized)	-0.14	0.21
Gain score	0.77*	-0.70

* Significant at $p < .05$.

Methods

Data Collection Activities

One pair of schools at each grade level was designated for a site visit, which would involve interviews with the principal or other school leader and the school technology coordinator (if there was one), as well as with each teacher who had participated in the treatment condition in the EETI study. We attempted to observe each teacher twice, once while using the software with students and once while teaching the relevant subject area (math or reading) without the software. In some cases, this protocol had to be modified for elementary reading because the implementation model for the product was to have a portion of the students working independently on computers while another portion worked with the teacher in a small group during all reading instruction.

For follow-up schools that did not receive a site visit, we conducted phone interviews with the principal, technology coordinator, and teachers, using the same interview protocols employed on the site visits.

For each type of interview, there was a form with a set of headings, organizing the data in a structure parallel to the flow of the interview protocol. Site visitors used the forms in taking notes during interviews and then edited and completed these forms as soon as possible after concluding an interview. The same protocols were used for interviews with both high- and low-gain sites, and site visitors and interviewers were not informed of the school's categorization as high- or low-gain.

Interview and Observation Data Coding

In preparation for analyzing the interview data, we developed a manual of codes and definitions related to issues of software implementation. Major coding categories included school practices (such as provision of on-site technical assistance), classroom practices (actions undertaken by individual teachers), conditions (demographic variables and other characteristics existing prior to software implementation), and outcomes. Each of these broad coding categories included codes for subtopics, such as integration of software with other parts of the curriculum, classroom management techniques, and use of software reports. Codes were designed to allow parsing of the qualitative data by topic, so that data on similar topics across interviews could be analyzed as a set. The interview protocols and the coding structure used for interviews are available in the appendices of this report.

Data coding began with two analysts independently coding each paragraph of the data forms for two schools. The analysts coding the school data did not know which schools had achieved above-average gains in their treatment classrooms and which had posted below-average gains. After independent coding, the analysts compared their codes, discussed discrepancies, and made several refinements of the coding manual to reduce ambiguity. Interrater agreement for the independent coding of topic relevance was above 75%. The remaining coding was conducted by a single analyst.

Once the qualitative data were coded, they were entered into an ATLAS.ti database, which was then used by analysts to identify data relevant to selected topics. One set of data inquiries was performed to make a judgment concerning the presence or absence of each of the recommended implementation practices dealt with in the follow-up protocols. Two analysts independently read the relevant data inquiries for two schools and made a judgment about the presence or absence of each practice. They then compared their judgments, discussed discrepancies, and made several refinements of the definitions of the practices to reduce ambiguity. Interrater agreement for the independent analysis of practices was 79%. The remaining judgments were made by a single analyst. A second round of data inquiries was made to identify descriptions of practices and classroom interactions that could be used to illustrate variations in implementation.

4. Case Study Findings

Contrasting High- and Low-Gain Schools

Both the coded qualitative data from the school interviews and follow-up visit observations and the implementation data collected by the EETI study in the first year of software implementation were compared for follow-up schools classified as high-gain and those classified as low-gain. The small number of schools participating in the follow-up study precluded statistical testing of hypotheses, and this section of the report is best characterized as a cross-case analysis.

School-Level Implementation Variables

Teachers in high-gain schools started to use the software earlier in the school year and made more use of software reports. Exhibit 5 shows the extent to which the teachers in the high-gain and low-gain schools in the follow-up sample differed from each other on the implementation variables correlating significantly with gain scores in the EETI data set as a whole.[5] Teachers at the high-gain schools in the follow-up sample reported starting use of the software earlier in the school year and doing more frequent review of the student performance reports generated by the software. The data in Exhibit 5 suggest that there may be some additional differences between high- and low-gain schools in the proportion of students getting the intended time on the software, number of hours of software use, and receipt of additional formal training from the software vendor, but none of these differences is very large in absolute magnitude and they do not attain statistical significance with this small sample.

The interviews conducted with school staff participating in the follow-up study addressed some broader school implementation issues that had not been covered in the EETI data collection. In particular, the follow-up interviews were used to obtain school staff perceptions regarding school-level implementation practices recommended in the

[5] The EETI study examined effectiveness as measured by the difference between post-test scores in treatment and control classrooms within the same schools. Given the study design, effects could be measured at the school level but not the level of the individual classroom (since all students in a classroom were either in the treatment condition or the control condition). To inform the conduct of the case studies, classroom-level achievement gains (the difference between posttest and pretest scores) were calculated and correlations between gains and the implementation measures collected as part of EETI were computed.

Exhibit 5. Implementation Variables for Teachers in High- and Low-Gain Schools

Variable	Teachers in High-Gain Schools (n = 12)		Teachers in Low-Gain Schools (n = 14)	
	Mean	Std Dev	Mean	Std Dev
Reported number of weeks of use	27.8	4.8	25.9	4.2
Weeks between school start and beginning software use	4.4*	1.6	7.5	4.7
Percentage of students receiving intended level of use	96.6	4.2	91.4	11.5
Total hours of use logged by software[a]	24.3	14.3	20.6	13.7
Frequency of reviewing software reports for all students	70%*	NA	14%	NA
Receipt of additional formal training from vendor	33%	NA	21%	NA

[a] Software records of student use were not available for one of the products in the follow-up sample.
* Significant at $p < .05$.

educational technology implementation literature but not addressed in EETI. These included integration of technology use with a schoolwide instructional vision, principal support for use of the software, and teacher collaboration around software use. Exhibit 6 contrasts the schoolwide implementation practices for high-gain and low-gain schools in the follow-up sample on these additional variables.

High-gain schools were more likely than low-gain schools to display a consistent instructional vision, principal support for software use, teacher collaboration around software use, and satisfaction with on-site technical support. We must be cautious about interpreting apparent differences in these measures because of the small sample size, but we can see that a number of the practices recommended in the educational technology literature were more common among the high-gain schools than among the low-gain schools. The majority of high-gain schools had a consistent instructional vision for the content area (reading or mathematics), with the principal and the treatment teachers expressing a coherent view of how the topic should be taught and the role that the software should play in implementing that instructional vision. Exhibit 7 contrasts the consistency of philosophies expressed in a high-gain school with the conflicting views of instruction and the software's role in a low-gain school.

Exhibit 6. Proportion of Schools Implementing Schoolwide Practices, by Gain Status

Variable	High-Gain Schools (n = 7)	Low-Gain Schools (n = 6)
Consistent instructional vision	4 of 7	2 of 6
Principal support for software use	5 of 7	2 of 6
Teacher collaboration around software use	7 of 7	2 of 6
Use of software data in making decisions	4 of 7	0 of 6
Satisfaction with on-site technical support	6 of 7	3 of 6

Exhibit 7. Contrasting Levels of Instructional Vision

Consistency of Instructional Vision

This large middle school served a low-income student body that included many students who were not yet fluent in English. All of the interviewed staff indicated that their top priority was to achieve the state/district content standards on the schedule designated in the district's instructional guide and pacing chart. The principal and both teachers noted in separate interviews that many of their students did not come in with the skills that the district's instructional guide assumed and that, while they were supposed to be teaching the more advanced skills in the district instructional guide, they also needed to work on basic skills for students who had not yet mastered them. They all cited the software as useful for this purpose. Thus, although they thought it would be better if students acquired basic skills before being moved to more advanced mathematics, the staff found that they had to teach both together and saw software as a useful tool for doing so.

Conflicting Views of the Software's Role

This middle school had a lack of central vision for the technology, coupled with a lack of coordination between the two teachers using the software. The principal had little involvement with the study and was unsure how well the software fit with current schoolwide initiatives.

One of the teachers using the software taught low-skilled and English language learner students and said that the software would be good for honors students but not for his students because the language and concepts were too advanced. The other software-using teacher taught honors students and said that they got bored with it, but the software would be good for remediation.

Another component of school coherence is the principal's support for use of the software, as evidenced not just by supportive verbal statements but by concrete actions, such as giving the classes using the software priority access to computer resources and arranging for joint planning periods or other paid opportunities for teachers to gain proficiency with the software and plan for its use. The majority of high-gain schools in the follow-up sample (5 of 7) had principals who supported the software implementation; the majority of low-gain schools (4 of 6) did not. Exhibit 8 describes the contributions of two principals, one of whom provided concrete supports relevant to implementing the instructional software and one of whom promoted technology in general but did not provide supports specific to the software in the study.

Beyond the support from the principal, support from one's colleagues appears to be another factor present in schools that achieve learning gains with technology. All the high-gain schools that could be scored for this variable reported that their teachers collaborated and supported each other on use of the software product. Only a third of the low-gain schools reported this kind of teacher collaboration. Exhibit 9 presents an example of the kind of teacher collaboration found in the high-gain schools.

Exhibit 8. Contrasting Levels of Principal Support

Concrete Principal Support for Software Implementation

The principal of this middle school supported technology use in general and the use of the mathematics software in particular. She made sure that the teachers using the software had a common planning time and exclusive access to a portable computer lab for use of the software. Whenever she gave presentations on the school's efforts to incorporate more technology, she cited the use of the pre-algebra software in the sixth grade. She had announced her plan to expand the use of the software to all sixth-grade mathematics classes the next year.

Lack of Concrete Principal Support for Software Implementation

The principal of this elementary school was very supportive of technology use in general. During the study year, she provided training for all of the school's teachers on starting and maintaining a classroom blog. She did not, however, provide specific support for implementing the reading software. Teachers using the software were not given any extra time for planning or collaboration. The principal never saw any of the software performance reports or discussed them with her teachers.

