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AUTHOR	Stecher, Brian
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ABSTRACT

A study was undertaken to summarize the results of the first 2 years of the Model Technology Schools (MTS) program in California. Research and evaluation reported from the five MTS schools were analyzed to provide information about basic questions. MTS projects involved the use of technology in instruction, administration, and school-community involvement. Five sites were selected to receive MTS funding in 1987-88. These projects focused on their original goals despite delays in obtaining program materials, and they conducted staff development activities as expected. There was clear evidence that MTS projects had impacts on instruction and curriculum, and there were clear indications of positive student changes in each of the MTS projects. A number of factors were identified that affected the implementation of the MTS projects, and the key areas of central philosophy, staff development emphasis, and the role of technology were highlighted as essential to successful imp ementation. Activities related to the defined statewide goals were being carried out at all project sites, although it was too early to draw conclusions about project effectiveness. Some recommendations are made for program continuation and educational policy. Two appendixes present a report on the MTS projects and a framework for reporting results. (Contains 13 references.) (SLD)

RESEARCH REPORT

ON THE ROAD TOWARD EDUCATIONAL TECHNOLOGY USE: SECOND YEAR RESEARCH FINDINGS FROM CALIFORNIA'S MODEL TECHNOLOGY SCHOOLS

Brian Stecher

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Educational Testing Service
Princeton, New Jersey
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ON THE ROAD TOWARD EDUCATIONAL TECHNOLOGY USE:

Second Year Research Findings from California's Model Technology Schools

December, 1989

Brian Stecher, Ph. D.

Educational Testing Service
2 North Lake Avenue
Pasadena, CA 91101

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Brian Stecher
December, 1989

EXECUTIVE SUMMARY

This study was undertaken to summarize the results of the first two years of the Model Technology Schools program. Research and evaluation reports from the five MTS projects were analyzed to provide answers to three basic questions:

HOW WELL DID THE MTS PROJECTS FUNCTION?

In the original Model Technology School Request for Proposals, the state indicated that the MTS sites were supposed to provide "technology-rich student learning environments for educational research, product development and teacher training." To date it appears that they are on the way to meeting this objective.

Management

The MTS projects continued to focus on their original goals for technology despite extensive delays in obtaining fundamental project materials. They made appropriate changes in plans and procedures to implement the program more effectively. Two major adaptations involved decentralizing activities and authority and modifying plans to accommodate differences between elementary and secondary settings.

Staff Development

In-service training, a critical project activity, was generally conducted on time and "on target." Teacher evaluations were favorable, and Training Coordinators appeared to be flexible enough to adjust to changing conditions (most notably delays) and changing needs. Furthermore, staff development appeared to have a direct positive impact on teachers' attitudes and use of technology. There was widespread evidence of professional growth in a number of different areas. Over time the focus of the in-service training shifted from group workshops to individualized, on-site assistance that provided better support for teachers who were beginning to use the technology on a regular basis. This change was accomplished by shifting some staff resources to the local school sites and by encouraging teachers to become "experts" for one another.

Instruction and Curriculum

There was clear evidence that the MTS projects had an impact on instruction and curriculum. Teachers changed the way they taught, and they expanded the scope of what they taught. There were more small group, collaborative activities and more individualized projects. Some traditional boundaries between subjects were broken down, most notably through increased attention to writing and language arts in many other subject fields. Changes were not uniform across teachers, and there was no way to quantify the extent of the changes nor to measure the overall impact of the MTS projects on curriculum and instruction.

Students

There were clear indications of positive student changes in each of the MTS projects. Though it is too early to expect to find significant impact on achievement, there was ample evidence of improvement in attitudes toward technology, motivation for learning in technology-related areas, and use of technology. Furthermore, preliminary impressions from some sites suggest that students' writing skills improved from the targeted use of technology in Language Arts.

EXECUTIVE SUMMARY

WHAT MADE THE MTS PROJECTS FUNCTION AS WELL AS THEY DID?

A number of factors were identified that affected the implementation of the MTS projects. These factors were:

- the amount of learning time
- the level of teacher and student access to technology
- delays in acquisition of hardware and software
- the level of principal support
- the extent of paperwork requirements
- the use of multi-year staggered implementation
- the presence of other school programs
- the choice of voluntary or required participation
- the degree of public visibility
- the degree of management flexibility
- the clarity of goals
- the provision of adequate structure for teacher planning and implementation
- the sequence of training and acquisition activities
- the level of district administrative support

These findings are consistent with with other research on technology implementation, and the factors identified in the MTS sites seem to play an important role in the implementation of a wide range of technology-based innovations. Schools considering the application of technology on a large scale would be wise to attend to them.

In addition, the study revealed three key elements of the MTS program model.

Central Approach or Philosophy

One key element that facilitated program implementation was the existence of an educational philosophy or approach to focus activities and guide decision making. The approach affected the actions of teachers as well as program managers. This context was critical for helping the management team guide the project and for helping teachers integrate technology into education.

Staff Development Emphasis

The second key to the effectiveness of the MTS program model was the emphasis placed on staff development. The breadth and depth of in-service training that was provided, both from district staff and from outside experts, was impressive. This massive infusion of staff development was at the heart of the success of the MTS projects, and its importance should be recognized.

