

Evaluation of the Enhancing Education Through Technology:  
Middle School Technology Project –Year 2

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Planning, Assessment and Research Division Publication No. 297  
January 9, 2006

## Acknowledgements

I would like to offer special thanks to Doug Adams, Lauren Kirkpatrick, Suzy Galen, Isaac Kerze, Carol Lazo, and Tim Sanford for their invaluable assistance in the synthesis of this report. I would also like to thank the principals, teachers, and MSTP coaches and staff, that were instrumental in supporting us in our data collection efforts.

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## EXECUTIVE SUMMARY

This document contains the findings from Year 2 of a two-year districtwide evaluation of the Middle School Technology Project (MSTP). This report is intended to provide feedback on the implementation of the program and its relationship to student achievement. In Year 2 (2004-05) we collected the following data: teacher, administrator, and coach interviews; classroom observations of instructional practice in mathematics and science classrooms; professional development offered to teachers; and student pre and posttests. The study examines the extent to which the program: 1) was implemented, 2) affected teachers' practice in the use of technology to further enhance their delivery of standards-based and project-based curricula, and 3) impacted student performance in mathematics and science classrooms.

The MSTP was a two-year grant intended to improve middle school students' mathematics and science achievement by integrating technology into the curricula. The MSTP consisted of the following three components: 1) provision of technological resources, networking, and access to instructional materials in mathematics and science, 2) professional development to teachers in order to increase their proficiency in the use of technology in the classroom, and 3) opportunities for students to use technology in their mathematics and science classroom. The goals of the MSTP were to provide teachers with the equipment and professional development support to enhance their delivery of project-based learning and to work toward the Teaching for Understanding (TFU) model developed at Harvard University. It was expected that increasing teachers' range of instructional strategies, including the increased use of technology, would lead to greater student performance in mathematics and science and also advance their proficiency in the use of technology.

The research questions addressed in this report are:

1. To what extent have the MSTP efforts led to the integration of technology and enhanced the delivery of standards-based curricula in mathematics and science classrooms?
2. To what extent did the professional development offered through the MSTP impact teachers' ability to use technology and deliver more standards-based and project-based instruction?

3. To what extent did school culture have an impact on how the MSTP efforts were able to affect teachers' implementation and integration of technology into their lessons?
4. To what extent has the infusion of technology in the matched treatment schools yielded gains in student performance?
5. To what extent has the infusion of technology in the non-matched treatment schools yielded gains in student performance?

### Method

This study employed an experimental design with a random selection of schools into treatment and control conditions. Using a stratified random selection procedure, we chose eight schools that had schoolwide Title I programs and mid-range values on the SCI: four schools were selected as treatment schools, and four schools were selected as control schools. Then, at the request of program staff, an additional four schools were added to the study as schools that were part of the program. These four schools did not meet the same criteria as the matched treatment and control schools. Thus, these schools were considered “non-matched” treatment schools.<sup>1</sup> The non-matched treatment schools were included in the analysis for the purposes of examining program implementation only. The student achievement data for this group will be included separately, and not in comparison to either of the two groups.

Once the schools were selected, we randomly selected 11 teachers at each school: three 6th grade teachers (teaching both core math and science courses), two 7th and two 8th grade science teachers, and two 7th and two 8th grade math teachers, for a total of 132 teachers.<sup>2</sup> We then randomly selected one class period for each teacher in order to observe classroom practice and test students. Classes were selected based on a minimum enrollment of 20 students, with an average class size of 30 students, for a total student sample of approximately 4000 students.

The principal method used to collect data related to the implementation of the MSTP and teachers' use of technology was observation. We conducted observations in classrooms as well as at off-site and site-based professional development. Additionally, we interviewed

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<sup>1</sup> The four additional schools fell in the SCI range (137-158.5) with an average of 150.4.

<sup>2</sup> Eighth grade teachers were added in Year 2.

teachers, coaches, principals, and technology coordinators. We examined students' California Standards Test (CST) in mathematics. We also administered two performance-based assessments to students – the Balanced Assessment in Mathematics (BAM) and the Partnership for the Assessment of Standards-based Science (PASS).

Qualitative and quantitative data reduction and analysis were conducted with each type of data collected. First, we used classroom observation data to examine the extent to which the technology resources and materials were used. We also examined the quality of their usage to enhance the delivery of standards-based curricula in mathematics and science. Second, we focused our analysis of classroom instruction on the extent and quality of instructional activities conducted in mathematics and science classrooms.

In addition to classroom observation data, we analyzed teacher interview data to determine the frequency of use by teachers of the technology and electronic curricular resource materials provided as part of MSTP. Using teacher feedback, we identified issues regarding program implementation that may have influenced the effectiveness of the program. We also examined interviews from teachers in the control group to determine whether they had access to similar technologies and if they made use of them during instruction. Coach interviews were analyzed to determine the factors influencing the on-site professional development provided to program teachers. We also analyzed principal interview data to identify organizational differences or qualities of leadership or support that may have impacted the program. The non-matched treatment group will be discussed in terms of program implementation only. The student achievement data for this group will be included separately, and not in comparison to either of the two groups.

### Findings

With respect to question one, we examined program implementation in two ways. First, we looked at whether the technology provided to program schools was used by teachers during the school year. We found overall, that technology use was more prevalent among the non-matched treatment teachers than the matched treatment teachers in both mathematics and science classrooms. In addition, control teachers had access to some of the very same technological resources as the teachers in the treatment schools.

Second, we analyzed the data to determine whether teachers used the program technology and resources as teaching and learning tools to deliver Standards-based and

project-based curricula reflecting both the content and the process skills of developing reasoning and problem solving skills. We looked specifically at the quality of technology use in mathematics and science classrooms. The overall average quality of the technology use in mathematics classrooms was low. We did not find that math teachers used the technology in new and different ways, but instead used it to replace former methods of instructional delivery (e.g., using the Activboard instead of the overhead projector or blackboard). Consistent with the research on technological reforms in education (Cuban, 2000), most teachers used the technology to maintain existing practices rather than to enhance student development of problem-solving and reasoning skills and the development of student understanding in these subject areas. In science classrooms we found technology use was of a higher quality and was more nuanced. In some cases teachers used digital video clips to quickly visually demonstrate scientific concepts. In other instances students were using the laptops and the Internet to visit virtual interactive lab websites for a hands-on lab experience. We did find more science teachers in the non-matched group demonstrating higher quality technology use in science. Across all school types we found higher quality uses of the technology in science classrooms compared to mathematics classrooms.

Lastly we did not find that the quality of instruction provided by the teacher was affected by the use of technology. This was particularly noticeable within the control group, where we found that regardless of their use of technology, overall instruction was of a higher quality in both math and science than the matched treatment teachers. Overall, the quality of instruction in mathematics was low compared to science instruction. We found higher quality instruction more prevalent in science classrooms. More of the control science teachers demonstrated evidence of higher quality instruction than the matched treatment teachers. In both mathematics and science classrooms, low quality instruction was characterized by drilled-based exercises requiring little “higher order” thinking skills. Teachers provided students with limited opportunities to engage in thoughtful discourse, recognize relationships among ideas, think critically and develop explanations, or to make predictions and/or debate alternative approaches to problems. Instructional dialogue consisted of teacher elicitation of responses from students to recall type questions. High quality instruction was characterized by more project-based activities, where the content of the lesson was presented as a problem requiring students to apply or synthesize previously learned knowledge, to make a claim or

justify solutions. Teachers functioned in a more supervisory or facilitative role in activities, sharing control of the discourse with students.

With respect to question two, we examined whether the professional development offered to MSTP teachers had an impact on their ability to use the technology in the delivery of their lessons. In Year 1, the emphasis of professional development was on introducing teachers to the technology for use in their classrooms. Teachers who participated in the program for two years had the time over extended summer breaks between Year 1 and Year 2 to explore and fine tune their use of the tools and resources. There were teachers who were newer to the program who felt that they needed more in depth training with specific tools. There were substantially fewer formal workshops in Year 2, and the newer teachers found that the few they attended were too dense with information or sporadic to be effective. While the emphasis of support in Year 2 was on modeling of lessons and technology integration rather than technical support, the data suggest that there were inconsistencies in the way in which teachers received professional development. It appears that teachers in the non-matched treatment group received more extensive support and one-on-one assistance, and these same teachers spoke more favorably about the support they received than the matched treatment teachers.

Additionally, we found that the modified coaching model of maintaining one coach throughout the year as the other rotated, ensuring a steady rapport, did translate into the provision of more continuous teacher support. However, as a result of the teachers added to the project in Year 2, the coaches were stretched too thin to meet the needs of all the teachers. Coaches were also tasked with a range of administrative duties that took valuable time away from their ability to deliver the site-based instructional support that teachers needed.

Regarding teachers' overall experience with the program, 81% of the matched treatment teachers and 90% of the non-matched teachers provided enthusiastic overall feedback on their experience with the MSTP program. For example, one teacher remarked as a result of her participation, "I feel like I'm a much more powerful teacher." Others spoke of the "growth" they experienced, and how their participation in the program increased their classroom effectiveness, or how it has allowed them to relinquish classroom control and

allow students to take more responsibility for their own learning, or how much “fun” technology made teaching.

With respect to question three, we identified varying conditions in school organizational structure that may contribute to differences in the way the teachers implemented or integrated the technology. The data revealed teachers’ use of the technology was impacted by a variety of factors beyond the presence of the technology or coaches in the classrooms. In many cases, time available, school organizational factors or structures, and administrative support impacted the way in which the coaches were able to effectively permeate the already existing “culture” at the school site. These differences translated into limited opportunities to schedule meetings with teachers one-on-one or as a cohort. At the schools in which we found conditions more characteristic of a learning community, we found more teachers using the technology, and we found more evidence of higher quality instruction. We found more of these supportive conditions among the non-matched treatment schools than among the matched. We also found that some elements of collegiality were present at two of the control schools.

With respect to the fourth question, student achievement data provided the following results. Overall, the control students in each grade level outperformed the matched treatment, in both math and science. The exception to this overall finding was among the 8th grade science students, where matched treatment students significantly outperformed control students, but only on the Performance Task section of the PASS exam. Students in the 6th and 7th grade in both the matched treatment and control classrooms, where teachers provided higher quality instruction, performed better on the Balanced Assessment in Mathematics, the CST in mathematics, and the PASS in science.

With respect to question five, we found among the non-matched students, 8th grade science students’ performance on the Multiple Choice and Performance section of the test, far exceeded our predictions. When examining 8th grade student performance associated with teachers receiving high quality of instruction ratings we found higher quality instruction did not have an affect on either section of the test. We did, however, find that students in the 8th grade non-matched treatment classrooms, associated with teachers whose use of technology received a high quality technology rating in science, outperformed their peers

whose science teachers use of technology was rated lower in quality on the Multiple Choice section of the test.

### Recommendations

In light of the above findings, we make the following recommendations to ensure that similar programs are more effectively implemented in subsequent years.

- Teachers should be provided with continuous and in-depth professional development that not only instructs them about the mechanics of using the technology, but also teaches them how to meaningfully integrate it equally across both content areas. The focus of professional development should also emphasize practices reflective of high quality instruction.
- Coaches should be assigned to only one school. They should work directly with the administration at their school site to ensure that professional development is available on a regular basis is incorporated into the school schedule.
- Professional development addressing issues of enhancing the curriculum with the use of technology should also be directed specifically to the administrators, as the addition of technology to the educational program may require adjustments in the professional development schedule already in place at the start of the school year.
- Coaches should deliver a consistent program of support across schools and within subject matter and grade level.
- Program staff should work directly with Central District program coordinators to integrate their extensive set of standards-based electronic resources into the Districts' Curriculum Guides for Mathematics and Science, so that teachers interested in utilizing those resources don't have to spend extensive time searching for examples of lessons that integrate the mathematics and science curriculum.
- Program staff should consider involving and training the technology coordinators at each of the school sites to provide the technology support necessary to teachers.

- Program staff should provide MSTP teachers with opportunities to meet with colleagues across program schools in order to learn from one another and share lessons learned. Similarly, program staff should consider utilizing the more experienced MSTP teachers into the support structure available to additional schools as they receive support and technological resources.

In order not to replicate the same patterns of previous technology reform efforts, the District will need to continue supporting schools through adequate staffing of both technical and curricular support.

#### Next Steps

While the MSTP is continuing to support these schools in Year 3, it may be worthwhile to consider collecting data to determine the sustainability of the MSTP efforts. Additionally, as the District continues to support the integration of technology across the curriculum, the findings in this report indicate that it may take a number of years to see the effect of these efforts on student achievement. It will take continued effort and support to further advance to integration of high quality uses of technology to support the delivery of standards-based curriculum in mathematics and science.

## Introduction

This document contains the findings from Year 2 of a two-year districtwide evaluation of the Middle School Technology Project (MSTP). This report is intended to provide feedback on the implementation of the program and its relationship to student achievement. In Year 2 we collected the following data: teacher, administrator, and coach interviews; classroom observations of instructional practice in mathematics and science classrooms; professional development offered to teachers; and student pre and posttests. The study examined the scope of the program in terms of its: 1) implementation and the degree to which it affected teachers' practice by increasing their use of technology; 2) delivery of standards-based and project-based curricula; and 3) impact on student performance in mathematics and science classrooms.

This report is organized as follows. The introductory section presents the background of the evaluation (including an overview of the MSTP), a literature review of research on the use of educational technology, and the research questions for this year's evaluation. Then, we describe the methodology employed to examine the implementation and effectiveness of the MSTP, including a discussion of the sample selection, data collection and data analysis. Next, we present the findings regarding the implementation and the effectiveness of the MSTP deliverables to teachers and the program's impact on student achievement. Finally, we present conclusions and recommendations for consideration by program management.

### *Background*

The MSTP, a result of the Enhancing Education Through Technology funding provided by California Department of Education, was a two-year grant that was intended to improve middle school students' mathematics and science achievement by integrating technology into the curricula. The MSTP was designed to augment the distribution of technology resources throughout LAUSD that had formerly targeted K-6 and 9-12 sites. The MSTP provided middle school math and science teachers with a carefully chosen set of tools, resources, and professional development to enhance teachers' access to and use of technology for instruction. The expectation was that by supplying teachers with the additional technology resources and training in their use of these educational tools, teachers would be better able to deliver standards-based and project-based mathematics and science curricula. It was expected that increasing teachers' range of instructional

materials, including the increased use of technology, would lead to greater student performance in mathematics and science as well as advance both teachers and students proficiency in the uses and applications of technology in these subject areas.

### *The Middle School Technology Program*

The MSTP consisted of the following three components: 1) provision of the technological resources, networking and access to instructional materials in mathematics and science, 2) professional development to teachers in order to increase their proficiency in the use of technology in the classroom; and 3) opportunities for students to use technology in their mathematics and science classroom. The goals of the MSTP were to provide teachers with the equipment and professional development support to enhance their delivery of project-based learning and to work toward the Teaching for Understanding (TFU) model developed at Harvard University. Sample teachers in the program schools received the following equipment:<sup>3</sup>

- 14 inch Apple iBook laptop/ Gateway laptop
- Twenty 12 inch Apple iBook laptops (in a cart for students)/ Gateways
- Wireless Airport Station
- Proscope digital microscope Kit (including eight Vernier probes each to measure (ph, Conductivity, Temperature and Motion) and eight Logger Pro interfaces (electronic data collection tools)
- Promethean ActivBoard (Electronic White Board)
- Handheld Slate (Connected to the ActivBoard)
- Projector
- Digital Camera
- Laser Printer
- Scanner
- Graphing Calculators (only to 8th grade math teachers)

Teachers were also given access to the following electronic resource materials:

- *Multimedia Services/Digital Curriculum-Los Angeles County of Education* – an extensive library of curricular resources aligned to the standards, with downloadable videos

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<sup>3</sup> In Year 2, the probeware was more appropriately distributed according to content area and grade level.

- *Task Stream* – an electronic lesson planner that offers communication tools, file sharing, and web page publication opportunities
- *Big Chalk* – a library of electronic resources aligned to the California and national standards
- *Video Discovery* – a collection of 30,000 instructional graphics, photos and videos aligned to the standards (Science related topics)
- *CTAP Online* – Electronic resource and database of standards-based lessons, lesson building tools and links to additional related resources, that allows for document sharing
- *Futures Channel*-Electronic video resource library of “real world” professionals using math and science in the field.

Additionally, in Year 2, the MSTP upgraded the technology available to all teachers at the selected schools to reduce the computer to student ratio to 6 to 1.

### *Literature Review*

Nationwide, private companies and federal and state grants have provided a significant amount of money to public schools in order to foster the use of technology in the classroom. The bulk of this financing has gone to hardware needs including purchasing computers and other multimedia equipment, ensuring that schools are wired for the Internet, and reducing the student to computer ratio. Ensuring that technology is available is only half of the educational agenda. The larger goal of these various reform efforts has ultimately been to improve the delivery of standards-based curricula. Cuban (2001) points out that the investments in a wide array of technologies have yet to produce their desired outcomes primarily because most teachers use new technologies to maintain existing practices rather than to enhance their teaching of student problem-solving and reasoning skills.

For technology to be effectively integrated into an instructional program to improve the delivery of standards-based curricula, several conditions need to be in place: strong leadership, professional development, and the technological capacity of the system (Lemke and Coughlin, 1998). The literature review addresses these topics.

### *Leadership and School Culture*

According to Elmore (2002), the organizational contexts or structures of many schools are not adequate to promote or sustain improvement, particularly in the area of instruction. Boyd (1992) argues that school culture is “the existence of an interplay between three factors: the attitudes and beliefs of persons inside the school, the cultural norms of the school and the relationships between persons in the school (p.27).” Typically, a “toxic” culture is one in which teachers work in isolation from each other, they do not collaborate, they do not learn from each other, and they do not grow professionally (Deal and Peterson; 1999). Hord’s (1997) dimensions of professional learning communities, on the other hand, highlights the five following attributes: 1) shared and supportive leadership, 2) shared vision and values, 3) collective learning and application of that learning, 4) shared personal practices, and 5) supportive conditions, relationships, and structures.

The principal’s role in creating a professional learning community has been the focus of much of the “effective schools” literature. Effective schools are ones in which students perform above what would be expected based upon their backgrounds, and in which the principal’s leadership and the disciplinary environment of the school have an effect on student outcomes (Coleman et al, 1996; Byrk, Lee and Smith, 1993; Chubb & Moe, 1990). Prestine (1991) proposes that a principal’s effective leadership relies on his/her ability to: 1) help formulate a shared vision, 2) cultivate a network of relationships, 3) allocate resources consistent with the vision, and 4) promote teacher development. Further, she describes a *transformational* leader as someone who sees it as his/her role to establish a community of learners, facilitates leadership in others, has the capacity to inspire commitment to jointly solve problems, and inspires others to the greater shared purpose of continually improving instructional practice. She suggests that the presence of a transformational leader is necessary to move a school toward a positive learning community in which reform can take place.