In contrast, there was no difference between the proportions of high- and low-gain schools in the follow-up sample that were judged to emphasize teacher collaboration generally (5 of 7 high-gain schools and 4 of 6 low-gain schools described themselves as collaborative), suggesting that the focus of the collaboration, not just a generally supportive climate, is important.

High-gain schools were more likely to report using software data of student performance in making decisions (4 of 7) than were low-gain schools (0 of 6). Reports of teacher-level practices, to be described below, also highlight the importance of the use of software-generated information about student performance. Finally, although responses to the items about the availability of a full- or part-time school technology support person included in the EETI data collection did not correlate significantly with school gains, when we asked teachers about the availability of good technology support as part of the follow-up, we found that high-gain schools nearly always had on-site technical support that teachers considered good. Half of the low-gain schools in the follow-up sample were similarly happy with their on-site support while half were not. Hence, the qualitative data suggest that the quality of on-site technology support, rather than its mere presence, is important and that good local support is not sufficient but may be necessary to ensure positive outcomes with technology.

Exhibit 9. Teacher Collaboration in Support of Software Use

Collaboration between the two teachers using the software at this elementary school was very close. The younger teacher, who was in her second year of teaching, "handles the technical side, does reports, registers kids." The older, veteran teacher mentored her younger colleague on instructional strategies for elementary reading. They planned together at the beginning of the year got together and throughout the year to look at software reports and discuss student progress. One teacher noted that they even "get in competition a little with the scores." The school's technology coordinator commented that "they work well together; they're both committed to the program."

Classroom-Level Implementation Variables

In addition to the examination of schoolwide implementation practices described above, we related the presence or absence of specific teacher practices to the gains that a teacher's students had attained in the first year of software implementation. (Posttest scores for the students in their 2005-06 classes were not yet available when this report was prepared.)

For each teacher and implementation practice, a research analyst blind to the teacher's gain score or the average gain of the teacher's school coded the practice as present or absent on the basis of teacher reports and, where available, observations conducted during the follow-up visit. Exhibit 10 contrasts the standardized average gain score for teachers who implemented various recommended practices with those of teachers who did not implement the practices. With the small follow-up sample, the only practice for which the difference in gain scores attained statistical significance was observers' coding of classroom management as effective or ineffective.

Exhibit 10. Relationship Between Classroom Implementation Practices and Standardized Achievement Gains

Practice	Gains When Present	Gains When Absent	Difference
Observed Implementation Practices			
Effective classroom management	0.69 (n=7)	-0.95 (n=5)	1.63*
Facilitation during software use	0.89 (n=3)	-0.55 (n=2)	1.45
Teacher-Reported Practices			
Integration of software use and other instruction	0.17 (n=19)	-0.61 (n=5)	0.78
Software data used for decisionmaking	0.15 (n=18)	-0.42 (n=6)	0.57
Instituted motivational system	0.28 (n=13)	-0.31 (n=11)	0.59
Met vendor usage guidance	0.03 (n=14)	-0.02 (n=10)	0.05

* Significant at $p < .05$.

Effective classroom management routines for software use appear to be important. In interviews, teachers talked about the need to develop classroom routines for moving onto and off the software. A number of the teachers said that students needed to learn how to execute this transition and log on and off the software independently for the class to run smoothly. When asked what advice they would give another teacher using the software for the first time, teachers were more likely to provide recommendations on classroom management than on any other topic. An elementary school teacher from a high-gain school, for example, recommended:

> *Make sure you have your management in place for running the kids through the program. Get familiar with the program yourself so you can answer student questions. Make sure the kids know how to log in by themselves. Place the computers in such a way, in the classroom, that they don't distract the kids who are not on the computers.*

Another implementation practice highlighted in classroom observations the teacher's facilitation of students' learning as the students are using the software. Technology advocates often make the argument that by engaging all students in learning independently, the use of software gives the teacher the opportunity to work one-on-one with struggling students. Some of the observed teachers appeared to do this, as described in Exhibit 11. Other teachers, though present in the room while the software was being used, engaged in behaviors unrelated to learning (also illustrated in Exhibit 11).

The observed quality of teacher facilitation was measured for only those teachers in the follow-up sample who could be observed teaching with the software during the school site visits. The small number of cases requires cautious interpretation, but the available observations were consistent with theoretical models linking teacher facilitation to student learning.

Exhibit 11. Contrasting Teacher Involvement in Software Use

Teacher Facilitation of Learning during Software Use

The teacher interacted with students throughout the class, both when students raised their hands and when the teacher noticed students were having trouble as she circulated through the computer lab. She helped one student who asked, “When you have a + and - sign, which do you keep?”

“Think about what the sign needs to be to get you to +2x,” the teacher said as she directed the student’s attention what he had written on a piece of scrap paper. “Think about that. That gets you to -2x + x….There you go, look at that! Good.”

The student responded, “Right, right, thank you,” and the teacher moved on to another student who had looked up for help. During the observation, this teacher never stopped moving and talking with students. She was continually either helping a student or looking for a student to help.

Teacher Disengagement from Learning during Software Use

As the teacher worked his way around the room, he often corrected students’ posture at the computer and reset the position of the scratch paper, usually asking whether the student was right- or left-handed to be sure he was positioning the paper in the right place. In general, students were working quietly and engaged. Occasionally, the teacher made disciplinary remarks.

Another teacher at the same school spent about half of the observed period of software use with the students and about half on other things: working at his desk, answering the phone or making a brief phone call, and working with a laptop brought in by a student.

Another implementation issue is the coordination of learning done through the software with instruction in the same topic that does not involve software. None of the classes did all of their reading or mathematics learning through software. Although there were two products in the study that were used as the core curriculum, those products include offline as well as technology-based activities and materials. Except when those two products were used, the software was not a component of the core curriculum, and therefore teachers were using software produced by one vendor and a textbook or other set of instructional materials considered the core curriculum that came from another source. This situation raises several challenges for the teacher. First, the teacher must coordinate the topics across the two sets of instructional materials. Most of the software products allow teachers flexibility in sequencing software modules so that they can fit the use of software on a given topic or skill into a logical place in their curriculum. Although quite feasible, this effort does take time. Exhibit 12 contrasts two elementary schools, one of which did this articulation while the other did not.

Exhibit 12. Contrasting Articulation of Instruction With and Without Software

Articulating Reading Instruction with and without Software

The first-grade class was divided into three groups, with one group on the software, one reading independently, and one working in a small group with the teacher. The teacher began by reviewing the vowels. In her interview, the teacher said she did this because she had heard one of the students singing an a-e-i-o-u song from the software during lunch. She said that she often listened to students humming to themselves or singing songs from the software and used that as an indication where they were in the software and what they might need reinforcement on.

Failure to Articulate Reading Software and Core Instruction

Teachers at this elementary school had a new curriculum this year, and both teachers and school leaders were unsure how well the software fit with the curriculum. No alignment or curriculum mapping had been done. One teacher thought it fit fairly well but said she has not "sat down and gone through the software" so she could not be sure. Another teacher using the software said she knew that it had an area where one could assign modules to match a curriculum, but she had not tried doing so, adding that "a lot of times we've just let it roll the kids into the next level." The principal said that the "jury's still out" and indicated that they would look to standardized test score results to see whether the software was working with the new curriculum.

A second issue related to integrating software use and other instruction is the way that concepts or procedures are presented. This appeared to be particularly troublesome in mathematics, when different terminology and different procedures for handling problems of the same type were likely to be conveyed in the textbook and in the software. Mathematics teachers at one school found this discrepancy to be so confusing to their students during the first year of using the software that they decided not to teach the same topic with the textbook and the software in close temporal proximity in the second year, reasoning that students would be less confused by the representation of something in the software if they had had time to forget how it was presented in the text.

Teachers' descriptions of their practices and observed practices (where available) were coded for evidence that the teachers were integrating instruction with and without software so that students received a logical sequence of materials and connections were made between what they learned through the two modalities.[6] We observed examples of teachers referring to what the students had experienced with the software as they began a teacher-led lesson, as well as examples of teachers reminding students of procedures and concepts they had learned in class as the students were working with software in the computer lab (see Exhibit 13). Our qualitative data appear to support the recommendation that technology-based and offline activities be coordinated. It appears that the kind of facilitation of students' work with software described in the first example in Exhibit 11 can enable teachers to improve their non-technology-based instruction by drawing on insights gained from interactions with the software. An algebra teacher, for example, reported that she finds that helping students individually while they are using the software is a

[6] Unless there was evidence of a lack of implementation of nonsoftware components, those teachers who used a core curriculum product with both computer-based and non-computer-based material were coded as having integrated software use and other instruction.

good way of gauging their understanding and identifying areas to reteach. She said that students "who won't ask questions in the classroom will ask in the computer lab because they don't feel so much on the spot." She described her practice of taking the questions that students asked in the computer lab back into the classroom and reteaching concepts as needed.

Exhibit 13. Integration of Mathematics Instruction With and Without Software

The high school algebra class returned from the computer lab and sat down in rows of desk-chairs, facing the blackboard. At 2:55 the class began with the teacher saying "Some of you were looking at this in the computer lab." She then began talking about simplifying rational expressions and went through some problems on the board. In her interview, the teacher said that she choose modules in the software each week during her planning time to match what she was teaching in the classroom.