The Role of Technology

Technology, too, played a significant role in the success of the MTS program. Evidence from the sites indicated that technology played four key roles: a disturbance, a catalyst, an incentive, and an educational tool. Each metaphor reveals something about the way technology functioned within the MTS model.

Technology as a Disturbance. One thing that technology did was to disturb the status quo. It allowed program planners and administrators to "shake the tree" and alert staff and students that changes were going to take place.

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Technology as a Catalyst. Technology became a focal point for discussions of student centered education, proactive learning, critical thinking, language acquisition, etc. The playing field was technology but the game was educational reform.

Technology as an Incentive. Technology was an incentive, and a powerful one, for many teachers and students. For teachers the opportunity to become computer/video/laser-literate excited them, challenged them, renewed their interest in their profession, etc.

Technology as an Educational Tool. Technology offered new educational tools and opportunities. Unlike reforms such as bonus pay, changes in scheduling or other incentives that might be offered to teachers, technology had direct educational relevance in new and exciting ways. It was a revolutionary medium that offered new possibilities in the classroom.

HAS THE PROGRAM ACHIEVED ITS STATEWIDE GOALS?

Finally, it is worth considering whether the program as a whole achieved its goals. In the original RFP the state described six broad goals for the MTS program on a statewide basis. The state's six objectives related to demonstrating technology use, developing training models, disseminating research on implementation, promoting the development of new products, determining facility standards, and disseminating results to policy makers. It appears that activities related to all six MTS statewide objectives were being carried out by the MTS projects during the first two years of the program, though it is too soon to tell whether or not these objectives will be achieved by the time program funding is completed.

RECOMMENDATIONS

It is far too early in the life of the MTS program to draw conclusions regarding program impact and effectiveness, though it is not too soon to recommend changes to forestall potential difficulties that might arise at the project- and statewide levels:

1. To permit an overall assessment of the value of the MTS program, the six MTS projects should be asked to identify important common outcomes and ways to measure them that will provide a reasonable reflection of projects' accomplishments.

2. MTS project management teams should review project goals and objectives and clarify any concepts or terminology that is not meaningful to participants.

3. Because any study of cost effectiveness depends upon definitions that are adopted and the purpose that the information is going to serve, the state should clarify its request for information regarding the cost-effectiveness of MTS projects.

4. To provide the most useful information for other districts, Researcher Coordinators should pay specific attention to differences between the elementary and secondary levels in terms of implementation and technology use.

5. Rather than focusing future dissemination efforts exclusively on technology-based lesson plans and curriculum units developed by teachers, the MTS projects should also prepare to share information

about acquiring technology, training staff, integrating technology into curriculum, and bringing about school-wide change, as well as the instruments they developed to evaluate these activities.

6. If the state wants information about the effects of technology use on students, teachers, and schools, it should support the development of measurement techniques to assess key student and teacher outcomes.

7. To maximize the value of the resources invested in MTS, the state should support annual or bi-annual discussions among policy makers, administrators, program developers, technology developers, staff development professionals, teachers, etc. about the role of technology in education and the implementation of technology-rich educational programs.

IMPLICATIONS FOR POLICY

The final issue to be considered is: What has been learned from the first two years of the MTS project that is relevant for policy making.

1. The strengths of the MTS model were threefold: requirements that technology infusion be framed in the service of a central educational theme, the strong emphasis on staff development, and the recognition that educational reform is a multi-year process. Future state educational program initiatives would do well to incorporate these notions wherever possible.

2. There were two primary weaknesses in the MTS model: the belief that basic research could be conducted in the context of a development and demonstration project, and the notion that site-specific independent research and evaluation efforts would produce generalizable conclusions about the statewide MTS program as a whole. If the state wants answers to particular policy-related questions regarding the overall MTS program, a single external evaluator should be hired to produce a summative evaluation of the program.

3. It is too soon to assess the overall value of the business and industry partnership component of the MTS program. To date most of the partnerships involved donations of equipment in return for increased product visibility and entre to the schools. The long-term benefits and costs of the partnership arrangements are still uncertain.

4. Consistency in project funding will improve the state's return on its investment. If policy makers want to improve education then they need to follow-through with funding commitments.

5. Initial estimates of the cost of realizing technology-rich environments such as those in the MTS sites on a large scale are quite high. Furthermore, the major expenses incurred to date by the MTS sites have not been in capital improvement, but in staffing to support technologically intensive changes. It will be important to monitor the success these sites have in becoming self-sustaining once the MTS grants are completed. This is a key component of the MTS experiment that will have significant implications for future educational policy.

6. Much has been learned to date about technology use from systematic study of a small number of well-designed, well-funded, long-term demonstration sites. If the dissemination phase of the MTS program is effective (and this should be monitored closely in the final two or three years of the program), the state should be encouraged to use similar long-term

demonstration/dissemination models for exploring other educational innovations, including other approaches to the use of technology in education.

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INTRODUCTION

BACKGROUND

The Model Technology Schools (MTS) project was initiated by the California State Department of Education (SDE) in 1986 in the belief that "state supported model technology schools/teacher training centers will greatly enhance the long-term potential contribution and cost-effectiveness of instructional technology" (according to the Guidelines for Preliminary Proposals issued by the SDE in November, 1986). That document explained that the program was envisioned as a five-year research and development effort to address complex questions involving "the use of technology in instruction, administration and school-community involvement."