Schools committed to becoming learning communities demonstrate evidence of continuous dialogue about what constitutes good teaching practice, and of continuous learning and improvement (Hall & Resnick, 1998). These schools facilitate a common learning culture, providing common meeting times during the school day, opportunities for teachers to visit other schools or classrooms where excellent instructional practices are modeled, rearranging schedules

to allow these types of interaction to occur, and investing in the development of teacher capacity by treating professional development as part of teachers' everyday work.

The extensive early literature on professional development focused primarily on staff development characterized by a 'training' paradigm— brief, standardized sessions designed to impart discrete skills and techniques. Professional development must be constructed in such ways as to “deepen the discussion, open up the debates, and enrich the possibilities for action’ (Little, 1993, p. 148) It must help teachers move beyond “mechanical use” of curriculum and technology to become facilitators of inquiry (Lieberman & Miller, 1990; Little 1993). Professional development programs that encourage and promote collegiality, and open discussion of issues, and enable teachers to collaborate and participate in their own professional growth. Little (1981) describes collegiality in schools is evidenced when: 1) teachers talk about practice; 2) they observe each other engaged in the practice of teaching; 3) colleagues engage together in work around curriculum by planning, designing, researching and evaluating; and 4) when teachers teach each other what they know about teaching and learning.

Research that focuses on the areas of professional development (Guskey, 2000; National Staff Development Council, 1995), school reform (Elmore, 2002), leadership (Fullan, 2001) and organizational learning (Preskill & Torres, 1999) present many similar themes regarding the characteristics of organizations in which adults learn. At the organizational (school) level, this involves an integrated focus on the organization's ultimate goals (student achievement); organizational capacity for ongoing improvement; an organizational culture that promotes inquiry and reflection; and structures and systems that foster the generation and sharing of information to further develop teachers' learning. If change efforts are going to be effective, the change must be clearly defined, support and assistance must be available, and leaders and policies must support the change (Fullan, 1993).

### *Content Knowledge*

Effective use of technology in the classroom is not merely predicated on training in the use of this technology; it is also predicated upon teachers' knowledge and understanding of skill acquisition within each content area (Shulman, 1986). When teachers are trained in both areas, they will then be able to use technology “in appropriate ways to deliver powerful instruction” (Hasselbring & Tulbert, 1991). Effective professional development experiences are those that are designed to help teachers build new understandings of teaching and learning and to experiment

with the teaching strategies that help students learn in new ways (Little, 1993; Loucks-Horsely et al., 1990). Their extensive work on professional development for math and science teachers, advocates that teachers must experience learning in ways that hold to constructivist principles. Only then will they understand why it is important for their students to learn in this way and for them to break their old models of teaching.

Even if teachers are comfortable with using technology, if they are not equally comfortable with the subject matter and the pedagogy called for to deliver a Standards-based curriculum, they will not be able to use technology effectively. Much of the research asserts that the students of teachers who can teach higher-order thinking skills as well as lower-order thinking skills outperform students whose teachers only teach lower-order thinking skills (Phelan, 1989; Langer & Applebee, 1987). Teaching higher-order thinking skills involves not so much conveying information as conveying conceptual understanding.

Unfortunately, the traditional mathematics curriculum at the middle school level concentrates on the acquisition of computational skills, such that repetitive computational exercises are ubiquitously performed without understanding (Stigler, et al., 1999; Weiss et al., 2003). Consistent with the literature on math and science reform, there is a predominant presence of content-driven lessons characterized by lecture, recitation, worksheets, tests, and minimal instructional discourse (Cohen & Hill, 2000; Stigler & Hiebert, 1999). According to the National Council of Teachers of Mathematics (NCTM), regardless of the debate about what mathematical content is most important to teach, there is a growing consensus that what students learn, they should learn with deep understanding. Learning for deep understanding of mathematics requires effective communication in the classroom (NCTM 1989, 1991). This emphasis is echoed in the work of Ball who focuses on an “inquiry classroom” (1993). Ball argues that the role of the teacher is to engage the students in meaningful mathematics discussions, in which students are asking questions, solving problems and formulating or critiquing mathematics arguments (1993). This discourse is not the rapid-fire questioning and short answers typically seen in recitation-style mathematics lessons.

Scientific literacy is defined as recognizing the interdependence of science, mathematics and technology, understanding key concepts and principles, and using this knowledge and ways of thinking for individual and social purposes (AAAS, 1989). Building on the work of the national reform efforts such as the American Association for the Advancement of Science’s Project 2061

and the National Science Teacher Association Scope and Sequence Project, the vision described in the National Science Education Standards is remarkably consistent with that of the NCTM Standards. Both agree that the focus should be on a limited number of concepts, emphasizing deep understanding, reasoning and problem solving rather than memorization of facts, terminology, and algorithms. According to Haury (1993), inquiry-based programs foster scientific literacy and understanding of scientific processes; vocabulary and conceptual understanding which lead to higher achievement. Drawing on prior studies, NAEP, TIMSS and the national Survey of Science and Math Education found that the majority of students in science classrooms experience limited opportunities to communicate, analyze and evaluate data collected to formulate scientific understanding (Weiss et al., 2002).

If teachers do not understand the pedagogy necessary for their content areas, they will not have the background for placing technology among the range of pedagogical alternatives required to increase student learning (Wenglinsky, 2005). According to the National Center for Improving Science Education (1993), indicators for effective professional development programs in science and mathematics are characterized by the following experiences that build a learning community: 1) continuous learning is a part of the school norms and culture; and 2) teachers are rewarded and encouraged to learn and share together.

### *Technology*

Kosakowski argued that “technology cannot exist in a vacuum, but must become part of the whole educational environment” if it is to be used effectively (1998). The North Central Regional Educational Laboratory (1999) suggested that the successful integration of technology into the American educational system would involve recognition on the part of all stakeholders that it is not the technology alone that will promote student achievement. It is, rather, the use of the technology as it relates to the larger educational goals that are established by the district or school.

Teachers need ongoing, in-depth professional development that instructs them on the mechanics of the technology as well as how to use it meaningfully in an instructional setting. Educators must be made aware of the mechanisms by which technology use leads to student learning (Hasselbring & Tulbert, 1991). Use of technology, must be aligned to the instructional goals of the teacher and the Standards they want their students to meet. Effective use of technology in the classroom requires that teachers know how to use the technologies and how to

integrate those tools into the most effective pedagogy for delivering the subject matter (Wenglinsky, 2005). As many of the reform efforts over the last decade have found, it's not enough to simply infuse schools with technology and offer workshops to increase technology literacy. Teachers need the hands-on experience and the time to apply new techniques to delivering the curriculum and refining their instructional approaches. In addition, the integration of technology into all aspects of teaching and learning takes time to establish, and the school day must be adjusted to allow this integration to occur. As Wenglinsky (1998) found, when technology is used to maintain lower order thinking skills, or drill based activities, the technology use demonstrated a negative impact on student achievement. As the Panel on Educational Technology (1997) found, new teaching and learning strategies may be necessary to promote the development of higher-order reasoning and problem-solving skills for students.

If the integration of technology is going to be successful, it is critical that teachers be properly trained and involved in the integration process. Increasing the frequency, depth and breadth of opportunities teachers have to collaborate and discuss and critique their own pedagogy influences the instructional context and the quality of technology use (Becker & Reil, 2000). As the studies (1995) from the Apple Classrooms of Tomorrow (ACOT) illustrate, teachers follow a series of stages to technology integration, and the earlier activities tend to mirror current teaching practices, or those that teachers feel comfortable with. They found that as teachers' comfort level and proficiency improve, they begin to use technology in more novel ways, and capitalize on the capabilities of the technology to improve their pedagogy.

The literature on school leadership and culture, teachers' content knowledge, teachers' content pedagogy, and the integration of technology into instruction point to the complexity of evaluating the impact of technology in a classroom setting. The use of technology in a math or science classroom is influenced by larger systemic or school factors. Thus, rather than simply make linear inferences between technology use and student achievement, this study focuses on the variety of factors and influences that work congruently with teachers' ability to use technology to improve the quality and delivery of Standards-based curricula in mathematics and science.

In light of this research, it is apparent that evaluating the impact of technology in a classroom setting is a complex process, and several key factors must be taken into account. It is difficult to measure the impact of technology on student achievement because changes in technology use are often part of larger systemic or school organizational constraints. Thus, it is

difficult to employ merely quantitative analysis to infer a simple, causal relationship between technology use and student achievement. The data included in this report attempts to capture the constellation of factors and influences that are working congruently with teachers' ability to integrate technology and use it to improve the quality and delivery of standards-based curricula in mathematics and science.

### Research Questions

The research questions addressed in this report are:

1. To what extent have the MSTP efforts led to the integration of technology and further enhanced the delivery of a standards-based and project-based curricula in mathematics and science classrooms?
2. To what extent did the professional development offered through the MSTP impact teachers' ability to use technology and deliver more Standards-based and project-based instruction?
3. To what extent did the school culture have an impact on how the MSTP efforts were able to affect teachers' implementation and integration of technology into the lessons?
4. To what extent has the use of technology in the matched treatment schools yielded gains in student performance?
5. To what extent has the use of technology in the non-matched treatment schools yielded gains in student performance?

### Method

This section presents the methodology employed to evaluate the implementation and effectiveness of the MSTP, during the 2004-05 school year. It contains a discussion of the sample selection, data collection, and data analysis procedures. This study employed an experimental design with a random selection of schools into treatment and control conditions. The term "matched treatment group" denotes the schools randomly selected to receive the MSTP technology and support. The term "control group" refers to the set of schools identified with similar characteristics based on the School Characteristics Index (SCI) that did not receive the technology equipment and professional development support offered by the MSTP. The study also contains an additional set of "non-matched treatment" schools that received the MSTP technology

and support. These teachers and student achievement data are included in the analyses but are identified as the non-matched group of students and teachers. The non-matched treatment group will be discussed in terms of program implementation only. The student achievement data for this group will be included separately, and not in comparison to either of the two groups.

### Sample Selection

The Program Evaluation and Research Branch (PERB) was asked to identify schools that would represent “typical” middle schools in LAUSD based on their SCI ranking. The SCI is a composite measure of a school’s background characteristics developed by the California Department of Education (CDE).<sup>4</sup> The initial stage of the selection procedure consisted of a stratified random selection of schools that have schoolwide Title I programs and mid-range values on the SCI. From a list of 13 schools, which fell into a range of 139.6 to 145.1 (with an overall average of 142.5) on their SCI, 8 schools were randomly selected: 4 schools were selected as treatment schools, and 4 schools were selected as control schools. Then, at the request of program staff, an additional four schools were added to the program treatment efforts. These 4 schools did not meet the same criteria as the matched treatment and control schools.<sup>5</sup> Thus, these schools were considered “non-matched” treatment schools.

In the second stage of the selection procedure, we randomly selected 11 teachers at each of the 12 middle schools: 3 6th grade teachers (teaching both core math and science courses), 7th grade and 2 8th science teachers, and 2 7th and 2 8th grade math teachers, for a total of 132 teachers. We then randomly selected one class period for each teacher in order to observe classroom practice and collect data on student performance among those students. Classes were selected based on a minimum class size of 20 students, with an average of 30 students, thus our study consists of approximately 4000 students. Table 1 summarizes the school and teacher sampling procedure.

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<sup>4</sup> The measure includes both student and school level data. Student level characteristics include student ethnicity, mobility, English proficiency and SES and school level data includes percentage of credentialed teachers and average class size.

<sup>5</sup> The four additional schools fell in the SCI range (137-158.5) with an average of 150.4. An analysis of student language classification and teacher characteristics confirmed that the non-matched treatment teachers were not comparable to the treatment teachers.

	Matched Treatment Schools (n=4)	Control Schools (n=4)	Non-Matched Treatment Schools (n=4)
Grade and Subject			
6th/Math/Science	3	3	3
7th/Math	2	2	2
7th/Science	2	2	2
8th /Math	2	2	2
8th/Science	2	2	2
Total/School	7	7	7
Overall Total	44	44	44

a. Two teachers from the matched schools, two from the non-matched and three from the control schools were removed due to substantial shifts in teacher assignments and student enrollment from Fall to Spring.

### *Student Sampling*

We confirmed the comparability of the matched treatment, and the control students in terms of home language and language classification or English language proficiency using data from the Student Information System (SIS). As shown in Table 2, there were differences between matched treatment and control students regarding home language and English Learner (EL) populations. The control group contained proportionately fewer students with a home language of Spanish and with Limited English Proficiency (EL) than the matched treatment students. We controlled for these differences when analyzing the outcome data.

Grade	Matched Treatment %			Control %		
	6th	7th	8th	6th	7th	8th
Home Language: Spanish	72	61	79	59	54	63
Home Language: English	17	25	14	30	31	23
Limited English Proficiency	31.9	24.2	33.5	15.5	10.2	12.1
English Only	13.6	21.2	10.8	29.4	30.5	22.7
Reclassified Fluent English Proficiency	39.8	41%	44.2	39.6	42.3	50.8

In addition to examining the student characteristics of the matched treatment and control groups, we also compared teachers for differences in years of experience, employment status, certification and emergency permit classification. Table 3 reveals that control teachers had more overall years of experience and were more likely to be fully credentialed teachers than the matched treatment teachers. Additionally, matched treatment teachers were more likely to be interns, or have probationary, provisional or emergency credentials than the control teachers.

	Matched Treatment (n = 41)			Control (n = 43)		
	6th	7th	8th	6th	7th	8th
Employment Status						
Continuing	64%	69%	73.3%	91%	81.3%	62.5%
Probationary	27.3%	19%	--	9%	6.3%	19%
Intern	9.1%	12.6%	13.3	--	--	19%
Provisional	--	--	13.4	--	12.6%	--
Years of Experience (mean)	6.4	8.2	8.7	8.9	14.1	12.1

We also examined the characteristics of the non-matched treatment students and teachers. Within the non-matched treatment student population we found a higher proportion of students classified as English only than either the control or matched treatment group (see Table 4).

Grade	6th	7th	8th
Home Language: Spanish	53	53	50
Home Language: English	41	42	41
Limited English Proficiency	20	9	12.3
English Only	43.8	43.9	40.5
Reclassified Fluent English Proficiency	22.1	34.8	33.7

As for the teachers in the non-matched treatment group (see Table 5), we found fewer interns than either the matched treatment or the control teachers, but a slightly higher percentage of teachers with probationary status than either group.

Employment Status	6 th	7 th	8th
Continuing	67%	60%	67%
Probationary	33%	13.4%	20%
Intern	--		6.7%
Provisional	--	6.7	6.7%
Years of Experience (mean)	6.2	11.4	8.0

## Data Collection

### *Classroom Observations*

The principal method used to collect data related to the implementation of the MSTP and teachers' use of technology was observation. Trained research assistants observed each sample teacher for one class period (ranging from 40 to 60 minutes) for three consecutive days (both Fall and Spring) for approximately 795 days of classroom observation data. The observation protocol consisted of narrative notes that captured the following dimensions of instruction: quality of the lesson goals, alignment of goals and lesson activities, cognitive challenge of the lesson, quality of discussion, and quality of teacher and student interaction. These instruments were utilized in the observation:

- Pre-Observation Questionnaire
  - Observation Checklist
  - Fieldnotes
- a. *Pre-Observation Questionnaire*: Prior to the lesson, observers asked the teacher about the goals of the lesson (the skills to be taught) and how these skills would be assessed (during the lesson or at a later date).
  - b. *Observation Checklist*: The checklist was designed to capture dimensions of mathematics and science classrooms that shaped the kind of learning environments afforded to students. These dimensions include: teacher activities and the role of the teacher in facilitating the

lesson (e.g., use of questioning strategies), student activities (the nature of the learning tasks), resources in use and tools available to students, and instructional strategies/student groupings and the social culture of the classroom.

- c. *Fieldnotes*: Fieldnotes are defined as a written narrative describing in concrete terms and great detail the duration and nature of the activities and interactions observed. Classroom observers documented the nature of the classroom tasks, the instructional strategies used by teachers, the questions asked by teacher and students, the level of discussion, the materials used, and the students' behavior during the class lesson. In addition to field notes, observers collected examples of worksheets and other supplemental materials. Within the field notes observers were asked to give a detailed description of the layout of the room and the resources visible, whether old or new, as well as the seating arrangement of students.

### *Interviews*

In addition to the classroom observations, data collectors conducted interviews with teachers and principals from the schools in our study and with the coaches. Through these interviews, we sought to identify issues regarding program implementation, and the extent and quality of MSTP professional development services offered.

- a. *Teacher Interviews*: Data collectors conducted teacher interviews at the end of the school year at the matched treatment, control, and non-matched treatment schools to identify teachers' technology use, their access to curricular resource material and technology, their comfort level using technology, and the professional development opportunities available to them to enhance their practice.
- b. *Coach Interviews*: Coaches were interviewed twice during the year in order to identify the specific nature of their work and to determine the degree of consistency in the delivery of site-based professional development available to teachers in the both the matched and non-matched treatment schools.
- c. *Principal Interviews*: We interviewed principals to identify issues of access, procurement and connectivity that may affect teachers' abilities to integrate technology in the classroom. We also identified the extent of additional professional development available at each of the school sites.

### *Professional Development*

In addition to classroom observations and interviews, we observed some of the site-based and off-site professional development to determine the range of professional development offered to teachers, the number of teachers attending, and the degree of assistance provided to teachers to integrate technology resources and instructional materials into their curricula.

### *Student Data*

We collected student achievement data for the California Standards Test (CST) in mathematics. We also administered a performance-based assessment in mathematics classrooms in order to assess the extent to which students enhanced their problem-solving and reasoning skills. Since middle school students were not required to take the CST in science, we administered a science performance assessment to measure the effectiveness of the MSTP in science classrooms. The assessments selected and administered were the Balanced Assessment in Mathematics (BAM) and the Partnership for the Assessment of Standards-based Science (PASS). These performance assessments were administered as pre and posttests in mathematics and science within each grade (6th-8th). Data collectors were trained to administer the tests. Test administration took place in one randomly selected class period. Tests were administered to the whole class with the teacher present in the room.

### *Balanced Assessment in Mathematics (BAM)*

The Balanced Assessment in Mathematics (BAM) is a product published by McGraw Hill and is aligned with the National Council for the Teaching of Mathematics (NCTM) Standards. This assessment was designed by the Mathematics Assessment Resource Service (MARS) under the direction of a mathematics board of national and international experts in mathematics education. The emphasis of the assessment is to assess student performance on worthwhile tasks involving practical contexts and substantial chains of reasoning. The Standards for the BAM are based on the Principles and Standards for School Mathematics developed by the NCTM. The test addresses the same content (Number and Operations, Algebra, Geometry, Measurement, Data Analysis and Probability) and process (Problem Solving, Reasoning and Proof, Representation, Connections and Communication) standards for each grade level, increasing in complexity as the student advances across grade levels. The BAM is built from a number of non-routine tasks, usually involving the student choosing and using appropriately a variety of skills and concepts.