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As sixth graders worked with the math software in the computer lab, their teacher looked for students with raised hands or puzzled looks and provided individual assistance. The students were working with problems calling for them to do arithmetic operations with combinations of positive and negative integers. After noting that several of the students were struggling, the teacher addressed the class as a whole: "Remember when you add integers, use those algebra tiles we talked about in class. Red was for positive numbers and blue for negative numbers." (The software uses a number line depiction rather than algebra tiles, but it also uses red for negative numbers and blue for positive numbers.)

After giving one student the suggestion to draw a picture of the problem in her journal and helping an English language learner confused about the meaning of the word "decreasing," the teacher helped a student struggling to subtract a negative number from a positive number. "The difference between 1 and –4. Copy-Change-Change." She wrote the "Copy-Change-Change" format for subtracting a negative number by changing its sign and adding into the student's journal. In this way, she reminded him of what he had learned to do in class.

The data reports generated by software systems are another potential source of insights into what should be taught in the regular classroom. Software vendors have long urged teachers to run the automated reports provided by their products and review them on a regular basis. Although the vendors' recommendation is rooted in concerns over teachers' support for software use and the desire to make sure the software is used appropriately, there appear to be broader benefits of this practice. Teachers in our follow-up sample who looked at software performance reports and based instructional decisions on them had above-average gains for their classes. Although it may be that achievement-oriented teachers implement many useful practices in addition to looking at data, our qualitative data are consistent with the hypothesis that the use of student performance information generated by software products such as those in the study can make learning gains more likely. (Correlational analyses on the entire EETI treatment classroom data set found a significant correlation between teacher-reported frequency of reviewing software reports and achievement gain scores.) Exhibit 14 provides two examples of ways in which teachers used the software reports to guide future instruction.

Some of the software vendors recommend instituting a motivational system around software use—creating a visible chart showing modules completed, giving certificates, or using software performance in grading. Some of the individual teachers in both the high-gain and the low-gain schools described setting up such systems, usually in the form of a public chart showing each student's record of software module completion. For the follow-up sample, average gain scores tended to be higher in the classes of teachers who mentioned setting up such a system than in the classes of those who did not, but the difference was not significant (and was opposite in direction to the association found in an analysis of all EETI treatment classrooms).

Finally, for each of the teachers in the follow-up study, we compared the reported level of software use with the recommendation made by the vendor of that particular product.7 Those teachers in the follow-up sample who reported giving their students less time on the software than recommended by the vendor of the product being used experienced achievement gains nearly identical to those attained in classes of teachers who reported adhering to the vendor's recommendation. In addition, we note that the difference between high-gain and low-gain classrooms in terms of weekly minutes of use (119 vs. 102 minutes per week) was not large.

Exhibit 14. Use of Software Reports to Inform Instruction

A fourth-grade teacher reported that she looked at the software student performance reports on a monthly basis to monitor student progress and check what students were working on. She used the results of one report to group students during the core reading instruction time by topic mastery, allowing her to differentiate the pacing of her core instruction. "These kids are working on similes; these kids are working on context clues—I tried to coordinate it," she said. She also used the software reports during some parent-teacher conferences to emphasize or clarify a point she wanted to make with parents about their child's progress.

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A teacher at another elementary school said she looked at the software reports often, using the data to decide how to group students in her class. She said she also looked at the software "to help with words for class and give students individualized spelling words based on where they are in the software." The reports helped her decide what to teach, based on where students were in the software and how they were doing. "I love using those reports and being able to see exactly where kids are," she said. "I can sit down with a parent in a conference, and there's no guessing on my part."

[7] Vendors' recommendations for weekly product use ranged from 75 to 135 minutes, and there is not necessarily an empirical basis for the different recommendations. In general, vendors of mathematics products call for more weekly use than vendors of reading products do.

Changes in Implementation over Time

Teachers in the follow-up sample were asked to describe ways in which their implementation practices changed from their first to their second year of working with the software. They also were asked, at the interviews conducted at the end of their second year with these software products, what changes they anticipated making, or being required to make as a matter of school or district policy, in the coming year.

On average, teachers reported that technology problems were reduced in their second year of software implementation. Teachers at 6 of the 13 follow-up schools reported fewer technology problems in Year 2. One of these schools had gained a technology coordinator, and two schools that had had major start-up delays in Year 1 did not have this same problem in their second year of implementation. Teachers also credited their own increased familiarity with technology and with the programs for a decrease in technology problems. Technology problems do not necessarily disappear with experience, however; two schools said that they had had more rather than fewer technology problems in Year 2. In both cases, a change in the school's technology infrastructure required reconfiguration of the technology for running the software.

Three teachers reported that they added motivational techniques in their second year of product use. Although many teachers continued to report that the software was intrinsically motivating to their students, a few teachers suggested that the novelty of the technology wears off over time. At one school, the technology coordinator (who facilitated software use) created a chart to track students' progress and rewarded students for completion of modules. A middle school teacher at another school started the same practice for her math classes. A teacher at an elementary school instituted a monthly contest for completing modules.

Provision of some of the recommended school-level supports for technology implementation appeared to decrease from Year 1 to Year 2. Three principals, for example, reported that they had dropped in on software-using classes during the first year of implementation but not during the second year. This change in behavior was described in terms of having already achieved an understanding of the way in which the software was used and having confidence that the teachers could implement it rather than as an indication of less support for the activity. Only one principal was reported by a teacher to be more involved with the software implementation in Year 2 than in Year 1, and that principal explained that she had assumed the principalship during the 2004-05 school year and had not had time to give the software implementation the attention she would have liked the first year.

Teachers at four schools reported spending less time on matching software to the core curriculum during their second year of implementation. The most common explanation was simply that they knew the product better in Year 2 and could adjust it to match their curriculum more quickly. Teachers at three schools reported doing less collaboration with colleagues around software use in their second year, a drop they attributed to the fact that they had become comfortable with the software and no longer needed each other's support.

Many of these decreases in the frequency of recommended practices (principal involvement, teacher collaboration, time spent articulating software and offline curriculum) appear to be related to teachers' growing familiarity and confidence with the products. Such changes would be consistent with growing teacher proficiency in product use. When asked directly about their confidence and comfort in implementing the software, teachers at 9 of the 13 follow-up schools reported being more confident and comfortable with the software in Year 2. Teachers said they were better at managing student use of the software during the second year, as well as being more efficient with their own time on the software. Teachers also said that they had more knowledge of how to fix the minor technology problems that arose with software use in Year 2.

On the other hand, there were some other reported changes that appeared to signal challenges to ongoing use of the products. Time pressures and competition with other school improvement initiatives were the most frequently cited reasons for reducing the amount of time devoted to software use during the second year of implementation.

Nine teachers from five different schools reported using the software for less time in Year 2 than in Year 1, and only one teacher reported increased use. Three of the schools where there was less software use in the second year had introduced a new core curriculum in the area covered by the software. Teachers said that the new curriculum required adjustment on their part and integrating the software with the new curriculum was difficult. At one of these schools, teachers felt the new curriculum required them to do more whole-class instruction, making it more difficult to find time for software use. A high school mathematics teacher reported that the class period had been shortened, making it more difficult to find time for software use in Year 2.

Teachers' Expectations for Future Software Use

All but one of the teachers in the follow-up study expressed the desire to use the software with their students again the next year. Some teachers expressed strong attachment to the software. Said one, "It's a superb program. I'm going to use it forever." Some teachers expressed an element of doubt, however, as to whether they would be able to continue with the software, and many anticipated some changes in the way they would use the software.

The most frequently mentioned barrier to another year of software use was the cost of software licenses. Teachers at 5 of the 13 schools expressed concern that the cost might be prohibitive. Teacher turnover at one school, disappointment in test results for the classes using the software at another, and district plans to move to new curricula at two schools were other events that teachers felt threatened the continuation of software use. Many products and innovations compete for the attention of school staff. One school said it already had several other math interventions, and another school's leader was considering other reading products, as well as the option of continuing to use the study software.

Several school leaders were aware of their teachers' strong allegiance to the software product they had been using. One elementary principal speculated that her teachers would "revolt" if told they couldn't continue with the reading product they had been using. (This was a reasonable inference, given the teacher at the same school who said that to get her to stop using this software "you're going to have to come and rip it out of the computer.")

Many of the teachers who planned or hoped to use the software again were planning to use it somewhat differently in subsequent years. Teachers at two schools planned to use software designed to be a part of a core-curriculum product as a supplement to a different core curriculum in the following year. Teachers at five schools planned to use the software less frequently. Several teachers said they would not commit to using the software for a certain amount of time, as they had during the EETI study. One teacher said that because the software would be available to all sixth-grade teachers in her school in the coming year, she would be unlikely to get as much lab time as she had during the two years of the EETI experiment. Although teachers were more likely to predict devoting less rather than more time to software use in future years, teachers at four schools did say that their schools anticipated expanding use of the software to other grade levels and teachers. There were also a number of reports of plans to use the software more for remediation purposes in the future, either in a remediation lab or with lower-level classes.

Teachers commonly expressed a desire to continue to refine their use of the software. Among the teachers who acknowledged that they had not individualized software use by students or had not coordinated software topics with core curriculum topics in the past, it was common to say that they planned to do so in the following year.

Teachers' Perceptions of Effects of Software Use

Perceived Effects on Students

A major influence on teachers' attitude toward software is their perception of its effects on their students. When asked to describe what if any effects they felt the software had had on their students, all the teachers in the follow-up sample indicated that the software had had a positive effect on student learning.