Two types of projects were supported: Level I - Advanced Educational Technology Schools (later changed to Model Technology Schools in the final Request for Proposals), which are the focus of this study, and Level II - Academic Technology Development Grants[1]. The Level I Model Technology School projects were envisioned as technology-rich environments where the full potential of technology in education could be explored. Each Model Technology School (MTS) project involved a cluster of three or four schools spanning grades K-12, including one high school and selected feeder schools. MTS school complexes were to receive multi-year funding to allow for the systematic "phase-in of grade levels" -- year one for the elementary level, year two for the intermediate level and year three for the secondary level. Continued funding for five years was anticipated to allow MTS complexes to implement their programs fully and to complete their extensive research and evaluation agendas. Annual funding of $500,000 per district was anticipated.

A two-stage proposal review process was used to identify school complexes to receive grants awards. In November 1986, five-page preliminary proposals were solicited from all school districts in the state. These were evaluated on a competitive basis, and, in February 1987, sixteen districts were invited to submit detailed proposals. These sixteen full proposals were thoroughly reviewed by a panel of experts, and each site was visited by a review team. Based on these reviews recommendations for awards were made to the Superintendent of Public Instruction, who made the final selection. Criteria for final selection included the merits of the proposal, the ability of the complex to represent the challenges posed by California's geographic, racial and urban-rural variations, and compliance with the technical and logistical requirements of the RFP process.

Five sites were selected to receive MTS funding in 1987-88. They were:

- Alhambra School District
- Cupertino Union School District/Fremont Union High School District
- Los Angeles Unified School District
- Monterey Peninsula Unified School District
- Sacramento City Unified School District

Two of the sites, Alhambra and Monterey, were notified of their awards in spring 1987 and began program activities in summer 1987, as anticipated. The other three sites were not notified of their awards until late summer 1987 and did not begin to implement their programs until fall 1987.

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[1] The Level II projects were subject-specific developmental programs designed to infuse technology into a major curriculum area at either the elementary, middle, or secondary level.

A sixth site, Hueneme Elementary School District/Oxnard Union High School District, was added as an MTS project began program implementation in the spring of the 1988-89 school year. As a result, research data from the Hueneme MTS project were not available for this report. Instead, this summary covers the first two years of program implementation at the five initial MTS sites.

GOALS OF THE MTS PROJECTS: RESEARCH, CURRICULUM AND TRAINING

The philosophy and goals of the Model Technology School project evolved from discussions between the State Department of Education and the California Educational Technology Committee. According to the MTS Request for Proposals, the long-term, statewide objectives of the Model Technology School program were as follows:

> Demonstrate instructional technology use that supports state curriculum frameworks.
>
> Develop quality teacher and administrator training models for implementing staff training systems.
>
> Support and disseminate research on the effective implementation of instructional, administrative and home-school uses of technology in schools.
>
> Field test and promote the development of new information technology products that support state curriculum and instructional objectives.
>
> Determine facility standards required for the efficient use of computer, video and interactive technologies in both existing and new schools.
>
> Disseminate results of the Model Technology Schools project so that decision makers and other educators can make optimum use of the information.

Specific project goals also were clearly stated in the RFP: "[to] provide a technology-rich student learning environment for educational research, product development, and teacher training." As a result, these three issues -- research, curriculum product development, and teacher training -- were key objectives in all the MTS projects.

Furthermore, the RFP prescribed a particular approach to meeting these goals. MTS projects were supposed to involve "partnerships between public schools, universities, and business and industry," as well as the broader community of parents and other local organizations. In particular, university partners were supposed to guide the research function of each MTS site, and business and industry partners were supposed to contribute advanced technology products, expertise and leadership.

Finally, the State Department of Education outlined an organizational structure for each project that highlighted these same key functions (as well as Project Management). Proposals were required to indicate the specific staff member who would coordinate each function. As a result, all projects had a Director, a Research Coordinator, a Curriculum Coordinator, and a Training Coordinator. In keeping with the overall philosophy of the MTS project, all of the research plans involved partnerships with external research agencies (such as universities and independent research organizations). The research partners helped the sites establish research agendas, develop data collection procedures, analyze information and prepare reports.

The present study was commissioned by the state to summarize the results of the research conducted at the five sites and to conduct cross-site analyses of related research findings. Of course, such analyses were only possible to the extent that sites addressed similar research questions. While the RFP gave sites wide latitude in choosing research and evaluation questions, it established guidelines to insure that there were some commonalities in the focus of the research. The guidelines were designed to create "separate, parallel, longitudinal research projects that are systematically organized to allow for assessing the impact of technology on student learning."

RESEARCH PARTNERS

This study is based upon the research conducted at the five MTS sites, and it builds directly upon the work carried out by the Research Coordinators and research partners at those sites. Primary data for this study were reports submitted in the summer of 1989 by the Research Coordinators from the five sites. Credit for the primary data is due to the following organizations:

MTS Site	Research Organization
Alhambra	Pepperdine University
Cupertino/Fremont	SRI International
Los Angeles	Center for the Study of Evaluation, UCLA
Monterey[2]	Educational Support Systems
Sacramento	Sacramento City USD (with UC Davis and CSU Sacramento)

Most sites had a single research partner, though some utilized the services of additional research consultants or multiple secondary research partners. The above list indicates the principal research organizations in each site during 1988-89. The names of other consultants and secondary research partners are available from each project.