Each test consists of two 40-minute parts (A and B), which constitute a well-balanced assessment inclusive of both content and process skills. Each section of the test is comprised of five separate tasks incorporating each of the Standards listed above. These tasks require students to integrate their skills using longer chains of reasoning and greater depth of knowledge. Students are asked to explain their answers and are given points for showing their work. Part B of the test has one short answer task, which doesn't require students to justify their reasoning. Form B is designed to complement Form A, sampling other areas in addition to the "big ideas" of mathematics at each grade level. BAM has established cut scores for performance divided into four levels, equally distributed on a scale from 1 through 40.

*Partnership for the Assessment of Standards Based Science (PASS)*

PASS is a Standards-based science assessment published by WestEd for elementary, middle, and secondary levels. It is aligned to the National Science Standards and the Benchmarks for Science Literacy. The PASS assessment is made up of three components: 1) Enhanced Multiple Choice, 2) Hands-On Performance Task, and 3) Open-Ended Questions or Constructed Response Investigations. The description and rationale for each component are listed below. The questions on the multiple choice component assess students' understanding of important scientific facts, concepts, principles, laws and theories and probe analytical reasoning skills. The tests are written into two alternate and interchangeable forms (1 and 2) and each form contains twenty-nine items. A matrix approach is used to sample across students and content Standards. The hands-on performance tasks provide students the opportunity to construct the "big ideas" of science through inquiry and investigation. These tasks are presented to students with a scenario or story line that identifies a problem to solve in the investigation. Students are provided with equipment and materials and are asked to perform short experiments, communicate scientific information, make scientific observations, generate and record data and analyze their results based on this data. The Open-Ended Questions and Constructed Response questions provide students with a problem and are similar to the performance tasks but do not require hands-on materials. These questions explore students' ability to analyze a problem, communicate scientific information, revise a hypothesis, and recommend solutions.

PASS modified their current available test aligned to the National Science Standards for grades 5, 8, and 10 to the California Content Standards for grade levels 6-8 so that they could be used in this study. Within each grade level, there are 35 key science concepts and PASS has

guaranteed an 86% alignment of the test we administered for grades 6 and 7 and a 59% alignment for the 8th grade.

### **Data Analysis**

Qualitative and quantitative data reduction and analysis were conducted with each type of data collected. First, we worked with a team of trained analysts to examine the extent of technology use, and second we looked at the quality of mathematics and science instruction. Using the classroom observation data, we focused our analysis of the classroom on the following: 1) whether teachers were using the technology, and 2) the nature of the learning tasks in mathematics and science classrooms.

We used the classroom observation data to determine the resources and materials used and the ways in which the technology was used. We used a modified version of the Apple Classrooms of Tomorrow (ACOT) model of the five stages of technology adoption and integration (Sandholtz, Ringstaff, & Dwyer, 1997) to analyze the quality of technology use in the classroom (See Appendix). Teachers' usage of the technology was rated using a 5-point scale (1=low, 5=high) in terms of the extent to which using the technologies provided students with innovative learning opportunities characteristic of high quality instructional practices.

Similarly we looked at the quality of instruction using a rubric based on a 5-point scale (1=low, 5=high) to analyze whether the instructional activities students were engaged in fostered the development of problem solving and reasoning skills explicit in the State Content Standards in Mathematics and Science. The rubric examined the following dimensions of the classroom: 1) the nature of the learning task; 2) the role of the teacher and 3) the social culture of the classroom. Evidence of high quality instruction in mathematics and science classrooms was determined by the extent to which the teacher had provided learning tasks that allowed students opportunities to demonstrate reasoning, communicate, draw connections, and solve real problems.

In addition to classroom observation data, we analyzed teacher interview data to determine the frequency of use by matched treatment and non-matched treatment teachers of the technology and electronic curricular resource materials provided as part of MSTP. In addition, we attempted to identify issues regarding program implementation that may have influenced the effectiveness of the program. We also examined the control teacher interview data to determine whether they had access to similar technologies and if they made use of them during instruction. Coach interviews were analyzed to determine the factors influencing the on-site professional development provided

to program teachers. Analysis of principal interview data was used to identify organizational differences in opportunities for professional development, site-based technical and coaching support, and characteristics of leadership or support that may have impacted the program and the overall school culture.

Quantitative data analysis was conducted on the pre and posttest assessment using multiple regression analyses to explore the relationship between student performance outcome gains, teachers' use of technology, the quality of instruction, and the interaction between use of technology and quality of instruction. These analyses were conducted within each grade level and within content area.

The next section presents the findings for the second year of MSTP implementation. The findings are presented first in terms of program implementation and professional development opportunities afforded to program teachers, as case studies across program schools, and finally, in terms of the overall impact program implementation had on student achievement.

## Findings

*Research Question 1: To what extent have the MSTP efforts led to the integration of technology to enhance the delivery of Standards-based and project-based curricula in mathematics and science classrooms?*

In order to determine the effect of the MSTP implementation in Year 2, we examined classroom observation data collected from all of our sample classrooms (matched treatment, non-matched treatment, and control). The first aspect of implementation examined was *whether* program teachers used the technology tools and supplemental curricular resources provided as part of MSTP. The second aspect examined was *how* the technology was used. The analysis compared matched, non-matched treatment, and control teachers to determine: 1) the degree of technology use within both mathematics and science classrooms; 2) the specific ways in which the technology was used within each content area; and 3) the quality of instruction in both mathematics and science classrooms.

### *Technology Use*

We looked separately within mathematics and science classrooms across the matched and non-matched treatment schools to determine if there were differences with respect to their

adoption and integration of the technology into their lessons. We aggregated the three days of observation data for each teacher in order to determine the frequency of technology use. We also looked at the control teachers in order to determine if their students were exposed to similar technology. Table 6 presents those teachers using the technology tools on two or more days.<sup>6</sup> First we looked at each group type – matched and non-matched treatment, and control and their overall use of the technology (including mathematics and science teachers combined). Second, we looked within each content area for differences in use of the technology.<sup>7</sup>

Technology Usage	Spring 2005		
	2 or More Days (ALL)	% Math Teachers using technology	% Science Teachers using technology
Matched Treatment	69% (N=39)	58% (N=19)	68% (N=22)
Non-matched Treatment	84% (N=40)	81% (N=24)	86% (N=23)
Control	28% (N=40)	4% (N=25)	33% (N=24)

a: The differences in teacher totals within content areas reflect mobility in sample population and the possible inclusion of the 6th grade teachers within both content areas.

As Table 6 reveals, we found differences in the use of the technology in the non-matched treatment group (84%) and the matched treatment group (69%) on two or more days. These findings are consistent with our findings in Year 1. We also found evidence of use in the control classrooms (28%) on two or more days. This finding is also similar to the findings in Year 1.

We also examined technology use within each school and across school types – matched and non-matched treatment, and control. We found that matched treatment teachers were less likely to use the technology than the non-matched treatment teachers. Looking at each of the four matched treatment schools, we found one school in which only 54% of the teachers were using the technology on two or more days. No more than 78% of the teachers at the other three schools were

<sup>6</sup> The 8th grade teachers and those entering the program in Year 2, did not receive all of their equipment until the middle of the school year, and thus we are using the data gathered during the Spring.

<sup>7</sup> The 6th grade teachers were included in both content areas only if they used the tools on two or more days in both content areas. The 6th grade teachers were cored and thus taught both mathematics and science to the same set of students.

observed using the technology on two or more days. Whereas among the non-matched treatment schools, we found schools in which 100% of the teachers were using the technology on two or more days, and no less than 80% on the low end. We also found that use of technology at the control schools was primarily concentrated at two of the four schools.

When we examined the schools by content area – (mathematics and science)- we also found a similar pattern by school type. As shown in Table 6, 81% of the non-matched treatment mathematics teachers were observed using the technology on two or more days, whereas only 58% of the matched treatment mathematics teachers used technology on two or more days. Only 4% of the control math teachers were observed using technology on two or more days. We found slightly more use of technology in the science lessons than in mathematics lessons across each school type. Within the non-matched treatment group, 86% of the science teachers used technology on two or more days, compared to only 68% of the science teachers in the matched treatment group. We also found more of the science teachers in the control group (33%) used technology on two or more days compared to math teachers (4%).

Additionally, as Table 7 reveals, when looking at technology use in mathematics classrooms only 57% of the math teachers in the matched treatment group were using some technology in their lessons on at least one day, whereas all of the non-matched mathematics teachers were using some of the technology. We also found that 24% of the mathematics teachers in the control group were incorporating technology into their lessons. These findings held true in science as well. As Table 8 illustrates, we found fewer instances of technology use among the matched treatment teachers in science (63%) compared to the non-matched treatment teachers (100%) on at least one day during our three days of observation. We also observed that science teachers (62%) in the control group used technology in their lessons on at least one day. Again, most of the science teachers in the control group using technology were from only two of the control schools.

As Table 7 also illustrates, the ways in which mathematics teachers used the technology in their classrooms, was not of a high quality.<sup>8</sup> High quality technology use in mathematics was only found among the control and the non-matched treatment teachers. The majority of mathematics teachers used technology in ways that resembled traditional mathematics instruction. Teachers used the technology primarily for drill and practice, rather than to advance students' opportunities

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<sup>8</sup> The rating was calculated as an average score based on days used. Using a 5-point scale we cut the scores at 2.2 and determined low and high.

to engage in problem solving activities involving mathematical reasoning. Frequently we found teachers used the Activboard much like they would use a chalkboard, whiteboard or overhead projector, to display problems, assignments or an agenda for the week. We observed teachers using the Activboard to demonstrate computational problems, asking students basic recall questions. Mathematics teachers' use of technology resembled what we found in the majority of mathematics classrooms without technology; students solving computational problems from the board (or a website), engaged in limited dialogue about their mathematical thinking. Given that the quality of technology use was consistent with traditional practices, it had no discernable effect on the quality of mathematics instruction.

Table 7: Technology Use and Quality of Technology Rating in Mathematics (QTRM) <sup>9</sup>		
	SPRING 2005	
	% Teachers using technology (at least 1 day)	% Teachers HIGH QTRM
Matched Treatment (N=19)	57% (N=14)	--
Non Matched Treatment (N=24)	100% (N=24)	4% (N=1)
Control (N=25)	24% (N=6)	4% (N=1)

Higher quality technology use ratings in mathematics were given in those few classrooms where students had more autonomy with technology use. Teachers' use consisted of guiding or directing students in their technology usage. In these classrooms, when the Activboard was used, it was used to demonstrate accessing a particular website or in more nuanced ways (utilizing more of its functions) to demonstrate graphing data. During the majority of these lessons, the students were also using technology. The tasks students were given, or the websites they accessed involved more problem-solving rather than math drills. We found students using laptops, working in pairs or individually, solving interactive math problems, playing challenging math games, or engaging in interactive learning websites. In one class, we found students using data collected on circumference and diameter to plot the line of best fit using graphing calculators while the teacher demonstrated the procedure using the probe tools projected onto the Activboard. Once students

<sup>9</sup> The QTRM and QTRS are based on a 5-point scale, with cut scores at 2.2 determining low and high.

finished calculating the slope of the line of best fit, they were able to conclude that it equaled Pi. In these ways, technology was used to solve problems and to expand thinking, not to just narrowly compute answers.

Overall, science teachers in all three groups demonstrated higher quality use of the technology to enhance the learning opportunities afforded to students than their math colleagues (see Table 8). These differences aside, we still found that in the vast majority of science classrooms technology use was of low quality; teachers used the technology much like their counterparts in mathematics. Science teachers used the Activboard as they would a chalkboard, to display terms or vocabulary for student note taking, or to list assignments or record agendas, and students were afforded little time to utilize the technology to conduct research or solve a problem. When teachers accessed websites, they were often a replication of the textbook or workbook already at their disposal.

Table 8: Technology Use and Quality of Technology Rating in Science (QTRS)		
	SPRING 2005	
	% Teachers' using technology (1 day)	% Teachers HIGH QTRS
Matched Treatment (N=22)	63% (N=14)	43% (N=6)
Non-matched Treatment (N=23)	100% (N=23)	39% (N=9)
Control (N=24)	62% (N=15)	47% (N=7)

Among science teachers using technology, 43% of the matched treatment teachers were using it in innovative and more advanced ways, and 47% of the control teachers received higher quality technology use rating. More of the non-matched treatment teachers were observed using the technology to engage students in problem solving or more complex activities than either the matched treatment or control teachers. The percentage of teachers only appears smaller (39%) due to the fact that all science teachers in the non-matched treatment group were observed using technology. In these science classrooms, we found students using the laptops and the Internet to visit interactive virtual hands-on lab websites. Students used the Internet to conduct research, and were observed integrating findings into PowerPoint presentations and presenting their findings to

their peers. For example, in one class, students designed roller coasters as part of a lab in order to apply speed and velocity concepts. They then measured distance and time using the probe tools and motion detectors and then charted their speed and velocity using the laptops and Excel. When the Activboard was used, it was utilized to illustrate graphing of data collected. Teachers were also comfortable accessing a wide range of the built in components such as the slate (the interactive accessory to the Activboard) to engage students in problem solving. Students had a significant amount of autonomy and control over technology usage. The authority of the classroom did not reside solely with the teacher. Students would often answer each other's questions as they used the laptops in pairs. In some instances the teacher used short digital video clips to quickly demonstrate experiments that illustrated scientific concepts discussed during class. On occasion, we found teachers with a high proportion of students with limited English using websites that allowed their students to access the content in their home language.

While we found differences in use between the matched and non-matched teachers in terms of use, we looked to interview data to compare teachers' reported use and their experience in order to explain these differences. The interview data confirmed substantial differences in use of the equipment and in experience with the implementation of the program.

We asked teachers to rate how frequently they used the resources provided through the MSTP. We looked at differences between the two groups of teachers and within schools, and we found substantial differences. There was a fairly overwhelming consensus regarding the possession of the teachers' personal laptop computer. Across all schools but one, we found nearly 90% to 100% of the teachers reported using it on a daily or weekly basis. The Activboard, which is a versatile electronic white board, received mixed reviews and was not as widely used as the teacher laptop. More of the teachers from the non-matched treatment group (41%) than from matched treatment teachers (27%) referred to the Activboard as the most useful tool. We looked at each school individually, and across school type and we found that use varied substantially between the matched and non-matched treatment groups. Within non-matched treatment schools we found schools in which 50% of the teachers reported using the Activboard on a daily or weekly basis. On the other end of the spectrum we found schools in which 100% of the teachers reported using the Activboard with such frequency. Among the matched treatment teachers, we found schools in which only 25% of the teachers reported using the Activboard that often. We also found

that there were no schools in which more than 65% of the teachers reported using it with such frequency.

Those who favored the Activboard, were emphatic about how it improved their experience as a teacher, as this teacher remarks, “Nothing can take the place of that Activboard!”

Other teachers mentioned how the Activboard functioned as a time saving device, allowing them to use saved pages for the next lesson, or that they were better able to maintain eye contact with their students when using it. Although most teachers found that the Activboard was a valued asset, quite a few teachers experienced technical difficulties in using it. We found that coincidentally more of the teachers reporting technical problems with their Activboards were among those from the matched treatment schools than the non-matched treatment schools. As this teacher from a matched school reported, “I used the Activboard in the beginning, but it broke down a lot and by the time it was fixed, I had gotten out of the habit of using it.”

As far as the student laptops, again we first looked individually at schools. We found that in two of the non-matched treatment schools 90% to 100% of the teachers reported using the laptop carts (distributing laptops for student use) on a daily or weekly basis. In three of the matched treatment schools, 70% to 90% of the teachers reported using the laptops on a daily or weekly basis. Among the remaining three schools (two non-matched, one matched), fewer teachers reported using the student laptops with such frequency, roughly 30% to 50% of the teachers. More of the science teachers reported using the student laptops than the math teachers. The science teachers reported using them for Internet research or WebQuests; or for interactive websites where students conducted virtual heart surgery. Overall, teachers spoke favorably about having the students use the laptops to access the Internet. They found that the laptops also forced students to work collaboratively. Teachers remarked that having the students work in pairs on the laptops encouraged them to utilize each other rather than relying exclusively on the teacher. Teachers frequently echoed this comment regarding use of the laptops, “You just engage students so much better when you have them on the computer rather than in a textbook, even though they are reading the same literature.”

The majority of teachers found some of the tools difficult to use due to a lack of training or experience in how to utilize them in their lessons. The probes, video cameras, scanner, slate and graphing calculators were rarely or never used across both groups. Although, nearly 10% more of

the non-matched than the matched treatment teachers mentioned using each of those resources with more frequency.

In Year 1, all teachers received the same equipment regardless of content area. In Year 2, the program redistributed some of the probes to target more appropriate content areas and grade levels. In addition, the program purchased graphing calculators to bolster the 8th grade math curriculum. The probe tools included temperature probes (durable digital thermometers), a conductivity probe (used for testing salinity, total dissolved solids, or conductivity in water samples), a pH sensor, a motion detector, and an electronic microscope called a Probe Scope. Each of these tools connected to software that logs, graphs, and saved the inputted information, so that students could spend more time analyzing data rather than struggling with the mechanics of collection. Overall, 81% of the matched treatment teachers and 66% of the non-matched treatment teachers mentioned that the probe tools were one of the items that were rarely or never used. While the probe tools received limited use, those that did use them were fairly impressed, as this comment reflects, “Loved the probes, they were amazing!” Another teacher remarked, “The probes are very useful to get the students to learn how to interpret graphs as opposed to only creating them.” The following tools were also reported as rarely or never used by both groups of teachers: the scanner (68%) matched treatment, (55%) non-matched treatment; the video cameras (73%), matched treatment, (67%) non-matched treatment; and the slate (68%) matched treatment, (43%) non-matched treatment. As these data reveal, more of the non-matched teachers reported using these tools with more frequency than the matched treatment teachers.

There were a variety of reasons offered by teachers to explain their lack of technology use. Teachers reported a variety of technical problems prevented them from using the technology in their classrooms. The 8th grade teachers added to the study in Year 2 were given Gateway PCs (rather than the MACs) and there were compatibility issues with the software. Others mentioned the challenge of trying to use the student laptop computers in more than one or two lessons, as the batteries needed to charge in between use. Teachers also reported networking issues that affected their ability to connect to the Internet.

Teachers in both groups reported rarely or never using the majority of the electronic curricular resources provided through the MSTP. The resource most highly regarded by teachers was the Los Angeles Country of Education (LACOE) multi-media services product: Digital Curriculum, while the other resources that were available in Year 1 (Task Stream, Video

Discovery and Big Chalk) were used by only about 8% of the teachers. The Future's Channel was a curricular resource added in Year 2, although due to a mid-year delivery, it too received limited use, as only 27% of the teachers mentioned using it. Many teachers spoke highly of the Future's Channel training and the product, and how they looked forward to integrating it into their lessons during the following school year.