Looking across the entire follow-up sample, we found that teachers whose Year 1 class had experienced below-average gains with the software were as likely as those whose students had made above-average gains to report that their students had learned from the experience. The fact that there is sometimes a discrepancy between teacher perceptions and achievement data may not be attributable entirely to teachers' wishful thinking. Teachers observe changes in students in areas that may not be tapped by conventional achievement tests. One teacher, for example, asserted, "I know my kids are more interested in reading than the kids in the other [control] classes, and that's what really matters to me."

This perception that use of the software had increased their students' interest in reading was very important to the elementary school teachers we interviewed:

> *Students [who] weren't into reading at all at the beginning of the year…are very motivated to pick up a book [and are] learning about topics they never would have read about.*

In some cases, the teachers had data, either from the software's internal assessments or from local formative or summative assessments, to support their perceptions of student learning gains. A striking example was provided by a high-gain school implementing a fourth-grade reading product. During the first year of implementing this product, the two treatment teachers observed that it worked well in general, but especially well for at-risk students. At the beginning of their second year using the product, the two teachers implementing the software decided that they wanted to use it to help the students who were really struggling. One of the teachers reported that they had asked to have "the really at-risk kids who are two, three grades below" assigned to their classes. They wanted "the kids who have always failed, the ones who have always been not successful." The teacher reported:

> *The result has been amazing. Now the majority of those students are either on grade level or above grade level…I had no one on grade level at the beginning of the year. Now I have 10 above grade level, 6 on grade level, and 2 below.*

Teachers consistently attributed to the software noticeable improvements in student motivation to learn. Most teachers at all 13 schools in the follow-up study reported that their students were more engaged when using the software. Again, teachers whose classes had made high gains and those whose classes had made low gains were equally likely to cite motivational benefits of software use. Teachers described students as more self-confident, generally or as problem solvers and learners, after their experience with the software. Teachers also reported that students were better behaved when using technology and that students liked working on the computer. Teachers at four schools described using the opportunity to work on the computer as a reward that motivated students to finish their non-computer-based work more quickly. Teachers at two schools said that, when working with the software, their students did not exhibit the negative and disengaged responses that were common during non-technology-based learning activities.

Perceived Changes in Teacher Practice

Technology advocates often cite positive changes to teacher practice as a benefit of technology integration (Sweet, Rasher, Abromitis, & Johnson, 2004). On the other hand, it has been observed also that teachers tend to integrate technology into their existing way of teaching (Cuban, 2001) and that real change in teacher practice is both slow and difficult (Sandholtz et al., 1997). Teachers and school leaders in the follow-up study were asked what if any changes in teacher practice had occurred over the course of two years of software implementation.

Although teachers were not as unanimous in reporting changes in their practice as they were in reporting changes in outcomes for students, a number of them did describe a range of software-associated modifications. Two of the 27 teachers in the follow-up study reported what they considered fundamental changes in their teaching practice. An algebra teacher described a conversion from a traditional, teacher-directed instructional style to a student-centered approach. A fourth-grade teacher said that her experience with the product had moved her away from whole-class instruction to a learning-centers approach. A third teacher said there had not been any fundamental change in her pedagogy, but she had picked up a specific technique from the software. This mathematics teacher said she had noticed that the software used visual representations as well as text to convey concepts, and she thought this was helpful for her students, many of whom were English language learners. As a result, she began using this technique, devising her own visual representations of math concepts and using them in her classroom teaching.

Another specific change that several teachers and school leaders attributed to the experience with the software was increasing use of differentiated instruction. At one high-gain school, the vice principal reported that the two teachers using the software were teaching differently since they started using the product. She reported that the software “assists them to be able to very easily dissect strengths and weaknesses” by using the software-generated reports, which she said “these teachers really print and look at…on a regular basis.” The teachers themselves confirmed that they were using the software data to provide more individualized instruction.

The school leader at another school lauded the way that the software had prompted teachers to “come out of their cubby holes, out of the classroom” to work with each other and discuss their students’ progress.

Finally, many of the teachers noted that they had gained increased capability and confidence with the software and with technology use in general. One of the high school teachers noted that she had begun the study having almost no technology experience and had come to the point where she was about to give a PowerPoint presentation at an education conference.

5. Implications for Practice: Implementation Themes and Lessons

The EETI data collection and the analyses reported in Dynarski et al. (2006) addressed specific, concrete implementation variables, such as the number of weeks the students used the software and the number of minutes of software instruction students experienced. The qualitative data collected from selected EETI teachers in their second year of software implementation complement data collected in the national experiment by providing information on aspects of teachers' implementation of software such as strategies for integrating software-based and other instruction, and school organizational capacity issues, such as principal support for and teacher collaboration around software use. Our interviews and observations of school staff highlight the multiple agendas school staff are navigating and their acute sense of limited time.

The *competition for instructional time* within a given subject or class is one of the clear themes that emerged in our visits to schools. This tension is particularly pronounced in the upper grades, where requirements for subject area coverage dictate that teachers fit a large number of topics into a fixed instructional period. When any new instructional intervention is introduced as an adjunct to a required core curriculum, teachers are faced with the challenge of allocating sufficient time to the new learning activities without sacrificing units of the core curriculum. As a result, congruence between the pace and order of software units and those of the larger curriculum, and teacher/school/district planning practices to support that congruence, can significantly influence whether the software enhances the curriculum in a given classroom or detracts from the coherence of the learning opportunities available to students.

The great majority of software products in the EETI study were used as supplements to a core curriculum rather than as a core curriculum in and of themselves. (The two exceptions were products with both computer-based and offline materials and activities.) Vendors made recommendations to teachers for how much time students should use the software each week and how they could coordinate software activities with regular instruction. But it was up to the teachers to decide whether to try to coordinate the sequencing of topics on and off the software, how much emphasis to place on the software, and how to help students see the connections between what they were learning with the software and their regular classroom activities.

A second, related theme emerging from our follow-up collection of qualitative data is the importance of *instructional coherence* in the implementation of software. Schools contribute to instructional coherence when they have a unified strategy for teaching reading or mathematics to their students and when they have an articulated and agreed-upon view of how the software fits into that strategy. Teachers foster instructional coherence when they draw explicit connections for their students between the content in the software and that in their nonelectronic instructional materials and when they reinforce what has been done in one medium with instruction in the other. Education systems (districts and states) support coherence when they provide aligned sets of standards, assessments, and curriculum. In our follow-up sample, the teachers and schools whose students benefited most from software use had devoted time to understanding the content of the software and comparing it with state and district standards and other curriculum materials with the aim of offering students a coherent, integrated experience in reading or math that made use of both online and offline instructional resources.

Competing demands on teachers and instructional time and the constant churn of ideas and mandates within public education can be sources of difficulty for software implementation. Although recent years have seen much more emphasis on content and performance standards and much more attention to issues of alignment with standards, our follow-up activities in the field found cases of both competing mandates for how reading or mathematics should be taught and frequent changes across time as a new superintendent, principal, or school board brought in new ideas. Some of the teachers who had put effort into identifying the alignment between a software product and their core curriculum in the first year of the EETI study were given a new mandated core curriculum, requiring another alignment activity, in Year 2.

One of the most encouraging findings from the qualitative data collection is the ways in which teachers are *taking advantage of affordances of technology to improve the teaching they do when not using technology*. When their students are using instructional software, teachers move out of the role of class leader and have the opportunity to closely observe and interact with individual students engaged in learning. Some of the teachers in the study took advantage of this change in classroom structure to circulate among the students working with the software to observe, ask questions, and provide suggestions to scaffold student learning. Some of the teachers who facilitated learning in this way also reported gaining insights from this experience that they applied in planning and executing teacher-led activities. In addition, teachers described their use of the detailed student performance reports generated by the software systems to see where their class as a whole and individual students stood with respect to mastering various skills. Teachers described their use of this information to form groups of students needing to work on similar skills, to decide on areas that required further instruction, and to describe students' progress, strengths, and weaknesses to parents.

Based on our case study research, we recommend the following practices for appropriate implementation of reading and mathematics software:

1. ***Principal support for software implementation.*** Principals are in a key position to foster coherence between the way technology is used and the school's overall instructional philosophy. They also play a key role in providing concrete supports for technology use, including equipment access and supported time both for learning to use the technology initially and for additional teacher learning and planning during the school year. Principals' support is felt also when they observe technology use and monitor student learning with the software and when they publicly recognize teacher accomplishments. The majority of principals at schools in the follow-up study that had experienced higher-than-average gains in their first year of software use made such concrete supports available to the effort.

2. ***Ongoing teacher collaboration around software implementation and improvement of practice with the technology.*** In all the schools in the follow-up study that had more than one treatment teacher and that experienced higher-than-average gains, the teachers reported working together to figure out how to use the software. Teachers commonly collaborated on the alignment of the software with their core curriculum, in figuring out schedules for equipment use, and in designing classroom management strategies. At some schools, teachers shared software-generated performance reports from their classes and discussed the implications of the reports for their instruction.

3. ***On-site technical support.*** All the high-gain schools in the follow-up sample had on-site technical support that teachers considered good. Half of the schools with lower-than-average gains also described their on-site technical support as good. Thus, we would not expect on-site technical support to cause learning gain, having competent technical help available when needed appears to be part of the context that allows an effective technology implementation to occur. The amount and nature of technical support required vary with the particular software product, the complexity of the needed hardware or network infrastructure, and the technology skills and confidence of the teachers. We noted that technology problems were common in the first year of software implementation but were reported to be reduced in most of the schools in our follow-up sample using the software for a second year.