[2] Note: The University of California, Santa Cruz, was the initial research partner of the Monterey MTS project, but a new partnership with Educational Support Systems was begun during the 1987-88 school year.

MTS RESEARCH AND EVALUATION ACTIVITIES

SETTING THE RESEARCH AGENDA

From the inception of the program, research has been a principal MTS theme. The Model Technology Schools Request for Proposals told districts to think of these clusters as long-term "research and development" projects. The RFP explained that the overall goal of the MTS project was to create "technology-rich student learning environments for educational research, product development and teacher training." Moreover, it directed applicants to identify universities or other qualified research partners to guide the research function.

The specific nature of the research to be conducted was not prescribed by the State Department of Education. Instead, applicants were directed to identify a "central learning issue" being addressed by the project, and to use this as the basis for developing research questions. The RFP directed each applicant to define its own research agenda based upon the central approach to the use of educational technology that was adopted. "Your selection of technologies to be used and (sic) identification of your project's research agenda will be guided by the approach you envision."

The research partners were directed to "plan a five-year longitudinal research and evaluation study of the effects of the proposed activities." With the central learning issue as a focal point, it was anticipated that projects would formulate research questions related to three areas: instruction, school climate, and school management. Each of the project proposals included a plan for a longitudinal research agenda that would address these concerns.

It was clear that some assessment of the impact of instruction was of great importance. The state established a standard that the research designs would all include the use of some common "measures of success." Acknowledging that each project would naturally identify some instruments that were unique to its own research agenda, the RFP required that a common measure of student achievement be collected at all MTS sites. The exact nature of the common measure was to be determined after project grants were awarded. For various reasons, including the desire to focus on implementation research during the first two years of project operation, no agreement has yet been reached about the value and appropriateness of common achievement measures.

PLANNING RESEARCH AND EVALUATION ACTIVITIES

Formulating Project Approaches.

Each of the five projects that received MTS awards in 1987-88 adopted an approach to the use of educational technology that guided its development. These approaches cannot each be characterized as a "central learning issue" (in the words of the RFP), however they served as a basis for selecting appropriate technology and focusing staff development activities. Furthermore, they provided a context for research and evaluation.

Projects selected central approaches with great care and elaborated them at length in their proposals. As it turned out, the main theme of each project could be summed up in a short phrase. Although these brief phrases omit important details that will be found in the proposals, they provide enough information to classify the projects in broad terms. The MTS projects adopted the following approaches to the use of technology. (The quoted descriptions are taken from <u>California's Model Technology School Projects. 18-Month Report.</u>, 1989, which will be found in Appendix A.)

Alhambra -- Student-Centered Education: "Student-centeredness refers to the power of choice, self-control, and self-monitoring that students apply to their education."

Cupertino/Fremont -- Teacher-Centered Technology Use: "The goal... is to empower teachers, by providing them appropriate access to technology, to increase their productivity and to enhance their methods of classroom delivery through the use of technology-assisted strategies."

Los Angeles -- Technology for Language Arts: "Since many students in the Project schools have a home language other than English... it was decided to focus on and emphasize the English/Language Arts portions of the curriculum... and to create bridges to all other areas of the curriculum whenever it was possible..."

Monterey -- Student-Centered Education: "The instructional strategies in the project emphasize the development of 'proactive behaviors' of students across the curriculum areas. 'Proactive behaviors' include student demonstration of higher order thinking skills and interest in school."

Sacramento -- Critical Thinking and Writing: "The curriculum thrust within the project emphasizes critical thinking skills and focuses on writing across the curriculum."

Developing Research and Evaluation Agendas.

Research agendas were developed to reflect project approaches; thus they differ from site to site. Furthermore, the individual interests of the researchers and the project management teams contributed to the choice of research and evaluation questions which led to further differences between projects. A brief summary of the major topics of concern provides background for later discussions of specific results. The following list provides a capsule summary of the research foci of the five MTS sites.

Site	Research Focus
Alhambra	The planning and implementation process Changes in teachers' concerns and roles Changes in teacher-student interaction Student achievement
Cupertino/Fremont	The implementation process Teachers' professional development Technology uses and consequences
Los Angeles	Language development Project management and implementation Teachers' attitudes toward technology and language
Monterey	Technology planning process Student proactive behaviors
Sacramento	Student and teacher behaviors Student writing skills Student attitudes and achievement Teacher readiness for innovation

It is immediately apparent that not all projects addressed the same questions and that many of the issues that were addressed were investigated by only one or two projects. Furthermore, researchers addressed particular aspects of each topic and chose to operationally define concepts in different ways. For example, researchers in one site operationally defined teachers' concerns in terms of the stages of concern model proposed by Hall & Loucks (1975) while researchers at another site first modified and then abandoned this approach in favor of a locally developed instrument. As a result, there was less overlap in the investigations than might be suggested by the similarities among broad categories displayed in the table.