Although usage of the curricular resources provided through the MSTP was limited, teachers used a wide range of additional resources or websites. These were either provided through the coaches' preparation of an extensive list of useful websites for both mathematics and science or through teachers' sharing their favorites with one another. Teachers' favorites included: Funbrain, Virtual Manipulatives, AAA math, Dole Pineapple website, Kids Health.org, Brain Pop, and the World book. Finally, teachers' explanation for their limited use of the electronic curricular resources supported by the MSTP, was primarily due to: a lack of familiarity with them, adequate training, and the time to explore the materials provided.

Theft was also a serious problem in both years of the program, as teachers in both groups continued to have issues securing the equipment. Among the non-matched treatment schools only 17% of the teachers reported experiencing theft, whereas in three of the matched treatment schools multiple teachers reported experiencing thefts. In two of the matched treatment schools between 50%-80% of the teachers reported experiencing theft over the course of the two years (and one teacher was robbed multiple times). Thieves took laptops, projectors, Proscope tools, digital cameras, a DVD player, and several cords. One teacher, frustrated with the loss of LCD projector and the time it took to get it replaced, invested in a new one, and within weeks it, too, was stolen.

When asked for overall feedback regarding their experience with the MSTP equipment it appeared that more of the non-matched treatment teachers (74%) than the matched treatment teachers (49%) gave a generally positive assessment. Some teachers lauded technology's ability to present information visually, while others cited its use as a behavior modification tool (both because it kept students engaged and because student laptop use could be used as a reward for good behavior). Other teachers noted how their technology tools had helped them plan lessons more efficiently and be more organized.

Regarding teachers' overall experience with each of the specific equipment and resources, 81% of the matched treatment teachers and 90% of the non-matched teachers provided

enthusiastic overall feedback on their experience with the MSTP program. Teachers reported how beneficial it had been for the students, as in the following statement made by one teacher:

It makes them [sic] and their students more organized, it appeals to visually oriented and tech savvy students, as well as students with limited English proficiency, and it enables shy students to have more one-on-one interaction with teachers to ask questions since the laptops free up the teacher to circulate around the room.

Or as these comments reflect, how using the technology had been beneficial for themselves as teachers:

I have increased my shelf life as a teacher.

I feel like I'm a much more powerful teacher.

I'm a much better teacher with the board. Students are responding

Better to the lessons when we are using technology and color, its more visual.

It's allowed me to be less authoritarian and more of an individual coach who can get to know each student's capabilities.

It helped me feel like I'm enhancing my skills and becoming more modern in my approach.

I find it exciting and the possibilities seem to be kind of endless.

It's just amazing, the resources and how quick you can get to things.

Teachers reported barriers to implementing technology successfully included lack of training, lack of time, and a rigid pacing plan that didn't include introducing technology. One teacher while acknowledging the value of it enabled a richer presentation of information, she remarked, that it took a substantial amount of time to become familiar with the tools and with how to find the right ways to use them.

In addition to examining the extent to which program teachers used technology provided by MSTP in their lesson, we also examined the quality of instruction in both math and science across our sample of schools. We present the mathematics findings first and then the science findings.

#### *Instructional Activities During Mathematics and Science*

As Table 9 reveals, the overall quality of instruction in mathematics was low, within each of the groups. We found that more teachers in the control group (40%) demonstrated evidence of high quality instruction than the matched treatment (11%) or the non-matched treatment teachers (4%).

Table 9: Quality of Instruction Rating in Mathematics (QIRM) <sup>10</sup>	
	% Teachers HIGH QIRM
Matched Treatment (N=19)	11%
Non-matched Treatment (N=24)	4%
Control (N=25)	40%

Instructional activities in mathematics generally consisted of the teacher lecturing or demonstrating computational problems from the board, overhead or Activboard. Students were then observed solving the problems, with little or no conversation about the subject matter. In the majority of classrooms we found the dialogue of the classroom consisted of the teacher asking students basic short, closed-ended recall questions rather than engaging their students in instructional conversations about the subject matter, or in problem solving using real-world contexts. Students were passive recipients of math-related content, solving problems from the board, in a textbook or worksheet independently and rarely worked in pairs or groups. There were limited activities consisting of projects or problems that applied math concepts to real-world scenarios nor to its relation to science.

The following dialogue is from a typical math lesson we observed. In this example, the teacher demonstrated addition and subtraction of positive and negative integers from the board. The teacher used manipulatives to demonstrate positive and negative numbers, although only she handles them. The lesson received a low quality rating as the lesson was primarily teacher-centered, with no evidence that students were required to demonstrate reasoning or justify their answers, the content was solely computational in nature, and students were merely asked to provide the correct answer.

Teacher: Example:  $+3 + 5 = 8$ . Do we need that sign right there? [Teacher referring to sign next to 3.]

Student: No.

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<sup>10</sup> Similar to the Quality of Technology Ratings, the Quality of Instruction Ratings for Mathematics (QIRM) and Science (QIRS) used the cut score of 2.2 to determine high and low.

Teacher: Example:  $-6 + (-1)$ . Add up the numbers, so it's  $-7$ . That's easy, so far so good. What happens if they're not both positive or negative?

Student: Whichever one's bigger. [Teacher writes on overhead: When signs are different. Teacher writes example problem:  $3 + (-5) = .$ ]

Teacher: This problem says to start with positive 3 and add negative 5.

Student:  $-8$ .

Teacher:  $-2$ .

Student: You only have to subtract.

Teacher: Let's try  $-8 + (+3)$ . [Teacher writes problem on overhead while speaking.]

Teacher: It says to start with negative 8. [Teacher uses red and blue chips on overhead to represent positive and negative numbers.]

Teacher: What am I left with?

Students:  $-5$ .

Teacher: What if we have  $12 + (-5)$ ?  
[Teacher arranges manipulatives, 12 blue and 4 red chips on overhead.]

Teacher: And we want to add 5 negatives.

Students: 7.

Teacher: What kind of 7?

Students: Positive 7.

Teacher: Everybody figure out what we need to do? [Teacher does not wait for response, then continues writing "Rules" on overhead.]  
[Teacher writes: Subtract and use the sign of the greater absolute value.]

Teacher: We know that 3 is bigger than  $(-5)$ . Which number is bigger?  
[Teacher writes a large 5 and a small 300 on overhead, and attempts to demonstrate the ambiguity of the word bigger.]

Teacher: 5 is the larger size but 300 is the larger number.

Student: What kind of bigger?

Teacher: Exactly. Bigger means more value. You have to be careful when using words. How many people learned this in 6th grade? [Most students raise hands.]

Teacher: The question was asked, what happens when you subtract?

[Teacher then ask students where they are in their notes, then erases notes on the overhead in order to write more.]

Teacher: Watch what happens when you subtract. [Teacher writes on overhead:  $-8 + 4$ .]

Teacher: This problem says to start with  $-8$ . How many reds do we need?

Students: 8 reds.

Teacher: Ok now what's next? Can I take off 4 blues right now?

Students: No.

Teacher: What can I do? [2 students raise hands.]

Student: Add 4 more reds.

The teacher continued this line of recall questioning and then assigned students a series of computational problems in a textbook, which they worked on individually until the end of the period. Their participation was generally procedural, and the content was solely computational in nature. Typically in math lessons, we found students working individually at their desks, answering short one-answer or basic recall questions elicited by the teacher, and then solving computational problems from a textbook, worksheet, or assignment from the board.

In math classrooms in which we found high quality of instruction, we observed the teacher in a more supervisory or facilitative role in activities, sharing control of the discourse with students. Activities were project based, or were presented as a problem that required students to apply or synthesize previously learned knowledge, in order to make a claim or justify their solution. The assignment may have also involved integrating mathematics and science, through the collection of data, graphing or displaying data in charts or tables, and concluding with a presentation of findings and sharing various solutions with peers.

The following example demonstrates a lesson in which we found high quality instruction in mathematics. Students worked in collaborative groups to solve a Problem of the Week (POW) at both an individual and group level. Students were given the assignment to create their own portfolio explaining the problem, their solution, and their own procedure for how it was solved. Students worked in groups assisting one another and discussed their solutions as they presented to the class, while other students debated the validity of their answers. Prior to this excerpt, the teacher reviewed with the students their various roles in the groups: predictor, questioner, clarifier, and summarizer. Here is an excerpt from the lesson.

The Problem of the Week (POW) is displayed on the overhead, which reads:

Ms. Torres purchased 2 pounds of chocolate candy and a weigh scale to divide the candy amongst her student helpers-Erin, Sam, Cara, Daemon and Maria. She tells them: Erin, take  $\frac{1}{3}$  of the chocolate for yourself. Sam, after Erin, take away  $\frac{1}{2}$  of what is left, and split it evenly between Cara and Daemon. Then take  $\frac{1}{5}$  for yourself and give the rest to Maria. 1) Who received more chocolate? 2) Who received the least? 3) Daemon says that his chocolate only fills  $\frac{2}{5}$  of his jar. How much can his jar hold?

[Students proceed to their work groups to discuss and prepare their presentations.]

Teacher: 3, 2, 1, excuse me, and zero. And now, 2, 1, 0. Go back to your original seats, not your original seats, where your group originally sits [Students go to tables where POW group started.]

Teacher: We have time for two presentations. And if we don't finish, we will go into nutrition. [Students quiet down.]

Teacher: Now, who feels confident enough, because we do have a visitor today, but I want you guys to ask questions and take notes like you normally do during POWs. So who's confident enough? Cara? [Cara nods.]

Teacher: Who's the summarizer and clarifier? Ok. She needs your attention. Student 1 and Audrey.

Student 1: Right. What we did to find how much chocolate each gets is we drew a diagram and divided it into 3 parts. Since Erin got  $\frac{1}{3}$ , and if Daemon and Cara each get  $\frac{1}{2}$  of  $\frac{1}{2}$  of what was left, we split the second third in half. Then if Sammy was supposed to get  $\frac{1}{5}$  of what was left, we changed the denominator into 30 and gave that to Cara.

[A rectangular diagram of the candy split is displayed on the back whiteboard.]

Student 2: No, no. [Student 2 is hesitant to ask questions.]

Teacher: No, go ahead.

Student 2: I think it's wrong. If it's supposed to be  $\frac{1}{3}$ , then ... {data not captured}

Teacher: Can you point out  $\frac{1}{3}$ , because I can see it, but other people can't. [Audrey points out  $\frac{1}{3}$  on diagram.]

Student 1:  $\frac{1}{2}$  of what's left?  $\frac{1}{2}$  of  $\frac{1}{3}$ . [All students discuss the presented solution.]

Mohica: But if you add Daemon and Cara with Maria and Sammy, isn't that more than  $2/3$ ?

Teacher: Can you explain it again and this time can you do it? [Teacher is referring to Audrey. Audrey gives similar explanation.]

Teacher: Who is the team captain? Carlos, can you show us how you got your proportions? [Carlos explains, showing how the group got 30 as the common denominator.]

Student 3: But I still don't see how those parts together, isn't more than  $1/3$ .

Student 4: It is  $2/3$ , if you make all the denominators the same it makes  $2/3$  if you make Daemon's  $1/2$  and Cara's  $1/2$ .

The dialogue of this lesson continued with students in the audience exploring correct procedure, while those students presenting validated their calculations. The teacher remained in the background, acting only as an intermediary between presenters and audience, occasionally offering open-ended questions to spur deeper inquiry by students. In this example of high quality math instruction, students were the focal point for the content, engaged in a problem-solving activity and there was evidence of classroom discourse in which the sharing of ideas exemplified the learning environment. The teacher's role was to encourage student interaction and inquiry, so that students applied concepts to mathematical arguments they arrived at on their own. Students were asked to present and justify mathematical arguments, and the lesson was posed as a question to be solved through student inquiry rather than working through computational problems in a rote manner.

As Table 10 reveals, similar to our findings in mathematics, we found among the science teachers, more evidence of high quality instruction among the control teachers (63%) compared to either the matched treatment teachers (46%) or the non-matched treatment teachers (57%). Additionally, in comparison to mathematics, there was much more evidence of high quality instruction in science among all three groups.

Table 10: Quality of Instruction Rating in Science (QIRS)	
	% Teachers HIGH QIRS
Matched Treatment (N=22)	46% (N=10)
Non-matched Treatment (N=23)	57% (N=13)
Control (N=24)	63% (N=15)

Low quality instruction in science was characterized by teacher-centered lessons in which the teacher lectured about a topic. We also observed students reading science-related content from textbooks or answering questions from workbooks or worksheets. Students' voices were rarely heard, and only to answer a short one answer, recall type of question or when they were asked to read outloud from the textbooks. In those lessons we found limited opportunities for students to conduct a lab or test a theory involving a "hands-on" activity.

The following example demonstrates what we saw frequently in science classrooms. In this lesson the students learned about volcanoes from the textbook. The lesson received a low quality of instruction rating, as the tasks required primarily passive participation by students through responding to short recall questions. The following interaction occurred toward the end of the lesson, after a rotation of oral reading from the textbook by various students. The class then answered short fill in the blank questions from the textbook.

- Teacher: OK, the questions on page 97.  
[Teacher reads the first question.]
- Teacher: Who knows the answer? Nolan?  
[Nolan reads an answer from the text.]
- Teacher: Where did you find that answer?
- Nolan: Page 96.  
[Teacher gives the students a minute to write down the answer in their notebooks.]
- Teacher (reads): Describe the process that makes lava plateau. How would you restate it?
- Student: The process that creates a lava flow is.
- Teacher: What page can I find this answer on?

Student: 96.

Student 2: 94.

Teacher: What is the answer?  
[3 students read the print in bold with the answer.]

Teacher: Good.  
[Teacher gives students a minute to copy down the answer.]

Teacher: OK, number 3. What features form as a result of magma hardening beneath the Earth's surface? Keith, please restate the question.

Keith: The features that form hardening under the Earth's surface are ?

Teacher: What would be one of those things be? Alejandra.

Alejandra: A volcanic neck.

Teacher: Yolanda, what else is there?

Yolanda: Batholiths.

Teacher: Damian.

Damian: Sills.

Teacher: What is the whole answer Damian?  
[Damian gives the entire answer in a complete sentence.]

Teacher: OK, #4. Describe how a Dome Mountain eventually forms out of magma beneath the Earth's surface. Restate it Sidney.

Sidney: The magma below the earth's surface forms a dome mountain by . . .

Teacher: Annie. What happens to the magma?  
[Annie doesn't know.]

Teacher: Blanca, then what happens? Read the last paragraph there.

Blanca: The top of the magma will be exposed.

Teacher: Good. So what's left when it wears away?

Blanca: The magma that hardened is exposed.

Teacher: Does this happen in one or two years?

Students: No.

Teacher: Right. It happens over thousands of years. #5, what features form when the magma chamber is empty? Peter, what feature is it? Go back a page.  
[Peter does nothing and just stares at the textbook.]

Teacher: You have to turn the page with your hand.  
[6 other students raise their hands to answer.]

Peter: Umm. A crater?

Teacher: Almost. Annie.

Annie: A caldera.

Teacher: Good. So, how would you describe the process? Jaime.

Jaime: . . . and makes a hollow shell.

Teacher: So, write that it simply collapses if it doesn't have support and it forms a caldera.

Student: What's #4?

Teacher: Look at the top of page 96.

This line of textbook-based lecture and recall questioning closed with a homework assignment to answer more questions from the textbook and a fill in the blank worksheet. These types of activities were quite common in science classrooms in which material was introduced in a lecture format or a review from a chapter summary followed by series of recall or basic fill in the blank type questions. In these classrooms there were few opportunities for students to engage with one another to solve a problem or conduct research to answer a question.

In science classrooms in which we found higher quality instruction, teacher roles, and dialogue in the classroom were more student-centered. In some classrooms, students worked in small groups engaged in problem based activities that usually involved a hands-on component, and were summarized with a write-up or student-generated presentation of a particular concept. The textbook was rarely the only source of information, and often, involved multiple sources and in many cases the Internet.

In the following example the teacher included the use of the Internet as a source of information. The teacher posed the rapidly changing temperature in the classroom as a problem in which concepts of heat transfer could be applied. The initial brainstorming with students served as a springboard for a project in which collaborative groups would design a proposal for climate control in their own classroom. In this lesson, students were applying and using different sources of researched information to an authentic problem. The role of the teacher functioned more as facilitator, encouraging dialogue about the subject matter rather than as a lecturer.

Teacher: So, my question is, sometimes it gets too cold, too hot, smelly, stuffy, etc. How can we fix these problems? So when you walk in, you can say, “Ah, this is a perfect temperature so I can concentrate and do my work and learn?” So how can we fix our room temperature problems? Let’s brainstorm some ideas. What is brainstorming?

Student: Think as a group.

Teacher: Alright, just ideas, not right, not wrong. Just ideas.  
[Teacher writes on Activboard with Stylus: Room temp. problems as students generate ideas.]

Student: We can get a heater in the morning.

Student: Wear more clothing.  
[Teacher adds suggestion to list, writing “hot” or “cold” to explain which problem each suggestion addresses.]

Teacher: We’re going to break into groups and you are going to come up with a plan to improve the current state of the classroom. You’re going to use the computers, do some research. Now, you need to use 3 terms that we’ve learned: radiation, convection, and conduction. These 3 terms have to be in your proposal. We’ll have 4 people per group and 2 computers each. I’m going to give you a minute to figure out who your fearsome foursome is going to be.  
[Students stand and get into groups. As students rearrange chairs, Teacher opens the computer closet, calls out students to come and collect laptops. Teacher reads what he just wrote, and assigns roles within each group.]

Teacher: Two people will be researchers on laptops, One person is the writer, writing ideas on paper, and the fourth person will be a communicator, communicating ideas from researchers to the writer.

Teacher: So writers, write what each person’s role is on your paper.  
[Teacher circulates to assess student progress. Teacher returns to the Activboard.]

Teacher: Alright, look here on the board. What is a remedy?

Student: A medicine.

Teacher: What does a medicine do?

Student: It cures.

Teacher: Right. So you're going to find 3 cures to fix the temperature. You need to come up with 3. Choose the best one, then demonstrate why. And you're going to have to use this specific vocabulary. This is not getting together as a team and fooling around time. Maybe the writer might want to copy down what I've written here so you don't have to keep looking up here.

[A few students protest that it's too much writing. Teacher says it's only a few sentences.]

Teacher: Where would be a good place to start researching?

Students: Yahoo. Or Google.

Teacher: Good. What would be good keywords? Places to start?

Students: Temperature, radiation?

Teacher: And you could use these 3 words [Teacher points to radiation, convection, and conduction on the Activboard.]

The teacher asked the students to write three solutions to the classroom temperature problem based on their initial research, encouraging students to structure their ideas in the form of questions and answers. Students continued to work in groups conducting research on temperature control and included that information in their proposal. As the students searched, the teacher circulated, suggesting websites that other groups discovered. The teacher continued in this role as facilitator of student learning as they explore answers to "real-world" problems. The way in which the teacher incorporated the technology into the above lesson was also of a high quality.