4. ***A clear rationale and plan for integrating software use with the core curriculum and central instructional goals of the school or class.*** Staff at a majority of the schools in the follow-up study that had experienced higher-than-average gains in their first year of software use expressed a consistent view of their approach to instruction in the domain and how the software fit with their approach. Where such consistency did not exist, and teachers within a school were more variable in their perceptions of the strengths of the software and the particular student subgroups (e.g., high vs. low achievers) they thought it suited, lower overall gains tended to be achieved.

5. ***Use of software performance data to inform future instruction.*** Teachers in high-gain classes used the software performance reports not only to make sure students were making progress through the software but also to inform their grouping of students during offline instruction in a way that supported differentiated instruction and to decide on the content they would address when students were not using technology. The software reports allowed them to base these decisions on a clearer understanding of the progress and needs of individual students.

6. ***Efficient routines for classroom management.*** The most frequently offered advice that teachers in our follow-up study said they would give teachers embarking on software implementation was to figure out an efficient, workable routine for managing the class as students transition into and use technology. Teachers talked about setting up routines that the students could execute independently and the importance of teaching students to handle logging on and logging off. Observed teachers who were judged to be strong on classroom management had had higher average achievement in their classes in Year 1 of the EETI study.

7. ***Teacher facilitation of student learning during software use.*** Working with individual students as they interact with the software is an opportunity for teachers to provide tailored assistance that can support the student's learning. When such facilitation becomes a regular practice, it is also an opportunity to gain insights into students' thinking and sources of confusion and difficulty in the subject matter. Some teachers cited the advantage of being able to incorporate such insights into their design of further instruction.

8. ***Teacher explication of connections between technology-based and other learning activities.*** Teachers in the follow-up sample who were observed pointing out connections between software-based and other instruction for their students or who described making linkages between the two sets of materials tended to have had students who made larger achievement gains in Year 1 of the EETI study. Although the difference in students' gain scores was not statistically significant with the small available teacher sample, activities that increase the coherence of the various instructional experiences provided to students logically could be expected to foster greater transfer of learning from one setting to another.

These eight practices have not been subject to an experimental test of their impact on achievement in reading or mathematics, but their relative prominence in schools and classrooms where larger achievement gains were made suggests their promise as topics for further research.

References

Adelman, N., Donnelly, M. B., Dove, T., Tiffany-Morales, J., Wayne, A., & Zucker, A. (2002). *The Integrated Studies of Educational Technology: Professional development and teachers' use of technology*. Menlo Park, CA: SRI International.

Agodini, R., Dynarski, M., Means, B., Murphy, R., & Rosenberg, L. (2005). *Analysis plan for the evaluation of the effectiveness of educational technology interventions.* Report prepared for Institute of Education Sciences, U.S. Department of Education. Princeton, NJ: Mathematica Policy Research, Inc.

Barnett, H. (2002). How *to guarantee a learning return on your technology investment.* Retrieved March 30, 2006, from http://www.eschoolnews.com/news/showstory.cfm?ArticleID=3678

Becker, H. J. (1994). How exemplary computer-using teachers differ from other teachers: Implications for realizing the potential of computers in schools. *Journal of Research on Computing in Education, 26,* 291-320.

Becker, H. J. (2000). Who's wired and who's not: Children's access to and use of computer technology. *The Future of Children*, *10*(2), 44-75.

Brand, G. A. (1997). What research says: Training teachers for using technology. *Journal of Staff Development, 19*(1). Retrieved on July 18, 2006, from http://www.nsdc.org/library/publications/jsd/brand191.cfm

Cavalier, J. C., & Klein, J. D. (1998). Effects of cooperative versus individual learning and orienting activities during computer-based instruction. *Educational Technology Research and Development, 46*(1), 5-17.

Coley, R. J., Cradler, J., & Engel, P. K. (1997). *Computers and classrooms: The status of technology in U.S. schools.* Princeton, NJ: Educational Testing Service. Available at http://www.ets.org/Media/Research/pdf/PICCOMPCLSS.pdf

Cuban, L. (2001). *Oversold and underused: Computers in the classroom.* Cambridge, MA: Harvard University Press.

Dynarski, M., Agodini, R., Heaviside, S., Novak, T., Carey, N., Means, B., et al., (2006). *Effectiveness of educational technology interventions.* Report prepared for Institute of Education Sciences, U.S. Department of Education. Princeton, NJ: Mathematica Policy Research, Inc.

Education Week. (2005). Technology Counts 2005. Electronic transfer: Moving technology dollars in new directions. *Education Week, 24*(35).

eMINTS Evaluation Team. (2003, January). *Analysis of 2002 MAP results for eMINTS students*. Retrieved July 29, 2006, from http://emints.org/evaluation/reports/map2002.pdf

Ertmer, P. A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development, 47*(4), 47-61.

Glennan, T. K., & Melmed, A. (1996). *Fostering the use of educational technology: Elements of a national strategy*. Santa Monica, CA: Critical Technologies Institute, RAND.

Jones, B. F., Valdez, G., Nowakowski, J., & Rasmussen, C. (1995). *Plugging in: Choosing and using educational technology*. Oak Brook, IL: North Central Educational Research Laboratory. (ERIC Document Reproduction Service No. ED415837)

Mann, D., Shakeshaft, C., Becker, J., & Kottkamp, R. (1998). *West Virginia story: Achievement gains from a statewide comprehensive instructional technology program*. Santa Monica, CA: Milken Exchange on Educational Technology.

Means, B., & Olson, K. (1995). *Technology and education reform: Technical research report.* Menlo Park, CA: SRI International.

O'Dwyer, L. M., Russell, M., & Bebell, D. (2004). Identifying teacher, school, and district characteristics associated with elementary teachers' use of technology: A multilevel perspective. *Education Policy Analysis Archives, 12*(48). Retrieved August 13, 2006, from http://epaa.asu.edu/epaa/v12n48/

O'Dwyer, L. M., Russell, M., & Bebell, D. (2005). Identifying teacher, school, and district characteristics associated with middle and high school teachers' use of technology: A multilevel perspective. *Journal of Educational Computing Research, 33*(4), 369-393.

OTA (Office of Technology Assessment, U.S. Congress). (1995). *Teachers and technology: Making the connection* (OTA-HER-616). Washington, DC: U.S. Government Printing Office.

Powell, J. V., Aeby, V. G., Jr., & Carpenter-Aeby, T. (2003). A comparison of student outcomes with and without teacher facilitated computer-based instruction. *Computers & Education, 40*, 183-191.

Quality Education Data. (2004). *Technology purchasing forecast, 2004-2005* (10th ed.). Denver, CO: Quality Education Data, Inc.

Sandholtz, J. H., Ringstaff, C., & Dwyer, D. C. (1997). *Teaching with technology: Creating student-centered classrooms.* New York: Teachers College Press.

Sarama, J., Clements, D. H., & Henry, J. J. (1998). Network of influences in an implementation of a mathematics curriculum innovation. *International Journal of Computers for Mathematical Learning, 3*(2), 113-148.

SRI International. (2006). *State strategies and practices for educational technology.* Washington, DC: U.S. Department of Education. Under review.

Sweet, J. R., Rasher, S. P., Abromitis, B. S., & Johnson, E. M. (2004). *Case studies of high-performing, high-technology schools: Final research report on schools with predominantly low-income, African-American, or Latino student populations.* Oak Brook, IL: North Central Regional Educational Laboratory.

U.S. Department of Education. (2000). *Does professional development change teaching practice? Results from a three-year study.* Washington, DC: Author.

Van Dusen, L. M., & Worthen, B. R. (1995). Can integrated instructional technology transform the classroom? *Educational Leadership, 53*(2), 28-33.

Wenglinsky, H. (1998). *Does it compute? The relationship between educational technology and student achievement in mathematics* (Policy Information Report). Princeton, NJ: Educational Testing Service Policy Information Center.

Zhao, Y., Pugh, K., Sheldon, S., & Byers, J. (2002). Conditions for classroom technology innovations. *Teachers College Record, 104*(3), 482-515.

Appendix A

Case Study Protocols

IMPLEMENTATION STUDY OBSERVATION PROTOCOL
SPRING 2006

A. CLASSROOM BASICS

Class/Teacher: ___________________________

Name of School: _________________________ **District:** ______________________

School's Target Application: __________________ **Grade:** _____________________

Observer: ______________________________

Date: _____________ **Observation start time:** __________ **End time:** ____________

1. Students: ______ Total _______males ______ females

Observable ethnic characteristics (describe): ____________________________________

____

2. Setting: (check one in each column)	❑ Classroom	❑ During class period
	❑ Computer lab	❑ Before/after school or study hall
	❑ Other (describe):	❑ Other (describe):

3. Number of computers: ______Total: _____ operating ____ not operating
_____ became non-operational during observation period

Describe the classroom layout and layout of computers:

*4. Total minutes of observation period during which 1 or more students were using target software: _______

*5. Total number of students who used target software sometime during observation period: _______

*6. General description of what students and teacher are doing: main lesson topics, activities happening concurrently, etc. – *include any information from the teacher about instructional objectives*

* Fill out at end of observation period.