Readers who want more information about the MTS projects themselves are directed to the Spring 1989 issue of *California Model Technology Schools* reproduced in Appendix A, and to the individual project directors referenced in that publication.

RESEARCH OR EVALUATION?

The RFP made no distinction between research and evaluation activities, though there can be significant differences between the two methods of inquiry. These differences are important when reviewing the data provided by the MTS projects, so differentiating research from evaluation is more than merely an academic exercise. It involves a practical distinction between two types of investigations that provide different kinds of information regarding the five MTS projects.

Research.

Research refers to the systematic collection of information for the purpose of developing generalizable conclusions about phenomena. The important features of research are independence, validation, and the careful identification or control of extraneous sources of variation. An MTS research question might be: How do writing strategies differ between students who use pencil and paper, students who are newly introduced to word processors (novices) and students who are adept at using word processors (experts)? One might investigate this question by staggering the introduction of word processors in classrooms and carefully measuring the writing habits of students under different conditions.

Evaluation.

Evaluation, by comparison, is the collection of information for specific decision-making. It is more dependent on the needs and values of users, more context-specific and less concerned about controlling extraneous factors. "What are the strengths and weaknesses of the in-service training program?" might be an MTS evaluation question. Data to answer the question could be collected from a questionnaire or from interviews with participants.

There is no rigid line between research and evaluation; in fact, many people describe the field of evaluation as "evaluation research." However, it is useful when talking about the MTS program to distinguish between activities that were more research-oriented and activities that were more evaluation-oriented.

The MTS projects engaged primarily in evaluation-oriented activities. In one or two sites researchers used inter-teacher or inter-school comparisons and other strategies to draw general conclusions they hope will be valid outside the specific MTS context. However, most of the data collection and analysis that was conducted during the first two years was useful, project-oriented evaluation. It involved the collection of data relevant to concerns of program administrators under circumstances in which few variables were rigidly controlled. The conclusions, to the extent there were any, apply primarily to the specific program under study.

Formative evaluation. In fact, much of the work done by the MTS researchers was "formative" evaluation. This label refers to data collected for the purpose of immediate program improvement. For example, a formative evaluation of an in-service workshop can help the training coordinator plan follow-up activities and to improve the next workshop. The results of formative evaluations usually have very short useful lives; they lead directly to changes in program activities and consequently no longer reflect the current status of a project. In some projects such formative evaluation was the responsibility of the Curriculum or Training Coordinator, in others the Research Coordinator conducted these studies.

Summative evaluation. Some of the MTS evaluation activities were more comprehensive in nature; they helped program directors draw conclusions about the overall impact of the project over time. Such "summative" evaluations provide results by which one can judge the value of some aspect of a specific MTS project. For example, a summative evaluation of the extent to which teachers completed their "Technology Intervention Plans" (individual plans for using technology in a particular curriculum unit) during the school year might provide a meaningful measure of the success of the project and might be very useful to the program director. Summative evaluations can provide valuable data about the effectiveness of a program or some aspect of a program, though they, too, are of limited value in a different type of setting.

The MTS projects conducted a diverse mix of research and evaluation activities. All engaged in formative evaluation, which is of interest to this study because projects were still in transition. All devoted resources to summative evaluation, which provided a basis for reporting on the status of the project as a whole and for making some cross-site comparisons. Finally, many began research studies, which yielded some preliminary conclusions and will provide more generalizable findings as the projects mature. The present study relied heavily on findings from the summative evaluation and research activities.

MTS RESEARCH AND EVALUATION PROCEDURES

Projects engaged in a number of different data collection and analysis activities in pursuit of answers to their research and evaluation questions. Details can be found in the research reports available from each project. A brief summary of site-level procedures will be presented first, followed by a more complete discussion of the techniques that were used to aggregate the data across sites.

Data Sources.

Research Coordinators used numerous data sources to supply information about project status and impact. Investigations primarily relied upon the following sources of information: locally-developed teacher and student attitude questionnaires, locally-developed in-service and activity rating forms, validated attitude surveys, locally-developed surveys of teacher and student computer use, structured classroom observations, student writing samples, structured and open-ended administrator, teacher and student interviews, standardized achievement tests, attendance records, informal site visit summary reports, locally-developed parent attitude questionnaires, structured telephone interviews of parents, informal classroom observations, formal and informal "case studies" of classrooms and schools, teacher logs, teacher-developed planning and implementation documents, videotaped samples of instruction, and student work products.

Analyses.

Various techniques were employed to analyze the data. Research Coordinators relied primarily on univariate analyses, such as tabulations, calculations of mean values and standard deviations, etc. Occasionally, bivariate analyses such as correlations and cross-tabulations were employed, but few, if any, tests of statistical significance were performed. The choice of analytic procedures was appropriate because most of the research was descriptive rather than experimental.

Aggregating Results Across Sites.

Common Reporting Format. The intent of the MTS program was to give local sites enough independence to create effective technology-rich programs organized around different approaches. This autonomy extended to the research function as well, and projects developed individual research agendas. While the sites were interested in some of the same general questions, they did not adopt the same approaches to answering them. Furthermore, each site had its own research and evaluation interests that were not shared by others. As a result, the interim research reports provided by the five Research Coordinators during the first two years had few common elements.