Overall, we found more evidence of technology use among the non-matched treatment teachers than the matched treatment in both math and science. We did see evidence of similar technology being used by the control teachers in both mathematics and science classrooms. The average quality of the technology use in mathematics was low, whereas use of technology in science was of a higher quality. In all of the school types we found higher quality uses of the technology in science than in mathematics classrooms.

Moreover, we found that overall instruction among the control group was of a higher quality in both math and science than the matched or non-matched treatment group. Quality of instruction in mathematics was low for both the matched and non-matched treatment teachers.

On the other hand, science teachers in the matched and non-matched treatment groups did provide their students with a higher quality of instruction than their math counterparts. The majority of the higher quality science instruction was found among the non-matched treatment and control teachers. Whether it was easier for science teachers to introduce the content into more problem-based activities than for math teachers is a question worthy of further study.

*Research Question 2: To what extent did the professional development offered through the MSTP impact teachers' ability to use technology during instruction?*

During Year 1, professional development provided to the program schools consisted of formal "off-site" trainings and site-based coaching. The off-site trainings were meant to introduce teachers to the equipment and electronic resource materials that comprised the MSTP. The coaching was intended to provide teachers with assistance in integrating the technology into their classroom instruction. In Year 2, the "off-site" trainings were limited to orientations for the newer teachers, as well as introductions to the additional electronic resources added to the program.

During the summer at the end of Year 1, teachers were invited to attend a more intensive multiple day workshop at the Thatcher Institute. The workshop provided teachers with a more extensive training, and time to explore some of the electronic curricular resources with greater depth than any of the previous trainings. This workshop was poorly attended by the program teachers. Only 8 teachers attended this training; 75% were from the non-matched treatment schools. Those teachers did not find that this workshop met their expectations, as teachers anticipated learning more than was accomplished during the workshop. This workshop did not have much impact on teachers' ability to use the technology in more advanced ways. At the end of Year 1, most teachers mentioned how they anticipated spending the summer further exploring the tools and resources provided on their own.

#### *Site-Based Support*

In Year 1 eight coaches were hired to provide informal site-based support on a regular basis throughout the school year. Coaches were hired based on their expertise in either mathematics or science and based on years of experience teaching (ranging from 10-32 years). Coaches were expected to provide site-based support to program teachers, introduce some of the curricular resource materials to the whole school, and ensure that the majority of teachers at the

program schools completed the California Technology Assistance Project (CTAP) surveys for teacher and student technology proficiencies.

The coaching model adopted by the MSTP paired two coaches together to work at two schools at a time. Coaches were assigned a different partner each rotation. In Year 2, one of the two coaches remained at the school for the school year, while the other rotated to another school during the semester break. During a given week, coaches were expected to divide their time between their two assigned schools, visiting the school either with their partner coach or separately, and engage in a variety of other program related activities that may not take place at the program schools. Coaching activities varied based on the rotation, the roll out of the equipment, and other program needs.<sup>11</sup>

During the first year of program implementation, coaches' time was spent on a wide range of activities that competed with one-on-one time with teachers. These activities included: their own formal trainings, attending program related staff meetings, spending time learning to use the equipment and electronic resources, researching websites in order to find suggestions to offer to teachers, writing reports or additional grants, and providing site-based support to two schools per rotation. In Year 2, coaches activities at the school sites varied between providing demonstration lessons to teachers, facilitating cohort meetings, providing professional development sessions to the whole school, troubleshooting with technical issues or equipment set up (for those newer teachers), addressing a variety of networking and security issues, and/or getting teachers to access the CTAP surveys.

For the most part, teachers understood that the role of the MSTP coaches was to help them integrate technology into their lessons. This included finding applicable lessons, giving lessons, sharing ideas, helping teachers understand the technology they are using, to act as a support system and generally acting as coaches who can help teachers become more effective through the use of technology.

Based on teacher interview data, we found a significant disparity in teachers' overall experience with coaching. For instance, 71% of teachers at non-matched schools rated coaches as "extremely helpful," "great," or "wonderful" (vs. only 35% of teachers at matched schools). One teacher, who referred to the coaches as "essential," pleaded with LAUSD to continue coach funding because if it doesn't she remarked, "what will happen is that technology will end up

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<sup>11</sup> In the two multi-track schools the 8th grade teachers did not receive their equipment until March when the A-track teachers returned from their winter break.

sitting in boxes. Somebody has to keep jumpstarting us every so often. I think it's the coaches who do that. They also unify us." Another teacher remarked, "For me to go as high as I want to go, as high as the children need me to go, to do things as deeply as is needed, I need to be coached. I need an outside party who is accentuating the positive, eliminating the negative." Those expressing a positive experience mentioned that the coaches "are always available, willing to stay late, armed with new ideas on how to integrate technology into lessons, and providing technical expertise."

Other teachers viewed the coaches as "overwhelmed" and therefore ineffective. Some of the biggest critics of MSTP coaching were teachers with the most technical expertise themselves. "I think at times they're only one step ahead of us . . . nobody had as much experience as everybody was pretending to have," remarked one teacher. Another referred to coaching as "the downfall of the program."

As a consequence of the increased number of teachers to the program in Year 2, the same number of coaches had to serve an additional 8 teachers per rotation. Due to the split between two schools coaches were available to serve 11 teachers at one school, approximately 10 days a month. A common response from teachers was that although coaches were "nice," they were "stretched too thin," especially with technical troubleshooting, and more specifically with modeling how to integrate the technology into their lessons. Particularly at schools where there is limited technical support, teachers expressed a desire to have a full time coach available at their school sites. More of the matched treatment teachers (32%) than the non-matched treatment teachers (19%) mentioned that the coaches weren't available enough. When asked one teacher responded, "I haven't seen them for a week to be honest. One coach came in last week and before that I hadn't seen anybody in over a month."

Teachers also expressed frustration with the range of responsibilities that consumed so much of the coaches' time. Teachers felt that coaches were often busy attending to technical issues with the equipment or assisting teachers to fill out CTAP surveys, which they found did little to advance their skill set. rather than helping them find ways to incorporate the technology into lessons. There continued to be some confusion as to the role the coaches were to play, as echoed by this teachers' remark, "A tennis coach is supposed to tell you how to hit the ball and not how to string the racquet."

Another impediment to effective coaching was the difficulty coaches had scheduling time to work with teachers. Coaches were challenged in this regard, and often used teachers' conference periods as the only time available to offer assistance. Teachers frequently had numerous priorities that took precedence over working directly with the coaches. In some of the schools, teachers did not even have conference periods, and thus their time was severely limited. Coaches also remarked that their effectiveness depended on teachers' desire for the assistance they could provide.

In Year 2, the coaches shifted their site-based support to providing demonstration (demo) lessons to teachers so that teachers could see first-hand how their technology could be used and integrated into their curriculum. For instance, a coach might teach students how to create a PowerPoint presentation about planets for an 8th grade science class. Often, coaches would demo during the first few periods of the day and let the teacher take over for the last few periods (while remaining in the classroom for support).

We found differences between the matched and non-matched teachers in terms of their experiences with the demo lessons. Looking at differences by school, we found among the program schools, a similar range of approximately 40% to 90% of teachers reported receiving at least one demo lesson from coaches this year. However, 85% of the teachers at the non-matched schools received multiple demo lessons whereas only 68% of the teachers in the matched schools received more than one demo lesson. We also found that only 50% of the matched treatment schools received any demo lessons in their 8th grade science classes. However, 100% of non-matched treatment schools received at least one 8th grade science demo lesson.

We also found differences between the two groups of teachers in terms of their experiences with the demo lessons they received. All teachers at the non-matched schools found the demo lessons to be beneficial, with several noting how useful it was to watch a coach anticipate and respond to questions and technical issues that they the teachers would never have been able to address. By contrast, only 50% of the teachers in the matched schools found the demo lessons beneficial. One noted that the demo "wasn't relevant." Another teacher reported that it was too "time consuming, didn't go very far, and... seemed pretty lower level." Another teacher mentioned that although she didn't feel she needed a demo lesson, her coach told her that one was required. One teacher perceived that the coaches at her school didn't share their time equitably

among the MSTP teachers: “Some teachers got all sorts of attention and some were left in the lurch. It should be more equitable.”

In Year 2, coaches tried to meet with the MSTP cohort of teachers on a regular basis at each school as another avenue toward professional development, but often these meetings were difficult to coordinate. In all but two of the schools, these meetings generally took place during a 30-minute lunch break once a month, and the agenda addressed logistical, rather than content-specific, issues. At two of the schools, these meetings were held after school and for approximately an hour, on a monthly basis. These two schools were non-matched schools. While teachers from the non-matched schools (48%) reported an increase over Year 1 in collaboration with colleagues on lesson plans, 54% of the teachers from the matched treatment schools report collaborating with colleagues the same or less so than the previous year. The extent to which the cohort meetings were helpful was often dependent upon the extent to which the teachers felt they could collaborate together within grade level or content area. Some teachers who found lunchtime meetings called by coaches “ineffective” did not blame the coaches but expressed, “I don’t think we had a good community of MSTPers here.” One teacher, who reported not meeting with his colleagues with any frequency, plead that the program should build in time for MSTP teachers to observe each other utilizing the technology and resources in their lessons as a result of his own discovery:

I literally started using the slate only because I saw one of my colleagues using it. But hearing a couple of the coaches tell me to do it or to try it wasn’t enough. I needed to see a guy with 30 students in the classroom, watch them engage, see them engage with him sitting down using the slate. That’s what I think makes a teacher go “whoa!”

Cohort meetings as a whole weren’t as effective as they could have been, but there was evidence to suggest that when MSTP colleagues were allowed to meet, share ideas, and observe each other implementing technology, there could be tremendous advantages. School culture and existing professional development structures are influential factors in this area.

In most schools, coaches did not have many opportunities to provide site-based professional development workshops. This has less to do with coaches’ willingness to create such events, and more to do with the already existing professional development structures in place at the school sites that did not allow for modification. In two notable exceptions, among the non-

matched treatment schools, coaches were given opportunities to provide a series of concentrated workshops, on Powerpoint, iMovie, and website development. These events were well attended by all staff at those schools and highly successful. These opportunities were not equally distributed across each of the schools.

One of the goals of the MSTP was to build capacity at the school level to ensure site-based support when coaches are no longer available. Forty nine percent of the matched treatment teachers found at least one of their MSTP colleagues to be a helpful resource. Whereas, at the non-matched treatment schools, 57% of matched teachers reported that there was a teacher within the school they could turn to. Also, the teachers that ended up assuming a lead role at their respective schools had described themselves as “tech savvy,” as this one stated, “I know more than all these people.”

We did find that coaches had an overall impact on the schools at large. For instance, coaches helped organize *MSTP Parent Nights* at all of the schools, which were uniformly well attended and well received. They also helped seven of the eight schools create or update school websites with links describing the MSTP program. When asked the effect the MSTP program had their whole school, 71% of the non-matched treatment teachers and 51% of the matched treatment teachers responded with enthusiastically positive comments such as the following:

It increased the general academic environment of the whole school.

The MSTP program got the whole school interested in tech.

Brought school into the computer age.

This is what teaching in the twenty first century should be like.

Students in program have begun helping students in other classes outside of the program.

On the other hand, some teachers felt a negative consequence of the program was a degree of jealousy from other teachers not selected to participate in the program. The negativity resulted in a constructive solution at two of the program schools where it was decided to seek out funding to purchase equipment for the entire math and science departments. As this teacher noted, “The effect is huge, because now the other math teachers are asking for a grant to purchase the same equipment, because they've seen the examples of our work, and they've seen how it works.” Most teachers credit the coaches as instrumental in funneling this enthusiasm, and as many teachers found they greatly valued their assistance in, “getting the stuff out of the boxes.” One principal

noted that MSTP was a “real plus” for his school, and he concluded that the coaches “have been really good” and that without them, the program would have “failed easily.”

Overall while the teachers who have participated in the program for the two years have had the time over extended summer breaks to explore and fine tune their use of the tools and resources, there were still teachers, particularly newer teachers to the program that feel that they needed more in depth training with specific tools and that some workshops were too dense with information or sporadic to be effective. Additionally, we found that the modified coaching model of maintaining one coach throughout the year as the other rotated, ensuring a steady rapport did translate into the provision of more continuous teacher support. However, as a result of the additional teachers to the study in Year 2 the coaches were stretched thin to meet the needs of all the teachers. Coaches were also tasked with a range of administrative duties that took valuable time away from their ability to deliver the site-based instructional support that teachers needed. The data suggest that there were inconsistencies in the way in which teachers received professional development on integrating the technology into their lessons. It appeared that teachers in the non-matched treatment group received more extensive support and one-on-one assistance, and spoke more favorably about the support they received than the matched treatment teachers.

As these data reveal, teachers’ use of the technology was impacted by a variety of factors beyond the presence or absence of the technology in the classrooms. In many cases teachers’ time, school conditions, and organizational factors or structures as well as administrative support impact the way in which coaches were able to effectively permeate the already existing “culture” at the school site, and thus provide the one-on-one or collaborative support that most teachers desired.

*Research Question 3: To what extent did the school culture affect teachers’ implementation and integration of technology into their lessons?*

In Year 1 we found that the non-matched treatment schools had a higher degree of program implementation than the matched treatment schools. Of the eight treatment schools in general, we found four schools (three non-matched and one matched) in which between 86% and 100% of the teachers were using some of the equipment on two or more of the days we observed them. On the other hand, of the four other treatment schools (three matched and one non-matched), between 28% and 57% of the teachers were observed using the technology on two or more of the days we

observed them. This finding appeared to be due to differences between the two types of schools. We posited that the non-matched treatment schools might be sites where, because of their organizational cultures, reforms were more easily taken up by the school site administrators and teaching faculty. Thus, in Year 2, we sought to collect data that would allow us to examine this question more carefully. We interviewed principals, teachers, and coaches in an attempt to identify aspects of each school's culture and organizational structure that might help us explain these obvious implementation differences if they continued to exist in Year 2.

While we did find that the overall use of technology increased in the matched treatment schools – from a low of 28% up to 54% of teachers using technology on two or more days – we continued to see significantly greater usage of technology at the non-matched treatment schools. Consequently, we examined the interview data to determine if there were differences between the cultures and organizational structures present at the matched treatment schools and the non-matched schools. Drawing from Hord (1997), we compared the schools in terms of five elements considered to reflect positive school cultures: shared and supportive leadership; shared visions and values; collective learning and application of that learning; shared personal practice; and supportive conditions. While we did not find all of the elements present at the schools in which we found more evidence of program implementation or higher quality instruction, we did find strong evidence that these schools were in the process of developing into learning communities. Each of the dimensions is presented below.

#### *Supportive and Shared Leadership*

Louis and Kruse (1995) identify supportive leadership of principals as one of the necessary human resources for fostering a staff into a school-based professional community. Using teacher interview data, we were able to determine the extent to which teachers felt supported by their principal. We found that those same schools in which we found higher use of technology, (three non-matched, one matched treatment) 70% to 90% of the teachers characterized their principal as “highly supportive.” On the other hand, among those schools in which we found fewer teachers frequently using the technology, (three matched treatment and one non-matched) between 62% and 90% of the teachers characterized their principal as only “moderately or “not particularly supportive.”

We also examined the principal interview data to determine the extent to which they shared or distributed power or authority among their staff. We found elements of distributed leadership in

schools where teachers felt more support from the administration. For example, the principals had their teachers conduct professional development sessions and peer led workshops, rather than relying on external “experts.”

### *Shared Visions and Values*

We looked for evidence that the principal expressed a vision that guided schoolwide decisions about instruction, and more specifically an enthusiasm about incorporating technology into the curriculum. We asked principals to articulate what it meant to be a leader at their school sites. We found that three principals (two non-matched and one matched) identified strongly with their role as instructional leaders. They also expressed a commitment to the goal of enhancing technology use at their school sites for the purpose of improving the quality of instruction. One of these principals clearly identified his role in establishing the school’s vision and values. He stated the following:

It’s like a lesson plan where you do backwards planning and start with the outcomes that you desire from the lesson. What do I want the kids to know and what do I want them to be able to do by the time they leave my classroom? Same thing with the principal, you set the expectations, goals and vision and desired outcomes with the teachers at the beginning of the year and then you tell them the ways that we’re going to get there and you explain how you’re going to support them.

These principals not only took a vested interest in the goals of the MSTP program, but articulated a vision about technology use and improving the quality of pedagogy. They wanted the technology to transform the instruction, and not merely perpetuate the same traditional pedagogy. One principal shared how he personally attended team meetings, visited classrooms regularly, and debriefed with teachers, to ensure the enactment of his vision for the school:

It’s my understanding that where we are in technology in education today is that we’ve done a fairly good job at technologizing [sic] teachers and that they are beginning to use it, but we have not made the next step, which is to put the technology in the hands of the students and I just don’t see enough of that. I have found that people are interested in using the technology for the things they are comfortable with. For example, many of our teachers have become proficient at using the Activboard, but those are the same teachers who are comfortable with

teacher presentation, that formal kind of classical [sic] presentation where the teacher is the expert and the student is the learner. Sure the Activboard enhances it, makes it more interesting, but it has not changed the teacher's style nor has it changed the learning environment for the students.

At one of the "higher use" matched treatment schools, the principal also mentioned that the school had decided to go all wireless and that he would no longer be purchasing desktops but rather laptops, and that he wanted to make the entire school wireless. At another school, the principal's commitment to his vision of using technology to promote a shared vision was expressed by ensuring that all teachers have a personal laptop.

#### *Collective Learning and Application of that Learning*

Next, we looked for evidence that the staff work collaboratively to plan, solve problems, or improve learning opportunities. We found that among three of the "higher use" schools (all non-matched treatment), the principals mentioned either a commitment to establish "small learning communities" or explained that these were already a part of the structure of the school. In these schools smaller "houses" of teachers and students met regularly to discuss and share issues regarding issues across curriculum and grade levels. Among the matched treatment schools, we found more fractured degrees of collegiality, confirmed by both the teachers and the MSTP coaches.

We also found in only three of the program schools (all non-matched treatment) principals included the efforts of the MSTP coaches in the wider school professional development agenda and in a few cases provided MSTP teachers release time from some of the department meetings in order to have cohort meetings.

#### *Shared Personal Practice*

In addition to grade level and department meetings, we looked for evidence of peer visits to classrooms and other opportunities to receive feedback on instructional practices as a way of examining the extent to which teachers shared their personal practices. In three of the "higher use" schools (two non-matched treatment, one matched) and one control school, principals mentioned that teachers shared their practice with one another through visiting one another's classroom, engaging in lesson study and /or videotaping of lessons for discussion on a department level in order to learn from one another. In some schools, these practices were planned for the future and in others, they were already embedded in the school culture. One principal explained how it's

done at her school as follows, “Teachers prepare a lesson and share it and model it for the other teachers and then we make a booklet of these lessons for the other teachers to use. It is very important that they have time to talk about students and that is why we work in teams.” On the other hand, at three of the matched treatment schools, where technology use was low, we found no evidence of structures in place that facilitate shared personal practice. If any occurred it was only informally in passing through the halls or at lunch.