B. NOTES AND VIGNETTES

Use this space for a general description of classroom activities and interactions including details justifying the ratings in Sections D & E, and detailed descriptions of examples of exemplary (or non-exemplary) practices, including:

- effective facilitation techniques and examples
- classroom management strategies
- evidence of curriculum integration on and off the computer
- teacher use of student progress reporting from the software

C. TEACHER-STUDENT INTERACTIONS

1. Types of facilitation - *Follow the teacher and tally each type of interaction with students within the 30-minute observation. Then tally those that lasted more than a minute. Applies to one-on-one or small group facilitation—NOT whole-class instruction.*

	# Interactions	#>1 minute
Introducing content	__________	__________
Clarifying content or answering ?s	__________	__________
Pushing students' thinking/helping students refine ideas	__________	__________
Hints/Procedural assistance (e.g. what to do next, how to use a manipulative)	__________	__________
Motivational or behavioral control	__________	__________
Technical assistance	__________	__________

2. Degree of cross-reference – *Within the 30-minute observation period, tally each observable time that the teacher (could be during whole-class instruction):*

Referred to something in the software when teaching without tech: __________

Referred to something from class when students are using tech: __________

3. Total time teacher spent:

On instructional activities? _____minutes

On housekeeping/interruptions/other unrelated to instruction? _____minutes

____

Total minutes

D. Activity Ratings

If students are working on different activities or the activity shifts (change in at least 2 of the 3 components of materials, leader, and configuration), complete the ratings for each activity.

Activity # 1

1. What is this activity? ____

2. Activity type:

(Circle)

A. Solo independent practice (at desk or computer): i.e., reading silently, worksheets, exercise
B. Peer or group independent practice, problem solving, project work
C. Question and answer: Teacher is leader, but there is *interaction* with students (include an interactive review of homework)
D. Rote review of student work: i.e. test, homework
E. Lecture: Teacher talking/presenting material
F. Presentation: Students present work
G. Test: Students work on an assessment activity
H. Other

3. *For all activities,* Rate the Quality of the Facilitation (adapted from Horizon Research, Inc. 2000)

		Not At All				To Great Extent	Don't Know	N/A
a.	Teacher demonstrates attention to students' experience, preparedness, and/or prior knowledge.	1	2	3	4	5	6	7
b.	Teacher appeared confident in ability to teach the subject.	1	2	3	4	5	6	7
c.	Teacher displayed an understanding of subject area content (e.g. in dialogue with students).	1	2	3	4	5	6	7
d.	Teacher's questioning strategies were likely to enhance the development of student conceptual understanding (e.g. emphasized higher-order questions, appropriately used "wait time", identified prior conceptions and misconceptions).	1	2	3	4	5	6	7
e.	Connections were made to real-world content, to prior ideas from class, or to other disciplines.	1	2	3	4	5	6	7

4. *For teacher-led activities ONLY (those classified as C, D, or E)* Rate the Quality of the Teaching (Items from Horizon Research, Inc., 2000)

		Not At All				To Great Extent	Don't Know	N/A
a.	Design of lesson reflected careful planning & organization.	1	2	3	4	5	6	7
b.	Teacher's classroom management style/strategies enhanced the quality of the lesson.	1	2	3	4	5	6	7
c.	Teacher was able to "read" the students' level of understanding and adjusted instruction accordingly.	1	2	3	4	5	6	7
d.	Students were intellectually engaged with important ideas relevant to the focus of the lesson.	1	2	3	4	5	6	7
e.	There was climate of respect for students' ideas, questions, and contributions.	1	2	3	4	5	6	7
f.	Intellectual rigor, constructive criticism, & challenging of ideas were evident.	1	2	3	4	5	6	7

Activity # 2

1. What is this activity? ____

2. Activity type:

(Circle)

A. Solo independent practice (at desk or computer): i.e., reading silently, worksheets, exercise

B. Peer or group independent practice, problem solving, or project work

C. Question and answer: Teacher is leader, but there is *interaction* with students (include an interactive review of homework)

D. Rote review of student work: i.e. test, homework

E. Lecture: Teacher talking or presenting material and students are listening

F. Presentation: Students present work

G. Test: Students work on an assessment activity

H. Other

3. *For all activities,* Rate the Quality of the Facilitation (adapted from Horizon Research, Inc. 2000)

		Not At All				To Great Extent	Don't Know	N/A
a.	Teacher demonstrates attention to students' experience, preparedness, and/or prior knowledge.	1	2	3	4	5	6	7
b.	Teacher appeared confident in his/her ability to teach the subject.	1	2	3	4	5	6	7
c.	Teacher displayed an understanding of subject area content (e.g. in dialogue with students).	1	2	3	4	5	6	7
d.	Teacher's questioning strategies were likely to enhance the development of student conceptual understanding (e.g. emphasized higher-order questions, appropriately used "wait time", identified prior conceptions and misconceptions).	1	2	3	4	5	6	7
e.	Connections were made to real-world content, to prior ideas from class, or to other disciplines.	1	2	3	4	5	6	7

4. *For teacher-led activities ONLY (those classified as C, D, or E)* Rate the Quality of the Teaching (Items from Horizon Research, Inc., 2000)

		Not At All				To Great Extent	Don't Know	N/A
a.	Design of the lesson reflected careful planning and organization.	1	2	3	4	5	6	7
b.	Teacher's classroom management style/strategies enhanced the quality of the lesson.	1	2	3	4	5	6	7
c.	Teacher was able to "read" the students' level of understanding and adjusted instruction accordingly.	1	2	3	4	5	6	7
d.	Students were intellectually engaged with important ideas relevant to the focus of the lesson.	1	2	3	4	5	6	7
e.	There was a climate of respect for students' ideas, questions, and contributions.	1	2	3	4	5	6	7
f.	Intellectual rigor, constructive criticism, and the challenging of ideas were evident.	1	2	3	4	5	6	7

Activity # 3

1. What is this activity? ____

2. Activity type:

(Circle)

A. Solo independent practice (at desk or computer): i.e., reading silently, worksheets, exercise

B. Peer or group independent practice, problem solving, or project work

C. Question and answer: Teacher is leader, but there is *interaction* with students (include an interactive review of homework)

D. Rote review of student work: i.e. test, homework

E. Lecture: Teacher talking or presenting material and students are listening

F. Presentation: Students present work

G. Test: Students work on an assessment activity

H. Other

3. *For all activities,* Rate the Quality of the Facilitation (adapted from Horizon Research, Inc. 2000)

		Not At All				To Great Extent	Don't Know	N/A
a.	Teacher demonstrates attention to students' experience, preparedness, and/or prior knowledge.	1	2	3	4	5	6	7
b.	Teacher appeared confident in his/her ability to teach the subject.	1	2	3	4	5	6	7
c.	Teacher displayed an understanding of subject area content (e.g. in dialogue with students).	1	2	3	4	5	6	7
d.	Teacher's questioning strategies were likely to enhance the development of student conceptual understanding (e.g. emphasized higher-order questions, appropriately used "wait time", identified prior conceptions and misconceptions).	1	2	3	4	5	6	7
e.	Connections were made to real-world content, to prior ideas from class, or to other disciplines.	1	2	3	4	5	6	7

4. *For teacher-led activities ONLY (those classified as C, or E)* Rate the Quality of the Teaching (Items from Horizon Research, Inc., 2000)

		Not At All				To Great Extent	Don't Know	N/A
a.	Design of the lesson reflected careful planning and organization.	1	2	3	4	5	6	7
b.	Teacher's classroom management style/strategies enhanced the quality of the lesson.	1	2	3	4	5	6	7
c.	Teacher was able to "read" the students' level of understanding and adjusted instruction accordingly.	1	2	3	4	5	6	7
d.	Students were intellectually engaged with important ideas relevant to the focus of the lesson.	1	2	3	4	5	6	7
e.	There was a climate of respect for students' ideas, questions, and contributions.	1	2	3	4	5	6	7
f.	Intellectual rigor, constructive criticism, and the challenging of ideas were evident.	1	2	3	4	5	6	7

E. Ratings of Whole Observed Period

Complete the following ratings after the 30-minute observation period.

1. Based on time spent, the focus of this lesson is best described as (check one box):

Facts/Basic skills		An even mix		High-order thinking
❑	❑	❑	❑	❑

Facts/Basic Skills= Decoding skills, vocabulary, facts or math procedures
Higher-order= Concepts and principles, problem solving, design activities

2. Avg % students off-task *(not doing the assigned activity)*	<10%	10-33%	34-66%	67% or more
	❑	❑	❑	❑

3. Record any problems with the software, hardware or necessary peripherals encountered during the time segment in the space below: (**EETI T-5)**

____

____

____

____

4. Did students use any (non-software) curricular materials or activities related to the product? (If YES, describe) (**EETI T-7**)

- ❑ No
- ❑ Yes

____

____

____

5. Was mathematics or reading technology other than the target application used by students during the class? (**EETI G-7)**

Educational software for reading
Name: _______________________
Educational software for mathematics
Name: _______________________

Study of Software Implementation Practices

Teacher Interview

Introduction

I'm [Name], from SRI International, working on the Dept. of Education's National Ed Tech study team. If you remember, this is a national study of the effectiveness of educational software products like [name of product]. In some of the schools we visited last year, we're contacting teachers to get more information about how educational technology works in practice. We want to be able to describe what appear to be the best implementation practices, and also to learn more about some of the challenges of using technology effectively in the classroom. The information we get from our interviews (and observations) will be used only to help us describe overall software implementation issues and practices. We are not evaluating teachers, and we won't disclose the names of the school or people we talk to.

FOR SITE VISITS: Before we start, I need to have you review and sign this consent form. [AFTER THE RESPONDENT REVIEWS CONSENT FORM] Do you have any questions before we get started? [FOR PHONE INTERVIEWS: Before we get started, did you receive the express mail package with the consent form? Please be sure and sign it and send it to us in the enclosed prepaid envelope.]