In order to facilitate the tasks of summarizing results without imposing external constraints on the research partners, the author developed a strategy for reporting results that could be used by all five sites. Interim research reports were reviewed and a comprehensive list of research and evaluation topics was developed. This list was used to construct a framework that subsumed every major question being studied at the five sites. The issues were grouped into similar categories to see if a general structure could be imposed. Working backwards from these clusters of topics the author identified a series of research questions that seemed to span all the key investigations being conducted. The questions were grouped into eight headings: Implementation, Curriculum, Instruction, Students, Teachers, Staff, School Management and Organization, and School/Community Relationships. These divisions were somewhat arbitrary, and they were not mutually exclusive, but they seemed to provide a reasonable common structure that Research Coordinators could use for organizing their second year reports. A reporting format was developed and communicated to all Research Coordinators. The scheme was designed to provide an umbrella under which most important findings could fall. (See Appendix B for a copy of the format for research reports.)

Cross-site analyses. In the past decade a number of rigorous procedures have been developed for aggregating results across studies. One process is called "meta-analysis" (Glass, 1977), and meta-analytic studies that are conducted according to certain guidelines can be subjected to the same rigorous verification and significance testing as primary research. Unfortunately, these procedures are only applicable to studies in which the same key variables have been measured quantitatively. In the present case there were very few quantitative measures of common variables.

Instead, the research reports provide some quantitative information about dissimilar variables and much qualitative information about program implementation. These data can only be summarized using rough informal methods. One such approach is to tally positive and negative findings about roughly similar issues and investigate any strong patterns that emerge. For example, if four of the five sites reported teacher dissatisfaction with initial in-service training programs this would warrant further investigation. If it was possible to examine similarities and differences among the training activities, it might be possible to report a hypothesis about problems with in-service training.

When researchers report qualitative data and relationships hypothesized on the basis of such information the task of aggregating the results becomes more complex. A similar process is undertaken, but the analyses must be impressionistic. Relationships hypothesized by researchers at one site are compared with those hypothesized at another site. Conditions at the two sites are compared as well, and when the situations are similar enough to reflect some common underlying phenomenon, this is reported. Although the author tried to make the process as scientific as possible, there may still be a certain amount of artistry in the conclusions drawn. The reader is cautioned that this process was not perfectly rigorous.

LIMITATIONS

Two limitations to the results of this study should be mentioned. They concern the status of project implementation and the quality of the primary data sources.

Project Implementation.

There may be misconceptions about the status of MTS project activities that lead to unrealistic expectations for current research. Although the MTS projects had been in operation for two years, they were still in a "start-up" phase at the time of these reports, and many changes were still occurring. It is premature to expect outcome data at such an early stage in the life of a program. In fact, it may be premature to expect more than formative evaluation during the time that new innovations are still being introduced in project schools. At best, those schools that were the focus of activities in the first year of the program may have reached a level of operational stability in the second year to warrant an examination of effects. More realistically, changes were still taking place in most schools. In such a situation it is reasonable to investigate the process, but there is little point in examining products.

A simpler way to describe the situation is to say that all the MTS projects were still in the process of implementation. This was due, in large part, to the design of the MTS model. The first three years of the program were supposed to be devoted to the gradual introduction of technology at the elementary, intermediate, and secondary levels, respectively. Thus, it is not until the end of the third year that the introduction of technology (according to the approach adopted by each project) is to be completed. The slowness of implementation was also due to delays in funding, hardware acquisition, training, and other elements (which will be described in the discussion of results). In some sites, the elementary school components were not fully operational until the middle of the second project year, and the intermediate components were behind schedule as well. The lack of concrete findings regarding student outcomes is to be expected under these circumstances.

Data quality and interpretation.[3]

Caution is warranted when interpreting the results of this study because of limitations in the research results supplied by the MTS Research Coordinators. These limitations are due to a number of factors, some controllable, others not. One common problem was lack of validated instruments to measure

[3] It should be noted that the MTS program model encouraged all Research Coordinators to participate on the project management teams. All did so to some degree, and at least two of the Research Coordinators were extensively involved in program planning and/or management functions. It could be argued that these individuals had vested interests in the success of the program that might have colored their judgment about results. Of course, one could argue that ALL researchers have vested interests in the outcomes of their research. One protects against such potential conflicts of interest through the use of standardized techniques, thorough disclosure of data, etc., and such procedures seem to have been followed in the present case.

variables of interest to the projects. For example, "critical thinking skills" are relevant to almost all the MTS projects, yet no appropriate measures of this construct were found. The MTS Research Coordinators conducted a telephone conference with three national experts on this topic, who failed to direct them to any validated measure that was appropriate to their needs.

A second limitation concerns the quality of the locally-developed instruments that were used to measure many of the variables of interest. As noted above, questionnaires, surveys and interviews were used to assess everything from teacher empowerment to student proactive behaviors. While the Research Coordinators should be praised for their ingenuity in operationalizing complex concepts, it must be noted that the measures they used have no reported reliability nor validity. Even something as simple as an in-service evaluation questionnaire is subject to misinterpretation. This study was not designed to evaluate the quality of locally-developed instruments; however, it is fair to say that the surveys seen by the author ranged from excellent to fair in terms of clarity, readability, lack of ambiguity, etc. (One unanticipated positive outcome of the MTS program may be the development of instruments other districts can use to monitor and evaluate the progress of their own technology implementation efforts. It might be helpful to disseminate some of the locally-developed instruments after they have been reviewed.)