### *Supportive Conditions and Structures*

We looked for the evidence of structures built into the school schedule that allowed for more collegiality or opportunities for teachers to receive the one-on-one professional development support offered through the MSTP. We examined the extent to which teachers had common planning time or common conference periods within subject or grade level. We also examined the extent to which math coaches (separate from the MSTP) and adequate or excellent technical support (outside of the MSTP) were available across the school sites. What we found was that factors that contributed to the use of technology at these schools seemed to not only be the extent to which technology was embraced by the principal in the overall vision for the school, and the degree to which technology use was addressed as a topic in school wide professional development opportunities, but also the availability of technical support available at the school site.

We also found differences across schools in terms of how time was allocated for the professional development available from the MSTP coaches, in terms of conference periods or cohort meetings. In addition to the 6th grade coring which existed in all of our schools (one teacher teaches two core subjects: math/science and language arts/social studies to the same set of students), we found that in most of the program schools teachers teamed in the 7th and 8th grade (sets of four teachers are responsible for the same set students), and met regularly to discuss student learning issues. We found that in four (three non-matched and one matched treatment) schools, teachers within the same grade and subject area were intentionally given common conference periods. On the other hand, in three of the matched treatment schools, teachers in the 7th and 8th grade had no common planning time or common conference periods.

In addition to formal planning time, in two of the non-matched treatment schools, the MSTP teachers met as a cohort, more regularly and for a longer period of time. In three of the matched treatment schools, lunch meetings were the only available option. We also found one school, a matched treatment school that had transitioned into block scheduling during Year 2.

With these differences in time available to teachers during a class period, or for conference periods, this school distinguished itself from the other schools in our study. However, the coaches were able to take advantage of those potential opportunities.

Adequate technical support was available at five of the schools (three matched treatment and two non-matched treatment) whereas technical support was not readily available unless the MSTP coaches were present at the remaining three schools (one matched, two non-matched). Although the coaches were not intended to service the schools in terms of technical support but rather as instructional support, their presence seemed to satisfy that unmet need. We also found that in three schools, (two non-matched treatment, one matched treatment) a math coach (outside of the MSTP program) was not available for the school.

One of the characteristics of a productive learning community is a willingness to accept and provide feedback to colleagues in working toward improved practice and opportunities to do so. Time was consistently the most significant issue cited as an obstacle or contributing factor to continuous school improvement.

Within the control schools, where we found more evidence of high quality instruction, teachers expressed a high degree of collegiality among the staff, with ample time to meet and share strategies, and engage in cross-curricular planning.

We found that when teachers felt support from their principals, had opportunities to discuss practice with colleagues, were afforded time to meet, shared collegiality among other teachers, and other school organizational factors or structures were in place to support these conditions, coaches were more effective in providing support. Moreover, the program was implemented more successfully. We found more evidence or positive characteristics of a school “culture” and supportive conditions among the non-matched treatment schools than within the matched treatment schools.

Consequently, those schools in which elements of positive “culture” existed, increased the likelihood for teachers to reflect on their practice, collectively engage in dialogue about effecting change in instructional practices, or in integrating technology into the curricula. For the most part we found elements of positive “culture” correlating with high technology use. Consequently, schools in which this positive “culture” existed were those in which the coaches were able to provide more opportunities for professional development (in the form of more frequent demo lessons, or site-based whole school workshops, or more extensive cohort meetings). Similarly,

schools in which we found stronger evidence of a learning community, teachers had opportunities to observe one another, provide feedback and engage in more opportunities to discuss instructional practices, or integration of technology into lessons.

The presence or absence of a positive culture not only affects school wide instructional practices and the opportunities afforded to teachers to engage in dialogue about integrating technology into the curriculum, but it can also have an effect on student achievement. In this last section we look at student achievement data and its correlation to the quality of instruction, as it relates to teachers’ use of technology.

*Research Question 4: To what extent has the infusion of technology in the matched treatment schools yielded gains in student performance?*

We examined the extent to which the program had an impact on student achievement. We examined achievement data collected from the BAM, the PASS, and CST, using matched treatment and control student scores for each test. This section presents the results of our analyses.

*Balanced Assessment in Mathematics*

The BAM was administered to 6th and 7th grade students in mathematics classrooms. Tables 11-13 show BAM pre and posttest scores for matched treatment and control students for each grade level for both parts of the test (A and B) separately. We conducted Analyses of Variance (ANOVAs) using a linear regression with pretest score as the predictor variable and posttest score as the outcome variable. We computed unstandardized residuals to estimate the gains students made from Fall to Spring and tested for significant differences in students’ pre and posttest scores. The control students demonstrated greater gains than the matched treatment students on both sections of the test. These differences were not found to be statistically significant (see Table 11).

Table 11: Pre and Posttest BAM Mean Scores and Adjusted Gains for 6th Grade

	Matched Treatment (N=257)			Control (N= 236)		
Test	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain

BAM Part A	6.47 (5.6)	11.1 (7.5)	2.1	9.09 (6.5)	13.6 (8.6)	2.3
BAM Part B	10.9 (7.5)	15.8 (8.3)	2.9	13.9 (8.6)	19.0 (9.1)	3.7

In 7th grade, as Table 12 reveals, the control group outperformed the matched treatment group on both parts of the test. The matched treatment group’s adjusted mean gain on Part A was 1.58 and the control group’s adjusted gain was 2.88. We found those differences to be significant at the  $p < .05$  level. On Part B we also found statistically significant differences between the control (M=4.0) and the matched treatment (M= 2.4) students.

Table 12: Pre and Posttest BAM Mean Scores and Adjusted Gains for 7th Grade

Test	Matched Treatment (N=163)			Control (N= 177)		
	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain
BAM Part A	5.62 (4.0)	7.48 (4.5)	1.58	7.01 (4.6)	9.62 (5.9)	2.88*
BAM Part B	7.83 (5.6)	10.67 (5.8)	2.42	10.68 (6.3)	14.01 (7.8)	4.00*

\* $p < .05$

In the 8th grade, as Table 13 illustrates, the control students (M=2.5) outperformed the matched treatment students (M=1.5) on Part A of the test. These differences were not found to be significant. On Part B of the test control students (M=3.3) similarly outperformed the matched treatment students (M=1.6) and these differences were found to be significant at the  $*p < .05$  level.

Table 13: Pre and Posttest BAM Mean Scores and Adjusted Gains for 8th Grade

Test	Matched Treatment (N=120)			Control (N= 176)		
	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain
BAM Part A	5.5 (4.0)	7.1 (4.0)	1.5	10.2 (5.7)	10.2 (6.3)	2.5
BAM Part B	4.6(5.8)	7.6 (5.2)	1.6	12.2 (7.3)	13.3 (8.0)	3.3*

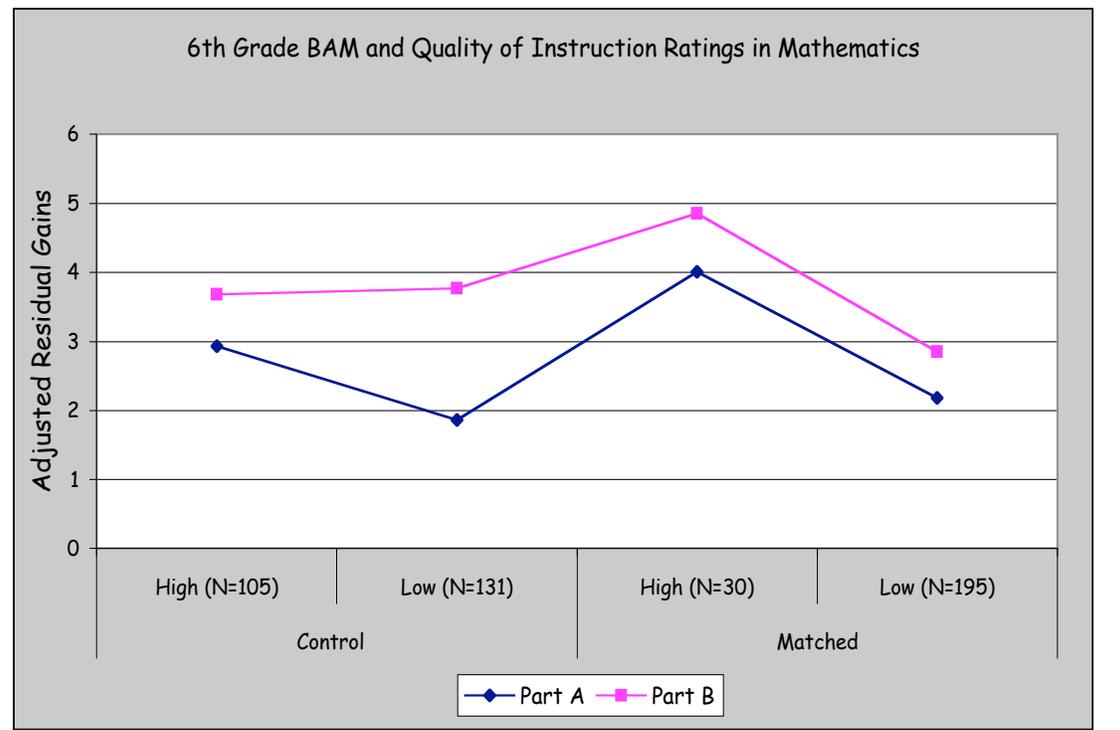
\* $p < .05$

The matched treatment and control groups were considerably different in terms of the composition of their 6th, 7th and 8th grade students’ English language proficiency. Matched treatment schools had higher proportions of Limited English Proficient (LEP) students than the

control schools. In order to control for differences that might be due to this varying composition between the groups, we isolated each grade and their LEP students and compared the means of the matched treatment and control students. We ran an ANOVA using the residuals of BAM scores, and for the 6th, 7th and 8th grade LEP students. Again, we found a similar pattern as for the larger group. There were no statistically significant differences.

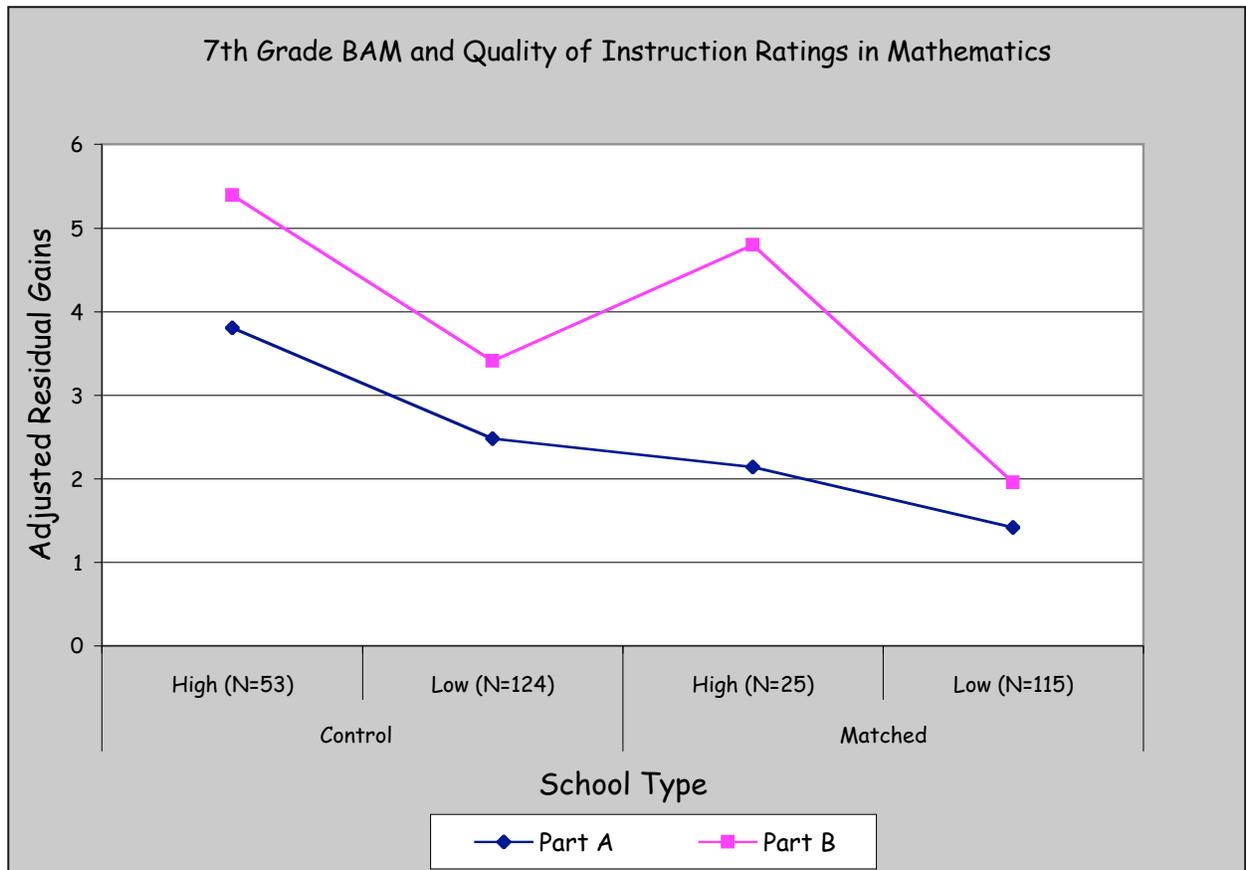
Using individual t-tests we compared 6th grade students' residual gains according to teachers' average quality of instruction rated as high (2.2 or above) or low (below 2.2) within grade (see Chart 1). We found that 6th grade students in both the control and matched treatment group associated with teachers receiving a higher rating of instructional quality outperformed their peers receiving a lower quality of instruction on both sections of the test. As shown below, the sample sizes of high quality instruction differ substantially between teachers in the control group and matched treatment group, such that there was much more evidence of higher quality instruction among the control teachers.

Chart 1: 6th Grade BAM Performance and Quality of Instruction



Again, using individual t-tests we compared 7th grade students' residual gains according to teachers' average quality of instruction. Similar to the 6th grade findings, 7th grade students in both the control and matched treatment groups associated with teachers receiving a higher rating of instructional quality outperformed their peers receiving a lower quality of instruction on both sections of the test. We also found these differences to be significant within each group on Part B of the BAM assessment at level  $*P < .05$  (See Chart 2). As shown below, the sample sizes of high quality instruction differ slightly between teachers in the control group and matched treatment group.

Chart 2: 7th Grade BAM Mathematics Performance and Quality of Instruction



BAM results indicate a link between higher quality instruction and student performance in both the 6th and 7th grade. In the 8th grade we found that higher quality of instruction did not have an effect on student performance.<sup>12</sup>

In 2004-05, the CAT/6 exam was not administered to middle school students. All students in our study took the California Standards Test (CST) in mathematics.<sup>13</sup> We conducted a linear regression using the residual 2005 CST mathematics scaled score and the 2004 scale score as the predictor to compute standardized residuals. Using these residuals as gain scores, we conducted ANOVAs for 6th, 7th and 8th grades separately. The analysis looked at students according to their math program, as students in the 8th grade either take the Algebra 1 exam or the General Math exam. All students in our study took the CST in mathematics associated with their grade level and math course. Consistent with the BAM findings in the 6th grade, using the scale scores, the control group (M=.530) outperformed the matched treatment (M=.342) students, although these differences were not found to be significant (see Table 14).

Table 14: CST Mathematics Scale Scores and Adjusted Gains for 6th Grade

		Mean Scale Score	Std Dev.	Adjusted Gain
Matched Treatment (N=351)	2005	344.02	65.6	.342
Control (N= 273)	2005	367.44	75.19	.530*

\*p<.05

Similar findings were discovered in 7th grade, such that the control group (M=.038) outperformed the matched treatment group (M=-.074) using the CST scale score. We did not find these differences to be statistically significant (see Table 15).

Table 15: 2005 CST Means and Adjusted Gains for 7th Grade

		Mean Scale Score	Std Dev.	Adjusted Gain
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<sup>12</sup> It should be noted that three (out of eight) of the 8th grade math teachers in the matched treatment group were removed from the study and not replaced.

<sup>13</sup> CST performance level tables can be found in the Appendix for each grade and school type.

Matched Treatment (N=479)	2005	317.2	46.4	-.074
Control (N= 472)	2005	339.1	60	.038

\*p<.05

Within the 8th grade, students were enrolled in either the two-year Algebra course or the one-year Algebra course. Course enrollment usually dictates which CST exam students take. As Table 16 illustrates, the majority of 8th grade students in the matched treatment schools were enrolled in the two year Algebra course, whereas in the control schools, the majority of students were enrolled in the one-year Algebra course, and thus took the more challenging exam.

Table 16: 2005 CST Means and Adjusted Gains for 8th Grade Two-Year Algebra Course

		Mean Scale Score	Std Dev.	Adjusted Gain
Matched Treatment (N=289)	2005	297.6	39.6	.003
Control (N= 70)	2005	307.8	43.6	-.039

\*p<.05

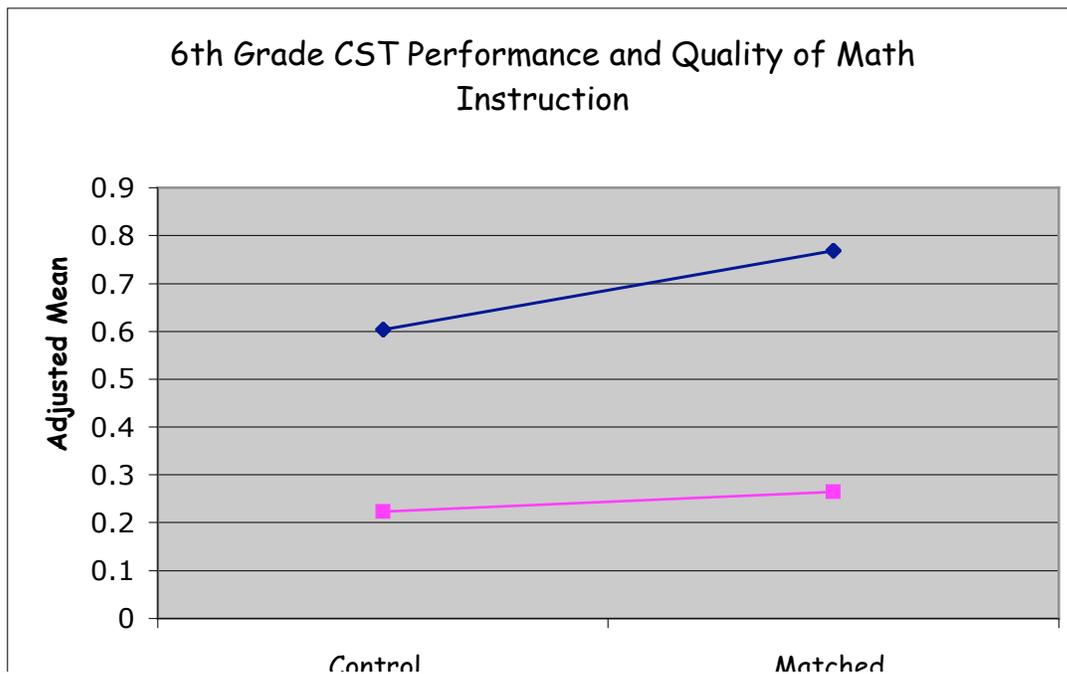
In order to confirm, that these differences in course enrollment were characteristic of the school and not a result of our sampling of teachers, we examined the distribution of 8th grade students across each school individually. We discovered that in three of the four control schools, 95% to 100% of the students were enrolled in the one-year Algebra course, and in only one of the control schools the opposite was true; the majority of 8th grade students were enrolled in the two year Algebra course. In the matched treatment schools, approximately 75% to 90% of all the students were enrolled in the two-year Algebra course. We thus concluded that our sample was representative of each school type and their course taking patterns. As shown in Tables 16 and 17, the sample sizes in student enrollment in the two-year Algebra courses differed dramatically between the control and matched treatment students, such that the majority of control students were enrolled in the one-year Algebra course. Given these differences we still found control students in the two-year Algebra course outperformed the matched treatment students using the scale scores. These differences in performance were not found to be significant. Performance in the one-year Algebra revealed that the matched treatment students demonstrated a slightly higher scale score than the control students.