Software use

1. Let me confirm my understanding of what you've already told us on the phone. *Confirm whether they've used [name of product] this year and last.*

2. Is the class you're using [name of product] with this year different from the class you had last year? **IF YES**: Please describe.

3. In your class this year, how much time are students typically spending with [name of product]? We're only looking for time they spend on the computer. *PROBE for average time per week or month, & for percentage of students receiving at least this much time with the software, then ASK 3a*.

Number of Sessions	*Week or Month*	*Avg Minutes per Session*	*% of Students*
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ Per week ☐ Per month	☐ <10 ☐ 10-19 ☐ 20-29 ☐ 30 or more	☐ 100% ☐ 75-99% ☐ 50-74% ☐ 25-49% ☐ Less than 25%

**3a. Is this more or less time than your students used [name of product] last year? [If a change] Please explain why.

4. Before you began using [name of product] two years ago, to what extent were you comfortable doing the following things with technology?:

	Not comfortable	*Somewhat comfortable*	*Very Comfortable*
a. Using email	☐	☐	☐
b. Researching using the Internet	☐	☐	☐
c. Using instructional software with your students	☐	☐	☐
d. Designing a multi-media presentation	☐	☐	☐
e. Creating your own Web page around the content you are teaching	☐	☐	☐

Overall Perceptions

5. In general, what have you found to be the *strengths* of [name of product] for instruction in [math or reading]?

> 5a. How about the *weaknesses*?

6. How well would you say [name of product] matches the way you're accustomed to teaching? Please explain.

> 6a. In general, would you say that it's important for kids to master the basic [math/language] skills before engaging in [mathematical problem-solving/reading text for meaning], or do you work at both those levels from the start?
>
> 6b. Which of these approaches is promoted by the school overall?
>
> 6c. Which of these approaches is promoted by [name of product]?

**7. Does your school have a dominant school- or district-wide instructional initiative? *E.g. literacy development, project-based learning* [If yes] To what extent has this impacted your use of [name of product]? Please give an example.

8. Last year you described [FILL IN] as your core curriculum. Is that still the case? [If NO] What is your core curriculum this year? How well does [name of product] work with this core curriculum?

**9. How is the sequence of content coverage in your non-computer-based core curriculum coordinated with that in the software? *After initial response, confirm a choice from the following four options*:

- ☐ You teach a topic or skill yourself and then have students use portions of the software covering the same topic or skill
- ☐ You have your students get instruction and practice on a topic or skill either from you or on the software but not both
- ☐ There is one sequence of topics you use in non-computer-based instruction and a different sequence in the software OR
- ☐ You follow the sequence of topics you use in non-computer-based instruction and allow students to use the software for self-directed supplemental exploration.

10. Were there any differences between the software and your core curriculum materials in terminology or the use of symbols? *Probe for description of any differences that caused problems for students. Probe for how differences in terminology or symbols were handled.*

11. How well does [name of product] integrate with the curriculum standards you're expected to teach to?

11a. With district pacing charts and other curriculum mandates?

11b. With the assessments on which your school is judged?

[*Take note of any effort to map the product onto local standards and of any conflicts that have arisen*.]

12. Some software products allow teachers to change the activity sequence to match their curriculum or lesson plans. Have you individually set or altered the sequence of software modules for some or all of your students?

If YES:

12a. What changes did you make and why?

13. Have you looked at any of the student performance reports available with [name of product]? [**If YES**] Which ones, and how often? Did you find these useful? [**If YES**] In what ways? Did you make any instructional decisions based on these reports? [*Tailor this question by product.*]

14. Did anyone else in your school or district look at reports from [name of product]? (e.g. principal, parents) [**If YES**] For what purposes? What, if any, decisions were made based on the reports?

Teacher Implementation

15. Last year (in 04-05), were you able to use [name of product] in the way you were trained, or did you find you had to make adjustments to make it workable in your school with your students?

15a. **IF CHANGES WERE NEEDED**, tell us about what you did and why.

15b. Did you find the changes you made were helpful? How so?

16. If you were going to provide a teacher new to [name of product] with tips based on your experience, what would you tell them to do?

Support

**17. Have you gotten any training or support from [name of company or vendor] this year? *Probe for formal training vs. informal support*.

**18. Have you gotten any training or support for using [name of product] from your *district* this year?

19. In general, to what extent do teachers at this school typically work together and support each other when trying out new instructional materials or approaches? (Rarely/Sometimes/Usually)

19a. [**If > 1** treatment teachers at the school] Has there been collaboration or mentoring among the teachers that are using [name of product]? If so, please describe. *Probe for whether this has changed from last year to this year*.

19b. Have you gotten supported time (i.e. paid time) for planning or collaboration this year that includes time to work together on issues related to using [name of product]? If so, how much? *Probe for whether this has changed from last year to this year*.

20. How much of an emphasis does your principal place on the use of educational technology? On [name of product] in particular?

21. How much of a barrier this year were technical problems? How did you handle them? How often did they occur?

**21a. Were technical problems more or less frequent this year (05/06) than last year (04/05)? Why?

**21b. Was there someone you could turn to for help on technical issues? How helpful was this support? Did it change from year 1 to year 2?

22. Is there anything else that particularly helped or hindered your use of [name of product] that we haven't discussed?

Perceived Outcomes

23. What, if any, effects have you seen of [name of product] on student learning of [math or reading]? *Probe for specific examples.*

24. What, if any, effects have you seen on student motivation?

**25. Have you seen any other student outcomes that are striking?

26. Do you find that [name of product] works better for some types of students than others?

**27. Has [name of product] changed your personal concept of how students learn [math or reading]? Of what students need to learn in the subject area, or strategies for teaching?

28. Have any of these outcomes (for students, or for you) changed since last year, now that you've been using [name of product] longer? **If YES**: In what ways, and why?

Closing

29. Do you plan to use [name of product] with your students again next year? Why or why not? Is there anything you'll do differently?

**30. Is there anything else you'd like to tell us about using [name of product] that we haven't already covered?

Study of Software Implementation Practices

School Leader Interview

Introduction

I'm [Name], from SRI International, working on the Dept. of Education's National Ed Tech study team. If you remember, this is a national study of the effectiveness of educational software products like [name of product]. In some of the schools we visited last year, we're contacting teachers and principals to get more information about how educational technology works in practice. We want to be able to describe what appear to be the best implementation practices, and also to learn more about some of the challenges of using technology effectively in the classroom. The information we get from our interviews (and observations) will be used only to help us describe overall software implementation issues and practices. We are not evaluating teachers, and we won't disclose the names of your school or the people we talk to.

> FOR SITE VISITS: Before we start, I need to have you review and sign this consent form. [AFTER THE RESPONDENT REVIEWS CONSENT FORM] Do you have any questions before we get started? [FOR PHONE INTERVIEWS: Before we get started, did you receive the express mail package with the consent form? Please be sure and sign it and send it to us in the enclosed prepaid envelope.]

School leader background / technology orientation

1. How long have you been the principal of this school?

2. What school- or district-wide initiatives have been dominant at the school this year in the past 2 years? *(E.g. literacy development, project-based learning, standards-based education.)*

3. I'd like to ask a question about your school's overall approach to teaching [math/language]. Would you say that it's important for kids to master the basic [math/language] skills before engaging in [mathematical problem-solving/reading text for meaning], or do teachers at this school work at both those levels from the start?

4. What is your vision for technology use at this school?

   4a. How extensively is technology used at this school?

   4b. What is the main driver of technology use in this school – is it a district initiative, a schoolwide effort, or a choice that individual teachers make?

5. Do students at this school use technology to practice for standardized tests in [math/reading]? If YES, what product are they using for that?

Product use and overall perceptions

6. To what extent has [name of product] been used this year at your school? *Probe for number of teachers/classes/grades, extent of use within class.*

7. To your knowledge, is usage of [name of product] more or less this year than last year, or is it about the same? *If usage has changed:* Why has usage changed?

8. Are there other software products that teachers are using for Xth-grade [reading or math] instruction here? Which ones, and how extensively are they being used?

9. How familiar are you personally with [name of software]? Did you attend any training in it, either this year or last year? (*If the school leader has little personal familiarity with the program, tailor the wording of the questions that follow appropriately.)*

10. *IF the school leader seems somewhat familiar with the product:* How congruent is [name of product] with the dominant instructional initiatives you described earlier? *Refer specifically to school leader's responses to question 2.* Has [name of product] been a support or a hindrance to these programs? Please explain.

Barriers

11. **From your perspective, what has been the biggest challenge to using [name of product] in the last two years?

12. ***After initial response to question 10, probe for the extent to which each of the following has been a barrier, and any solutions they've put in place:*

- Technical problems and/or equipment availability
- Integration with curriculum and standards
- Lack of teacher training or expertise in teaching with technology
- Resistance from teachers

13. **Has your school experienced other important challenges to using [name of product] that we haven't discussed?

Schoolwide Supports

14. **What schoolwide supports have been available in the last 2 years for teachers using [name of product]? *Probe for:*

- Training (initial and ongoing)
- Informal teacher peer support *(ask only if multiple teachers at the school are using the product)*
- Technical support *(Probe for who provides it and response time)*
- Discussions in schoolwide teacher meetings *(probe for types of discussion content: technical or instructional, and examples)*

15. **Were teachers given any extra prep/planning time for getting familiar with [name of product] and deciding how to use it instructionally? IF YES: How much time?

16. **Did the district provide any type of support for using [name of product]? IF YES: Please describe.