A third problem stems from differences in the standards the Research Coordinators used to interpret their own data. Seldom were tests of statistical significance possible, thus the analysis had to rely on the impressions of the individual Research Coordinators about which differences were important and which observations were valid.

In many cases the MTS project was not the only change occurring at a participating site. In these situations MTS project activities were "mingled" with other treatments, and the results were completely confounded. This represents a fourth limitation in the MTS research: it was not possible to separate the effects of MTS, the effects of other innovations, and the joint effects of MTS and other activities occurring together. The degree of confounding varied from school to school, but it was quite significant in at least one or two locations.

A fifth limitation concerned missing data. In at least two MTS sites, analyses of existing data were incomplete at the time this research summary was written. Data had been collected to answer certain questions but the Research Coordinators had not yet completed their data analyses. This problem should be reduced significantly in future years because the research reporting cycle has been changed to provide adequate time for fuller analysis.

Finally, because the MTS projects were highly-competitive, highly-visible, well-funded, special projects in an area of widespread interest, participants received an unusual amount of attention. Project staff, district administrators, school principals, teachers, students and even parents were put in the public spotlight on different occasions. Changes in behaviors and outcomes achieved under these conditions may be due as much to the increased attention which was present to an unknown degree in each of the five sites as to the planned program. This phenomenon is knows as the "Hawthorne effect" (Roethlisberger & Dickson, 1939). Furthermore, project directors utilized the special nature of the programs to woo industry partners, solicit donations, etc. The same conditions probably would not be present were another school to try to replicate all or part of an MTS model. The unique nature of the current MTS projects makes it less likely that the results can be generalized to other settings in which the level of public concern and attention would not be equivalent.

RESULTS: PROCESS AND OUTCOMES

INTRODUCTION

The MTS research reports contained descriptions of project activities, judgments about effectiveness, measurements of impact on teachers and students, discussions of changes in programs, and conclusions regarding the factors that affected MTS implementation. The reports presented a hodge-podge of formative evaluation, summative evaluation, naturalistic research, experimental research, and interpretation, and they addressed varying topics depending upon the research focus of the projects.

Fortunately, the projects had many research questions in common. Where commonalities existed the collection of information was far more powerful than any single result would be in isolation. Answers to shared questions reflected characteristics of the MTS program as a whole rather than just peculiarities of a single site. The relationships derived from analyses of results from five sites can be accepted with more confidence than those based on a single instance, so it is these common questions that were the focus of this report.

References. References to occurrences at individual sites will be made throughout the discussion. In addition, extensive use is made of quotes from the second-year research reports submitted by the five Research Coordinators. Site references are noted by a single letter as follows:

[A]lhambra
[C]upertino/Fremont
[L]os Angeles
[M]onterey
[S]acramento

The same symbols followed by page numbers will be used to reference quotes from the research reports. For example, [A/10] refers to page 10 of the Alhambra second-year report. In addition to these five second-year reports, a 15-month report was prepared by the Research Coordinator from the Cupertino MTS project. The symbol [Cu] is used to refer to this interim report.

Organization of Findings. The presentation of results will be organized around the major functional units common to all MTS programs: Management (including project goals, organization, coordination and procedures), Technology, Staff Development, and Curriculum and Instruction. After these four discussions, information will be presented regarding the impact of the projects on students. In general, each section begins with a brief summary of descriptive results that answer the question: What is the status of the project in this area? Following that there is a discussion of challenges that were faced and changes that occurred.

A separate section is devoted to the broad question of implementation and the factors that affected it. Most of the Research Coordinators addressed this question specifically in their second year research reports, and the discussion in this report will be based primarily on their conclusions.

This report focuses almost exclusively on questions that were common to the MTS projects. However, some of the results that were unique to a single site were also noteworthy. Following the presentation of statewide findings there is a section which highlights the most interesting research questions being addressed singly by one of the five sites. Readers interested in one or more of these topics should contact the Program Directors from the associated MTS projects.

Finally, conclusions about the MTS program as a whole will be presented. This section discusses the nature of the MTS program as it functioned at these five sites. It is based upon the impressions formulated during the review of the individual MTS projects and their research activities.

MANAGEMENT

The management story was one of coping with delays and adjusting to the changing needs of teachers and students.

Coping With Delays.

One of the most difficult problems faced by all of the project directors was how to accommodate unanticipated delays in implementation. Delays in implementing planned activities ranged from a few months to 1 1/2 years! While these delays did not affect all project activities, most projects had some significant components that were six months to one year behind schedule.

Delays in implementation could be traced to a number of different causes: receipt of funding, acquisition of hardware and software, preparation of facilities, negotiation of partnerships, and changes in project design.