Table 17: 2005 CST Means and Adjusted Gains for 8th Grade One-Year Algebra Course

		Mean Scale Score	Std Dev.	Adjusted Gain
Matched Treatment (N=90)	2005	315.3	39.7	-.07
Control (N= 413)	2005	305.7	52.9	.10

We also compared students within each grade level and school type to see differences in performance based on quality of instruction ratings. Using individual t-tests we compared students' residual gains according to teachers' average quality of instruction rating as high (2.2 or above) or low (below 2.2) within grade and group. We found that overall only in the 6th grade students (M=.58) associated with teachers receiving a higher rating of instructional quality outperformed their peers (M=.24) receiving a lower quality of instruction. We found this held true within each of the groups (see Chart 4). The differences within both the control group and the matched treatment group were found to be significant at  $*p < .05$ . In both the 7th and 8th grade we found scant instances of high quality mathematics instruction and where we did, we did not find that higher quality instruction had an effect on higher performance on the CST.

Chart 4: 6th Grade CST Mathematics Performance and Quality of Instruction



Similar to the BAM analyses, we isolated the LEP students, and ran an ANOVA using the residuals from the CST scale score means for each grade, and LEP students, and we found that the 6th grade LEP students in the matched treatment group (.142) outperformed the LEP students in the control group (-.214). Within the 7th grade we found a similar pattern as we found for the larger group, among the LEP students. Within the 8th grade the discrepancies in sample sizes prevented us from determining any findings.

As mentioned previously, there are currently no state mandated tests in science in the middle grades. Therefore, we used the PASS science assessment as a pre and posttest. We administered the PASS to each grade level in the matched treatment and control science classrooms. We examined differences between groups and across grade levels for the pre and posttest of the PASS assessment.<sup>14</sup> We conducted a linear regression analysis predicting the posttest raw scores for the three sections of the test – the multiple-choice, the performance task, and the constructed response/open-ended section of the assessment – as a function of the pretest. As Table 18 demonstrates, students overall scored higher on the performance task section of the assessment in the 6th grade than on any other portion of the test. Students in the control group (.256) outperformed the matched treatment students (-.202) on both the Multiple Choice section of the test, and on the Performance Task section, although these differences were not found to be significant. On the Constructed Response section of the test, only those students in the matched treatment group demonstrated gains, as performance in the control group declined from the pre to the posttest.

Table 18: Pre and Posttest PASS Mean Scores and Adjusted Gains for 6th Grade

Test	Matched Treatment (N=261)			Control (N= 229)		
	Pretest Mean % (SD)	Posttest Mean % (SD)	Adjusted Gain	Pretest Mean% (SD)	Posttest Mean % (SD)	Adjusted Gain
Multiple Choice	48.7 (.15)	53.2 (.17)	-.202	53.9 (.15)	58.9 (.18)	.256
Performance Task	54.6 (.18)	62.0 (.18)	.040	62.6 (.17)	66.4 (.18)	.037
Constructed Response	30.5 (27)	42.3 (29)	.050	42.9 (25)	38.3 (28)	.008

<sup>14</sup> The PASS test consists of 3 parts: multiple choice, performance task, constructed response. Our analysis includes only those students that were present for all 3 sections of the test.

Among the 7th grade students, the control students (.383) outperformed the matched treatment (.158) on the Multiple Choice section of the test. These differences were found to be only marginally significant. This pattern held true for the Performance Task portion of the test. The control students (.389) outperformed the matched treatment students (-.427). We found these differences to be statistically significant at  $*p < .05$  level (see Table 19). Student performance on the Constructed Response section of the test also showed greater gains among the control students than the matched treatment students.

**Table 19: Pre and Posttest PASS Mean Scores and Adjusted Gains for 7th Grade**

Test	Matched Treatment (N=144)			Control (N= 177)		
	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain
Multiple Choice	42.5 (.15)	51.7(.15)	.158	52.4 (.13)	59.3 (.15)	.383
Performance Task	49.7 (.16)	54.5 (.15)	-.427	56.5 (.17)	64.4 (.12)	.389*
Constructed Response	29.7 (.31)	41.9 (.33)	-.146	42.6 (.36)	48.7 (.37)	.026

\* $p < .05$

Among the 8th grade students (see Table 20) we found the control students ( $M = -.190$ ) outperformed the matched treatment students ( $M = -.541$ ) on the Multiple Choice section of the test, although these differences were not found to be significant. In addition, the control students (.302) outperformed the matched treatment (-.402) students on the Constructed Response section of the test and we found those differences to be significant.

**Table 20: Pre and Posttest PASS Mean Scores and Adjusted Gains for 8th Grade**

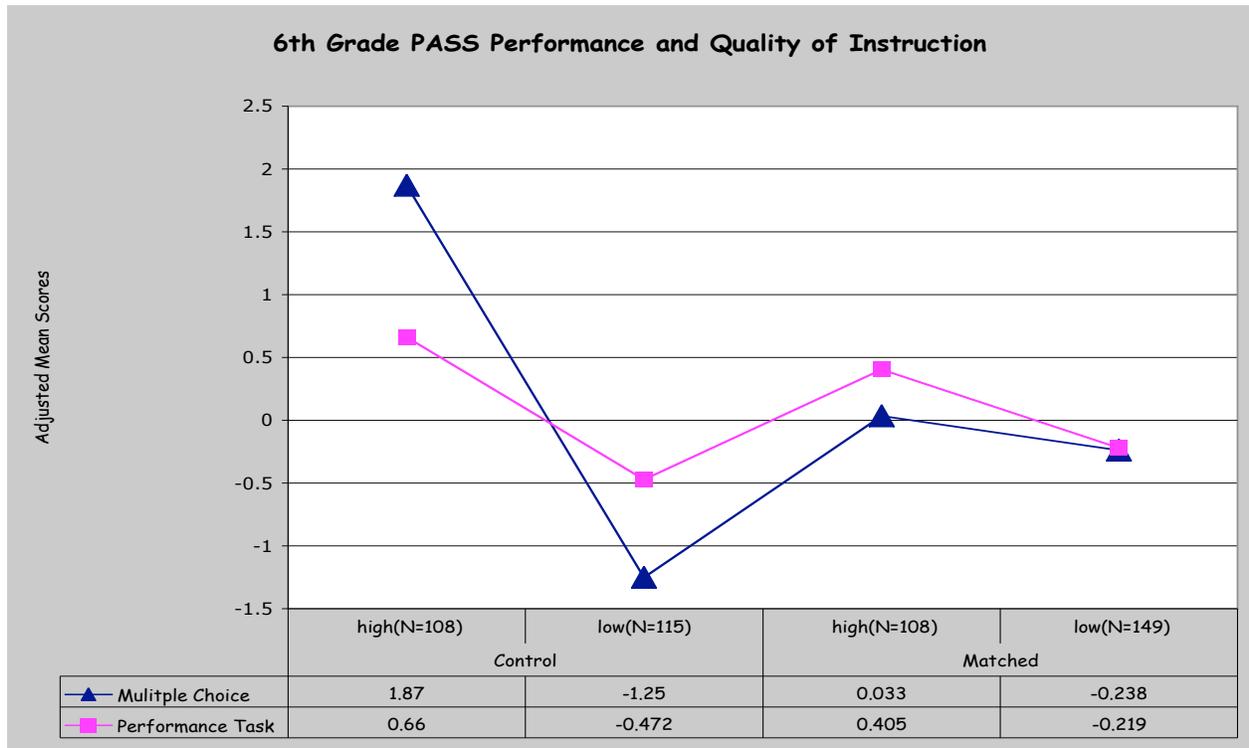
Test	Matched Treatment (N=197)			Control (N= 170)		
	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain
Multiple Choice	42.9 (.10)	45.3 (.12)	-.541	46.2 (.12)	48.2 (.14)	-.190
Performance Task	34.9 (4.1)	42.6 (4.2)	.577*	43.6 (5.0)	41.1 (6.3)	-1.28
Constructed Response	25.2 (20)	33.3 (21)	-.402	34.4 (23)	45.6 (22)	.302*

\* $p < .05$

In contrast, we found on the Performance Task section of the test, students within the matched treatment (.577) group outperformed the control (-1.28) students. We found those differences to be significant at  $*p < .05$  level of significance.

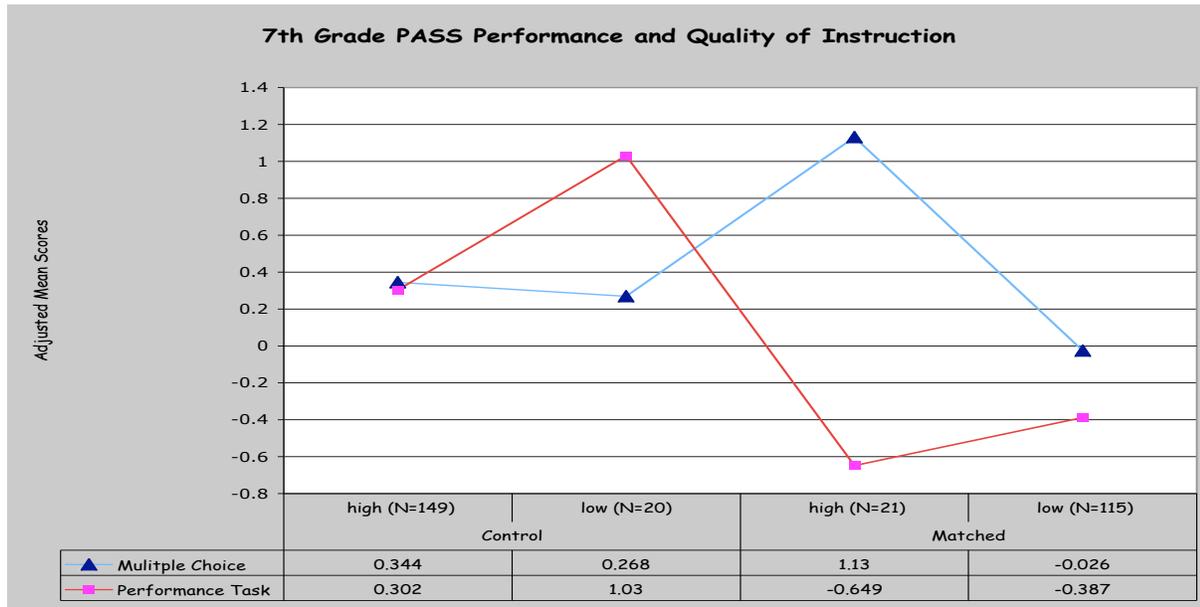
Using individual t-tests we compared students' residual gains according to teachers' average quality of instruction rating as high (2.2 or above) or low (below 2.2) within grade and school type. We found, among the 6th grade, that student performance was impacted by the quality of instruction on both the multiple choice and performance sections of the test among the control group. We also found that in the control group, performance differences between higher and lower quality instruction were found to be significant on the Multiple Choice and the Performance Task sections of the test. Significant differences were found in the matched treatment group only on the Performance Task section of the test. (see Chart 5). We did see evidence of fairly equal amounts of high quality science instruction in the 6th grade, across both school types- (control and matched treatment).

Chart 5: 6th Grade PASS Performance and Quality of Instruction



Again, using individual t-tests to examine student performance and the impact of the quality of instruction, we found that student performance was only impacted by higher quality instruction among the control and the matched treatment groups on the Multiple Choice section of the test, although these differences were not found to be significant. Within the matched treatment group, this difference is attributable to only one teacher. As Chart 6 reveals, a higher percentage of teachers in the control group demonstrated higher quality science instruction than the matched treatment teachers.

Chart 6: 7th Grade PASS Performance and Quality of Instruction



We did not find that high quality instruction had an effect on student performance in the 8th grade between the control and matched treatment students.

What these findings reveal across all tests is that overall, students in the 6th and 7th grade associated with higher quality instruction performed better on the Balanced Assessment in Mathematics, the CST in mathematics, and the PASS assessment in science. Overall, the control students in each grade level outperformed the matched treatment, in both math and science. Only among the 8th grade did we see the matched treatment students outperform the control students, and this was found on the Performance Task section of the PASS exam. These findings were found to be significant.

*Research Question 5: To what extent has the infusion of technology in the non- matched treatment schools yielded gains in student performance?*

The performance data for the non-matched students is presented below, for each exam BAM, CST, and PASS- and for each grade level. We used a linear regression using the pretest scores as predictor variables and posttest scores as the outcome variable. We then computed unstandardized residuals to estimate the gains students made from the pre to the posttests.

Table 21: Pre and Posttest BAM Mean Scores and Adjusted Gains for 6th Grade

Non-Matched Treatment (N=285)			
Test	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain
BAM Part A	6.79 (5.3)	11.5 (7.8)	2.2
BAM Part B	11.02 (7.3)	15.5 (7.5)	2.4

6th grade students in non-matched treatment group demonstrated an adjusted gain of 2.2 on Part A of the exam and 2.4 on Part B.

Table 22: Pre and Posttest BAM Mean Scores and Adjusted Gains for 7th Grade

Non-Matched Treatment (N=180)			
Test	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain
BAM Part A	7.23 (4.4)	9.16 (5.3)	2.29
BAM Part B	10.44 (5.6)	12.93 (6.8)	3.07

7th grade students in the non-matched group demonstrated an adjusted gain of 2.29 on Part A of the exam and 3.07 on Part B. We found no evidence of high quality math instruction among the 7th grade teachers in the non-matched treatment group. Within the 8th grade student performance demonstrated an adjusted gain of 4.3 on Part A and 5.3 on Part B.

Table 23: Pre and Posttest BAM Mean Scores and Adjusted Gains for 8th Grade

Non-Matched Treatment (N=179)			
Test	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain
BAM Part A	9.2 (5.3)	11.58 (5.9)	4.3
BAM Part B	10.9 (7.6)	14.7 (8.3)	5.3

Additionally, we found that 26% of the 8th students in the non-matched group participated in the study in both years of the program. The continued exposure to the program may be a contributing factor to these findings.

Data for the non-matched treatment students' CST mean scale 2005 score and their adjusted gain using their 2004 mean scale score as a predictor, we calculated their adjusted gains. On the CST, 6th grade students demonstrated an adjusted gain of .212, 7th grade students demonstrated an adjusted gain of .082.

Table 24: CST Mathematics Scale Scores and Adjusted Gains Non-Matched Treatment Students

		Mean Scale Score	Std Dev.	Adjusted Gain
6th Grade (N=391)	2005	330.46	57.7	.212
7th Grade (N=459)	2005	330.9	65.3	.082
8th Grade (two-year) Algebra (N=393)	2005	347.7	57.5	.440
8th Grade (one-year) Algebra (N=82)	2005	344.91	52.1	.290

We found that approximately 75% to 90% of the 8th students were enrolled in the two-year Algebra course in the non-matched schools. This finding confirmed that our sample was reflective of the enrollment patterns of the school as a whole. The majority of 8th grade students in our sample in the non-matched treatment schools enroll in the two-year Algebra course (N=393) compared to the one-year Algebra course (N=82). Students taking the one-year Algebra were taking a more difficult exam than those students in the two-year Algebra course.

Student performance for the PASS assessment, are included in the following Tables 25-27. We found among the 6th grade non-matched treatment students, across all sections of the exam, students' performance was slightly lower than we would have expected. Among the non-matched 6th grade treatment students, higher quality instruction had no effect on student performance on both the Multiple Choice and Performance section of the test.

Table 25: Pre and Posttest PASS Mean Scores and Adjusted Gains for 6th Grade Non-Matched Treatment (N=251)

Test	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain
Multiple Choice	50.0 (.16)	54.9 (.18)	-.023
Performance Task	56.5 (.16)	62.3 (.16)	-.077
Constructed Response	39.7 (28)	39.1 (28)	-.057

Within the 7th grade non-matched treatment students we found that student performance similarly did not reflect what we would have expected given their pretest scores. Using the t-tests to examine students' performance and the impact of the quality of instruction, we found that the majority of students (N=106) were associated with teachers receiving high quality instruction ratings, whereas only one teacher (N=37) received a low quality instruction rating. Students associated with higher quality instruction (M=.042) outperformed those students associated with lower quality instruction (-.324) on the Performance Task section of the test only.

Table 26: Pre and Posttest PASS Mean Scores and Adjusted Gains for 7th Grade Non-Matched Treatment (N=153)

Test	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain
Multiple Choice	53.4 (.16)	56.8 (.19)	-.592
Performance Task	56.0 (.19)	59.9 (.15)	-.052
Constructed Response	40.0 (35)	46.8 (35)	-.102

Within the 8th grade the data reveal that the non-matched students performance on the Multiple Choice and Performance section of the test, far exceeded our predictions. (see Table 27). When examining 8th grade student performance associated with teachers receiving high quality of instruction ratings we found higher quality instruction did not have an affect on either section of the test. We did, however, find that students in the 8th grade non-matched treatment classrooms, associated with teachers whose use of technology received a high quality technology rating in

science, outperformed their peers whose science teachers' use of technology was rated lower in quality on the Multiple Choice section of the test.

Table 27: Pre and Posttest PASS Mean Scores and Adjusted Gains for 8th Grade Non-Matched Treatment (N=144)

Test	Pretest Mean (SD)	Posttest Mean (SD)	Adjusted Gain
Multiple Choice	46.6 (.16)	52.3 (.18)	.965*
Performance Task	45.9 (5.5)	50.8 (4.9)	.675*
Constructed Response	35.9 (21)	44.4 (25)	.186

### Conclusions

The second year of this two-year evaluation provides feedback on the implementation of the program, during the 2004-05 school year, and its relationship to student achievement. The findings addressed the following research questions:

1. To what extent have the MSTP efforts led to the integration of technology and further enhanced the delivery of a Standards-based and project-based curricula in mathematics and science classrooms?
2. To what extent did the professional development offered through the MSTP impact teachers' ability to use technology during instruction?
3. To what extent did the school culture have an impact on how the MSTP efforts were able to affect teachers' implementation and integration of technology into the lessons?
4. To what extent has the infusion of technology in the program schools yielded gains in student performance?
5. To what extent has the infusion of technology in the non-matched treatment schools yielded gains in student performance?