17. **Have there been any other important supports that we haven't discussed?

Perceived Outcomes

Now I'd like to ask you about your perception of the outcomes for students and teachers from using [name of product]. Do you feel that's something you have knowledge of? (If NO, skip to Question 21.)

18. What, if any, effects have you seen of [name of product] on students? (e.g. student learning outcomes, differences in motivation) *Probe for specific examples.*

19. Do you think that teachers are teaching any differently now that they are using [name of product]? If so, in what ways? Have you noticed any other outcomes for teachers (e.g. professional growth, increased professional community)?

20. Have any of these outcomes (for students, or for teachers) changed since last year, now that teachers have been using [name of product] longer? In what ways, and why?

21. Have you looked at any of the student performance reports available with [name of product]? Which types of reports, and how often? Did you find them useful? What kinds of instructional decisions were the reports used to support? What else was done with them?

22. **Does your school use a formal system of student data to make instructional decisions as a general practice? (e.g. benchmark assessment data) To your knowledge, have any reports from [name of product] been used in school, department, or grade-level decision making?

Futures

23. Do you think your teachers plan or would like to use [name of product] next year? Would you like more of your teachers to use it? Why or why not? Is there anything you think teachers will do differently with [name of product]?

24. **Is there anything else you'd like to tell us about your experience with [name of product]?

Study of Software Implementation Practices

Technology Coordinator Interview

Introduction

I'm [Name], from SRI International, working on the Dept. of Education's National Ed Tech study team. If you remember, this is a national study of the effectiveness of educational software products like [name of product]. In some of the schools we visited last year, we're contacting staff to get more information about how educational technology works in practice. We want to be able to describe what appear to be the best implementation practices, and also to learn more about some of the challenges of using technology effectively in the classroom. The information we get from our interviews (and observations) will be used only to help us describe overall software implementation issues and practices. We are not evaluating teachers, and we won't disclose the names of the school or the people we talk to.

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Role and School Context

1. What is your role at the school? Your role with respect to technology support? Has this changed since last year?

2. How much interaction have you had with [name of product] and with the teachers that are using it?

3. How much of an emphasis does your principal place on the use of educational technology? On [name of product] in particular? *PROBE for schoolwide emphasis on technology, and what drives it.*

Software use

4. To your knowledge, are teachers in your school still using [name of product]?

4a. NO or DON'T KNOW [Skip to Question 5]

4b. **IF YES**, are all teachers [list from study records] using [name of product]? IF only some, explain.

5. Do you think teachers are using [name of product] more or less than last year? [IF there's variation] Explain.

6. Did you receive any training or instruction on how to support use of [name of product] from [name of vendor]? **IF YES**, please describe briefly.

7. Some software products allow teachers to change the software activity sequence to match their curriculum or lesson plans. Have you helped teachers tailor the software to match their curriculum this year, either at the beginning of the year or ongoing? **If YES**: How much time, and what did you do to help teachers?

8. Did you have any involvement in producing or using reports from [name of product] for instructional decision-making? **If YES**:

    8a. What did you do to support report production, and how much time did it take?

    8b. Were teachers able to produce and use their own reports?

    8c. What types of decisions were the reports used to support? What else was done with them?

Support

9. In general, what has your role been in supporting teachers' use of [name of product]? *PROBE for whether role is purely technical, or includes instructional or classroom help as well.* If NONE, Skip to Question #11.

10. Compared to other [reading/math] software students use at this school, how much of a technical challenge does [name of product] pose? (More Than Most, Average, Less than Most, Don't Know)

11. How much of a barrier were technical problems to teachers using [name of product] this year? What have been the most typical technical problems with [name of product]? Describe.

    11a. Compared to last year, have teachers run into technical problems more or less this year? Why?

12. How often did teachers need technical support this year? How quickly were technical problems resolved?

13. Is there someone at the district level who helps with technical issues (e.g. hardware)? **IF YES**, how reliable is this support? Did it change from year 1 to year 2?

14. Have you had any contact with [name of company or vendor] this year to resolve technical problems? **IF YES**, describe.

15. To your knowledge, have teachers supported each other in their use of [name of product], such as through collaboration or mentoring with other teachers who are using the product?

16. Do teachers here generally tend to collaborate a lot when the school does new things with technology? In what ways?

Perceived Outcomes [Optional]

The following questions may be applicable if interviewing someone with curriculum integration responsibilities (e.g. a curriculum specialist or math or reading coordinator).

17. *If applicable.* In general, what have you found to be the strengths of [name of product] for instruction in [math or reading]? How about the weaknesses? *Probe for specific examples.*

18. *If applicable.* What, if any, effects have you seen of [name of product] on student learning of [math or reading] content? *Probe for specific examples.*

19. *If applicable.* What, if any, effects have you seen on student motivation?

20. *If applicable.* Have you seen any other student outcomes that are striking?

21. *If applicable.* Do you find that [name of product] works better for some types of students than others? Please describe.

Closing

22. Is there anything else you'd like to tell us about your experience supporting teachers in their use of [name of product] that we have not already covered?

Appendix B

Qualitative Data Coding Structure

Implementation Practices Coding Structure

1 DISTRICT/STATE PRACTICES

- 1.1 Priority/support for this software at the district/state level
- 1.2 Priority/support for tech in general at the district/state level
- 1.3 District-wide instructional initiatives
- 1.4 Mandated curriculum, scope & sequence, pacing, and standards
- 1.5 Testing (benchmarks, state exams)
- 1.6 AYP/NCLB
- 1.99 Other district/state practices

2 SCHOOL PRACTICES

- 2.1 PRIORITY/SUPPORT/VISION FOR THIS SOFTWARE
  - 2.1.1 Prioritizing time in computer lab
  - 2.1.2 Prioritizing tech support for this software
  - 2.1.99 Other priority/support/vision for this software
- 2.2 TECH AT SCHOOL
  - 2.2.1 Priority/support/vision for tech in general
  - 2.2.2 Tech use for standardized test prep
  - 2.2.3 Use of other software products
  - 2.2.99 Other tech at school
- 2.3 USE OF DATA
  - 2.3.1 Data-based decision-making
  - 2.3.2 Use of software reports
  - 2.3.99 Other use of data
- 2.4 School-wide instructional initiatives
- 2.5 Basic vs. problem-solving
- 2.6 SUPPORT FOR TEACHERS
  - 2.6.1 Providing paid time for teachers
  - 2.6.2 Incentives/recognition
  - 2.6.3 Collaboration support (e.g. shared time in the schedule)
  - 2.6.4 Scheduling of school day conducive to tech use
  - 2.6.5 Teacher autonomy
  - 2.6.6 No special supports
  - 2.6.99 Other support for teachers
- 2.7 Teacher collaboration/peer support/joint usage decisions
- 2.99 Other school practices

3 CLASSROOM PRACTICES

- 3.1 Amount and schedule of software use
- 3.2 Physical setup
- 3.3 Use of software reports (including teacher showing to parents)
- 3.4 INTEGRATING SOFTWARE WITH CURRICULUM AND NON-S/W
  - 3.4.1 Differences in language, symbol use

3.4.2 Sequence/pacing
3.4.3 Use of product-related non-software materials
3.4.99 Other integration of software with core curriculum

3.5 CLASSROOM TECHNIQUES

3.5.1 FACILITATION EXAMPLES AND TECHNIQUES
3.5.1.1 Differentiation
3.5.1.99 Other facilitation examples and techniques

3.5.2 CLASSROOM MGMT EXAMPLES AND TECHNIQUES
3.5.2.1 Established routines for transitioning into/out of technology
3.5.2.99 Other classroom mgmt skills and techniques

3.5.3 Motivation techniques
3.5.4 Student group work on the software/student peer to peer support
3.5.5 Classroom interruptions/off-task work
3.5.6 Student work (no teacher facilitation)
3.5.99 Other classroom techniques (including lesson topic)

3.6 Student preparation/training on the software
3.7 Teacher pedagogical beliefs
3.99 Other classroom practices

4 CONDITIONS

4.1 DEMOGRAPHICS
4.1.1 School demographics/prior achievement
4.1.2 Classroom demographics/prior achievement
4.1.3 Class size (school/classroom)
4.1.99 Other demographics

4.2 INFORMANT INFO

4.2.1 TEACHER INFO
4.2.1.1 Teacher background
4.2.1.2 Teacher tech background
4.2.1.3 Teacher quality, perceived strength
4.2.1.99 Other teacher info

4.2.2 Principal background/role
4.2.3 Tech coordinator background/role
4.2.4 Turnover
4.2.99 Other informant info

4.3 SCHOOL RESOURCES
4.3.1 Tech support availability
4.3.2 Equipment
4.3.3 Budget
4.3.99 Other school resources

4.4 Teacher, school leader, tech coordinator training
4.5 Other vendor contact
4.99 Other conditions

5 OUTCOMES

- 5.1 STUDENT OUTCOMES
  - 5.1.1 Student learning
  - 5.1.2 Student motivation/engagement/confidence/etc. in learning
  - 5.1.3 Student metacognition
  - 5.1.99 Other student outcomes
- 5.2 Teacher outcomes
- 5.99 Other outcomes

6 PRODUCT CHARACTERISTICS

- 6.1 Product design
- 6.2 Tech issues/comments
- 6.3 Other product materials
- 6.4 Logistics/classroom management
- 6.99 Other product characteristics

7 THEMES

- 7.1 Plans for next year
- 7.2 Competition for time in the classroom
- 7.3 Increased time on the subject
- 7.99 Other themes