With respect to question one, we examined program implementation in two ways. First we looked at whether the technology provided to program schools was used by teachers during the

school year. We found more evidence of technology use among the non-matched treatment teachers than the matched treatment in both mathematics and science. We did see some evidence of similar technology being used by control teachers in both mathematics and science classrooms. We also analyzed the quality of technology use in mathematics and science classrooms. The overall average quality of the technology use in mathematics was low, whereas science use of technology was of a higher quality.

Second, we analyzed the data to determine whether teachers used the program technology and resources as teaching and learning tools to deliver standards-based and project-based curricula reflective of both the content and the process skills of developing reasoning and problem solving skills. We did not find that teachers used the technology in new and different ways but instead used it to take the place of other methods of instructional delivery (e.g., using the Activboard instead of the overhead projector or blackboard) in mathematics. Consistent with the research on technological reforms in education (Cuban, 2000), most teachers used the technology to maintain existing practices rather than to enhance student development of problem-solving and reasoning skills and the development of student understanding in these subject areas. We also found overall, more evidence of technology use among the non-matched treatment teachers than the matched treatment in both mathematics and science. In addition, control classrooms had access to some of the very same technological resources as the program schools. The overall average quality of the technology use in mathematics was low, whereas science use of technology was of a higher quality. We did find that more of the non-matched teachers demonstrated high quality technology use in science compared to the matched treatment teachers. In all of the school types we found higher quality uses of the technology in science than in mathematics classrooms.

Lastly we found the quality of instruction was not affected by the use of technology. This was particularly noticeable within the control group, where we found that regardless of their use of technology, overall instruction was of a higher quality in both math and science. Quality of instruction in mathematics was low within both the matched and non-matched treatment teachers. We did find higher quality of instruction more prevalent in science classrooms as opposed to math. More of the non-matched and control science teachers demonstrated evidence of higher quality instruction than the matched treatment teachers. On the other hand, matched and non-matched science teachers provided their students with a higher quality of instruction than their math counterparts. Higher quality science instruction was found among the majority of the science

teachers in both the non-matched treatment and control group teachers. In fact, in both mathematics and science classrooms low quality instruction was characterized as limited opportunities for students to engage in thoughtful discourse and recognize relationships among ideas, or have opportunities to think critically and to develop explanations, make predictions or debate alternative approaches to problems. The data suggests that use of technology did not necessarily have an affect on the quality of instruction.

With respect to question two, we examined whether the professional development offered to MSTP teachers had an impact on their ability to use the technology in the delivery of their lessons. In Year 2, coaches activities at the school sites varied between providing demonstration lessons to teachers, facilitating cohort meetings, providing professional development sessions to the whole school, troubleshooting with technical issues or equipment set up (for those newer teachers), addressing a variety of networking and security issues, and/or getting teachers to access the CTAP surveys.

Teachers who participated in the program for the two years had the time over extended summer breaks to explore and fine tune their use of the tools and resources at the end of Year 1. Nevertheless, there were still teachers, particularly newer teachers to the program that felt that they needed more in depth training with specific tools and that some workshops were too dense with information or sporadic to be effective. The data suggest that there were inconsistencies in the way in which teachers received professional development on integrating the technology into their lessons. It appears that teachers in the non-matched treatment group received more extensive site-based support. They also spoke more favorably about the support they received than the matched treatment teachers.

In many cases teachers' time, school conditions, and organizational factors or structures as well as administrative support impacted the way in which coaches were able to effectively permeate the already existing "culture" at the school site, and thus provide the one-on-one or collaborative support that most teachers desired. Interestingly, while the equipment and access to resources teachers received through the MSTP were quite advanced and "cutting edge" the professional development they received was very traditional, and "old school".

While 81% of the matched treatment teachers and 90% of the non-matched teachers' overall experience with the program, was enthusiastic and positive, teachers' use of technology did not guarantee high quality instruction. One teacher said, about the effect of the MSTP on her

teaching, “I feel like I’m a much more powerful teacher.” Others spoke of the “growth” they’ve experienced, and how their participation in the program increased their classroom effectiveness, or how it has allowed them to relinquish classroom control and allow students to take more responsibility for their own learning, or how much “fun” technology made teaching.

Given the fact that the program is only a two-year grant, it might be too early to expect that teachers could integrate the technology in inventive ways towards more student-centered collaborative project-based learning, unless that was previously a part of their practice. Unless teachers are provided with extensive examples and the time to transform their instructional practices, and to successfully integrate the technology tools and resources, their instructional pedagogy may not be different than their practice without the tools and resources.

Regarding the third question, we identified variations in school organizational structure that seemed to contribute to differences in the way the teachers implemented or integrated the technology. Our findings suggest that when teachers felt supported by the principal, had opportunities to discuss practice with colleagues, were afforded time to meet, and collegiality existed among the teachers, and other school organizational factors or structures were in place to support these conditions, coaches were more effective in providing support, and thus the program was implemented more successfully. We found more of these supportive conditions among the non-matched treatment schools than among the matched. For the most part we found elements of positive “culture” correlating with either high use, as in the case for most of the non-matched treatment schools or higher quality instruction, as noted in two of the control schools. Consequently, schools in which this positive “culture” existed increased the likelihood for teachers to reflect on their practice, collectively engage in dialogue about affecting change in instructional practices, or in integrating technology into the curriculum.

With respect to the fourth question, the control students in each grade level outperformed the matched treatment, in both math and science. Students in the 6th and 7th grade associated with higher quality instruction performed better on the Balanced Assessment in Mathematics, the CST in mathematics and the PASS in science. Only in 8th grade did we see that the matched treatment students significantly outperformed the control students in science.

With respect to question five, we found among the non-matched students, 8th grade science students’ performance on the Multiple Choice and Performance section of the test, far exceeded our predictions. When examining 8th grade student performance associated with

teachers receiving high quality of instruction ratings we found higher quality instruction did not have an affect on either section of the test. We did, however, find that students in the 8th grade non-matched treatment classrooms, associated with teachers whose use of technology received a high quality technology rating in science, outperformed their peers whose science teachers use of technology was rated lower in quality, on the Multiple Choice section of the PASS assessment.

### Recommendations

In light of the above findings, we make the following recommendations to ensure that similar programs are more effectively implemented in subsequent years.

- Teachers should be provided with continuous and in-depth professional development that not only instructs them about the mechanics of using the technology, but also teaches them how to meaningfully integrate it equally across both content areas. The focus of professional development should also emphasize practices reflective of high quality instruction.
- Coaches should be assigned to only one school. They should work directly with the administration at their school site to ensure that professional development is available on a regular basis is incorporated into the school schedule.
- Professional development addressing issues of enhancing the curriculum with the use of technology should also be directed specifically to the administrators, as the addition of technology to the educational program may require adjustments in the professional development schedule already in place at the start of the school year.
- Coaches should deliver a consistent program of support across schools and within subject matter and grade level.
- Program staff should work directly with Central District program coordinators to integrate their extensive set of Standards-based electronic resources into the Districts' Curriculum Guides for Mathematics and Science, so that teachers interested in utilizing those resources do not have to spend extensive time searching for examples of lessons that integrate the mathematics and science curriculum.
- If technology integration into the curriculum is a District goal, the District should ensure adequate site-based technical support staffing.

- Program staff could provide MSTP teachers with opportunities to meet with colleagues across program schools, either remotely, through the use of technology or in person, in order to learn from one another and share lessons learned.
- Similarly, program staff should consider utilizing the more experienced MSTP teachers into the support structure available to additional schools as they receive support and technological resources.
- The District may want to encourage principals to engage school staff in a process of reflective inquiry characteristic of a learning community, by providing teachers time to visit one another's classrooms, and providing time during the day to reflect on instructional practices.

MSTP was to serve as a pilot program to determine its effect on student achievement, with the intention of scaling up the resources available to schools within the district. The success or failure of the MSTP efforts depends not only on the program but the permeable school culture in which the program intends to infiltrate. If we have an expectation that these efforts will be institutionalized into the school's organizational culture when the MSTP funding is no longer available, then it should be noted that conditional factors play a strong role. The informal rules that govern behavior in schools play a significant role in the institutionalization of school improvement efforts. In order for a reform agenda to be successfully implemented so that changes in instructional practice occur and student learning and achievement improve, the traditional school culture that preceded the initiative must be challenged and simultaneously transformed. In order not to replicate the same pitfalls of previous technology reform efforts, the District will need to continue supporting schools through adequate staffing of both technical and curricular support.

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## Appendices

### Appendix A: Quality of Instruction and Technology Rubrics

<p><b>Nature of the Classroom Tasks</b></p>	<p>○1 Tasks typically take the form of text study, worksheets, introducing concepts and facts, or skill/drill exercises. Students are asked questions that require them to restate, or recall information, or fill in the blanks. Tasks do not ask students to demonstrate evidence of mathematical or scientific reasoning.</p>	<p>○2 Tasks require some prescription to follow with a focus on procedural or skills driven activities to order or group information. Students may be asked to organize or display data or read or produce tables. Tasks may require solving equations or routine word problems.</p>	<p>○3 Tasks require students to synthesize information using both prior and new knowledge and understand relationships between concepts. May be asked to analyze cause and effect of a problem. Students are asked to communicate their ideas or explain their findings.</p>	<p>○4 Tasks provide students opportunities to apply new knowledge and skills to interesting authentic problems. Tasks involve problem-solving, requiring students explore a scenario, or investigate a problem, or analyze data using reasoning skills.</p>	<p>○5 Tasks require students to treat a situation as a problem and to research, and think critically and reflectively using evidence to justify a claim. The task requires students to draw from multiple strategies or resources and requires them to synthesize content in order to prove the solution or make a claim.</p>
<p><b>Role of the Teacher</b></p>	<p>○1 Teacher presents lessons that are teacher centered, and students' contributions are rarely heard. Classroom discourse consists of short-answer (yes/no) questions.</p>	<p>○2 Teacher presents lesson that are teacher centered, and recitation oriented, and while students occasionally provide responses (the right answer), the teacher curtails or controls the dialogue or any ongoing exchange. Student participation is primarily procedural or clarifying.</p>	<p>○3 Teacher approaches subject with a questioning strategy/exposes students to inquiry about the subject but does not approach the learning as an opportunity or problem to be solved, nor encourages discussion about various solutions or methods. The authority of the lesson continues to reside with the teacher.</p>	<p>○4 Teacher functions as a facilitator as students co-construct their own learning about the subject. Teacher provides sufficient modeling and scaffolding of ideas and encourages classroom dialogue. Teacher asks students to explain or justify their explanations.</p>	<p>○5 The teacher presents the lesson as a problem or a question to be solved, functioning as a guide or coach in the collaborative learning of the classroom utilizing students previous knowledge, errors, and analysis to encourage participation, reflection and communication to co-construct understanding of authentic problems.</p>

<p><b>Social Culture of the Classroom</b></p>	<p>○1 Teacher talks rather than questions or interacts with students. Students are passive recipients of information from the teacher or textbook. The teacher may ask questions of a rhetorical or perhaps fill in the blank nature. Student work individually.</p>	<p>○2 The classroom dialogue is limited and consists primarily of teacher eliciting information. Students are not encouraged to develop or share ideas and thoughts about the lesson content with the teacher and/or their classmates.</p>	<p>○3 Students participation is constrained and controlled by the teacher, and students have limited opportunities to reflect or communicate with classmates about the subject matter. Little interaction between students as the authority still resides with the teacher..</p>	<p>○4 The teacher encourages students to engage in conversations around the lesson topic. Students initiate dialogue, and raise questions, and have opportunities to work in pairs or groups and have opportunities to communicate and share their thoughts about the subject matter,</p>	<p>○ 5 The climate in the classroom provides evidence that students are challenged to think and share control of the discourse with the teacher and their peers. Reflection on and communication about mathematics and science are highly valued and students do not depend on teacher to correct solutions but evaluate correctness using persuasiveness of the mathematical or scientific argument. Strong evidence of learning community.</p>
<p><b>Tools as Learning Supports</b></p>	<p>○1 Minimal use of technology or tool integration into lessons or activities for students in terms of time spent.</p>	<p>○2 Some evidence of students using technology both in terms of time and as a support to the learning, Students may connect to a website to solve computational problems, for drill or practice, or to find answers to short recall questions. If technology is used by the teacher it is resembles traditional instruction.</p>	<p>○3 There is evidence that the teacher is using the tools to create tasks for the students to solve mathematical problems or scientific investigations. Students are using computer tools to analyze data, create charts and graphs. Students/and or teacher are using the internet to download materials or research information. Students may integrate findings into a presentation.</p>	<p>○4 Students are asked to solve problems and use the tools/technology to make observations or investigate, and the tools further assist them to complete a problem-solving task. The tools are used to expand thinking not just to generate an answer to solve problems and as an aid to record their ideas and methods, in spreadsheets or databases (e.g) and asked to synthesize information, communicate, and present to fellow students their findings.</p>	<p>○ 5 Students use the technology frequently and are comfortable conducting research, or accessing information with real time two-way interactivity with professionals in the field. Students are using technology to create their own authentic research or design a mathematical proof.</p>

Appendix B: CST Performance Levels for Matched, Control and Non-Matched Students

**School Year 2004-2005**

California Standards Mathematics Scores Students in MSTP Study

I

Matched Treatment					
Grade 6 (2004-2005)	Baseline 2003-2004		School Year 2004-2005		% change
	N	%	N	%	
Far Below Basic	17	4.7	25	7.0	+ 2.3
Below Basic	88	24.6	82	23.1	-1.5
Basic	90	25.1	83	23.4	-1.7
Proficient	105	29.3	116	32.7	+3.4
Advanced	58	16.2	49	13.8	-2.4
Total	358	100.0	355	100.0	
Percent Proficient and Above	45.5%		46.5%		+1.0%
Non-Matched Treatment					
Grade 6 (2004-2005)	Baseline 2003-2004		School Year 2004-2005		% change
	N	%	N	%	
Far Below Basic	16	4.1	30	7.6	+ 3.5
Below Basic	102	26.0	107	27.2	+1.2
Basic	133	33.8	117	29.8	-4.0
Proficient	106	27.0	105	26.7	-.3
Advanced	36	9.2	34	8.7	-.5
Total	393	100.0	393	100.0	
Percent Proficient and Above	36.2%		35.4%		-0.8%
Control					
Grade 6 (2004-2005)	Baseline 2003-2004		School Year 2004-2005		% change
	N	%	N	%	
Far Below Basic	4	1.5	12	4.4	+ 2.9
Below Basic	49	17.8	52	19.0	+1.2
Basic	65	23.6	53	19.4	-4.2
Proficient	100	36.4	82	30.0	-6.4
Advanced	57	20.7	74	27.1	+6.4
Total	275	100.0	273	100.0	
Percent Proficient and Above	57.1%		57.1%		--

Matched Treatment					
Grade 7 (2004-2005)	Baseline 2003-2004		School Year 2004-2005		% change
	N	%	N	%	
Far Below Basic	18	3.7	33	6.8	+3.1
Below Basic	150	30.5	160	32.9	+2.4
Basic	195	39.6	187	38.5	-1.1
Proficient	100	20.3	85	17.5	-2.8
Advanced	29	5.9	21	4.3	-1.6
Total	492	100.0	486	100.0	
Percent Proficient and Above	26.2%		21.8%		-4.4
Non-Matched Treatment					
Grade 7 (2004-2005)	Baseline 2003-2004		School Year 2004-2005		% change
	N	%	N	%	
Far Below Basic	25	5.3	52	11.3	+6.0
Below Basic	133	28.3	119	25.8	-2.5
Basic	160	34.0	121	26.2	-7.8
Proficient	101	21.5	114	24.7	+3.2
Advanced	51	10.9	55	11.9	+1.0
Total	470	100	461	100.0	
Percent Proficient and Above	32.4%		36.6%		+4.2
Control					
Grade 7 (2004-2005)	Baseline 2003-2004		School Year 2004-2005		% change
	N	%	N	%	
Far Below Basic	22	4.6	29	6.1	+1.5
Below Basic	89	18.6	109	23.0	+4.4
Basic	156	32.6	147	31.0	-1.6
Proficient	147	30.8	129	27.2	-3.6
Advanced	64	13.4	60	12.7	-0.7
Total	478	100	474	100.0	
Percent Proficient and Above	44.2%		39.9%		-4.3

Matched Treatment					
Grade 8 (2004-2005)	Baseline 2003-2004		School Year 2004-2005		% change
	N	%	N	%	
Far Below Basic	55	<b>14.0</b>	52	<b>13.6</b>	<b>-0.4</b>
Below Basic	173	<b>44.0</b>	133	<b>34.8</b>	<b>-9.2</b>
Basic	107	<b>27.2</b>	156	<b>40.8</b>	<b>+13.6</b>
Proficient	53	<b>13.5</b>	41	<b>10.7</b>	<b>-2.8</b>
Advanced	5	<b>1.3</b>	--	--	<b>-1.3</b>
Total	393	100.0	382	100.0	
Percent Proficient and Above	<b>14.8%</b>		<b>10.7%</b>		<b>-4.1</b>
Non-Matched Treatment					
Grade 8 (2004-2005)	Baseline 2003-2004		School Year 2004-2005		% change
	N	%	N	%	
Far Below Basic	30	<b>6.2</b>	22	<b>4.5</b>	<b>-1.7</b>
Below Basic	107	<b>22.0</b>	90	<b>18.5</b>	<b>-3.5</b>
Basic	154	<b>31.7</b>	131	<b>27.0</b>	<b>-4.7</b>
Proficient	160	<b>32.9</b>	184	<b>37.9</b>	<b>+5.0</b>
Advanced	35	<b>7.2</b>	59	<b>12.1</b>	<b>+4.9</b>
Total	486	100.0	486	100.0	
Percent Proficient and Above	<b>40.1%</b>		<b>50.0%</b>		<b>+9.9</b>

Control					
Grade 8 (2004-2005)	Baseline 2003-2004		School Year 2004-2005		% change
	N	%	N	%	
Far Below Basic	33	<b>6.4</b>	70	<b>13.8</b>	<b>+7.4</b>
Below Basic	154	<b>29.9</b>	188	<b>37.2</b>	<b>+7.3</b>
Basic	190	<b>36.9</b>	152	<b>30.0</b>	<b>-6.9</b>
Proficient	105	<b>20.4</b>	79	<b>15.6</b>	<b>-4.8</b>
Advanced	33	<b>6.4</b>	17	<b>3.4</b>	<b>-3.0</b>
Total	515	100.0	506	100.0	
Percent Proficient and Above	<b>26.8%</b>		<b>19.0%</b>		<b>-7.8</b>