Funding delays. Applicants were instructed to develop project plans that began in FY 87. Awards were supposed to have been made to the winning proposals in May 1987, allowing project activities to begin during the summer of that year. Summer provides a unique opportunity for intensive staff development that is not possible during the school year, and in-service training was the major staff activity scheduled for the summer. Four projects were planning to provide initial training to the elementary teachers during the summer [A,C,M,S]; the other site [L] planned to use the time for initial training of the management team. The other significant project activity planned for the first summer by all sites was ordering equipment and preparing facilities, so technology related activities could begin in earnest once the school year started.

Unfortunately, the process of selecting the winning MTS bids took longer than anticipated. Two projects [A,M] were notified of their awards in late spring 1987, and they were able to conduct most of their summer activities as planned. The other three projects [C,L,S] did not receive notification of their awards until October 1987. As a result, they were not able to offer summer training and could not begin the process of ordering hardware and preparing facilities until fall 1987. All three sites had to change their implementation schedules accordingly.

Acquisition delays. The ordering and acquisition of hardware and software was the second major source of delays for most MTS projects. Program planners did not accurately estimate the length of time that would be required to place orders and have them filled by manufacturers. This was true despite the fact that some of these estimates were based on delivery schedules supplied by the vendors themselves. There were actually two sources of delays: district ordering procedures and vendor deliveries. District procedures and policies (such as processing orders in periodic batches and ordering only from existing approved hardware and software lists) provided unanticipated hurdles to some projects [C,L,S]. Manufacturers delays in filling orders were equally troublesome [all]. "Delays in the delivery of materials" were the second most frequently mentioned factor "that impeded implementation of the project" [M/9].

Technology and compatibility delays. While most of the projects opted to use "off the shelf" technology (i.e., current versions of hardware that were readily available), one [S] decided to incorporate a new video network that had to be customized to their specifications. The manufacturer was not able to meet his original schedule for development and installation of this network; in fact, it was not operational until spring of the second year of the MTS project. In another district "a total of 56 computers will be networked (sic) when the system is complete; however, the implementation has taken about a year longer than anticipated" [C/9]. Other problems arose even when district plans called for the use of current equipment. Hardware models were changed, and new versions were no longer perfectly compatible with older models [S] causing delays while special interfaces were developed.

Facilities delays. Almost all sites found that renovation of facilities took longer than anticipated. New wiring, which was almost a universal requirement, was handled reasonably efficiently in most places. However, other changes to the physical plant were not always completed on time. Not surprisingly, the length of the delay seemed to be directly proportional to the scope of the building renovation, with the greatest lag occurring in the site undertaking the largest retro-fitting project [S].

Partnership delays. Another unanticipated source of problems was the time it took to negotiate agreements with, and receive donations from, industry partners. Project Directors can relate a wealth of stories about discussions gone awry, promises unkept, potential partners leaving the educational marketplace, etc. They can also report at length on positive working relationships, generous donations, expeditious processing and delivery, etc. In the end, all sites benefitted from these partnerships, and the value of goods and services received was significant.

However, all sites experienced some delays derived from the donation process. The norm was probably to suffer through minor delays that affected only one or two components. In some cases important activities were delayed three to six months by small pieces of donated equipment that did not arrive on time [A]. Furthermore, because they did not know which donations would be offered and when they would arrive, Project Directors experienced some difficulty making purchasing decisions. Some held back on purchase orders while discussions took place. All learned to be flexible and to try to take advantage of contributions by shifting budgeted resources to other project components.

Industry partners should not be faulted too greatly on this account. They were operating in uncharted waters, as well. For example, each of the five sites negotiated partnerships independently, and many contacted the same manufacturers. This could lead to confusion and duplication. For some vendors it became easier to say no to all requests; others adopted a wait and see attitude that frustrated Project Directors who had contacted them early in the process. The industry partnerships were one of the most interesting aspects of the MTS model, and they deserve further investigation in their own right.

Summary. In general, some aspects of each MTS project were between six and twelve months behind schedule by the end of the second year. Not all components were delayed, nor were delays experienced equally at the elementary and intermediate levels. In general, the delays affected the first year participants, and most problems were resolved for the second cadre of teachers. However, at the elementary level teacher training activities were behind schedule, equipment was not available as quickly as planned, and the overall application of educational technology to the teaching and learning process was taking place far more slowly than anticipated.

As one might expect, the delays caused problems for management, trainers, and teachers. One report calmly noted, "The predictable difficulties of obtaining and scheduling the use of new materials and equipment caused some frustration" [M/9]. The delays were particularly difficult for people who were eager to begin an exciting new project. Another Research Coordinator commented, "...delays in equipment deliveries led to frustration among teachers who were in a high state of readiness to implement technology..." [C/6]. Such frustration and disappointment was widespread during the first year of the MTS project.

Faithfulness To Original Approach.

Despite the delays and frustrations, the projects were faithful to their original goals. The five projects continued to pursue their original visions regarding the application of educational technology with no major shifts in approaches. Student-centered programs remained focused on using technology to promote autonomy and pro-activity among learners [A,M]. The teacher-centered project maintained its focus on producing technology-using teachers [C]. Language Arts and Thinking Skills programs continued to apply technology in the service of better communication across the curriculum [L,S].

Changing Implementation Strategies.

Though the projects maintained their initial technological approaches, they made some broad changes in their organization for implementation. The ends did not change, but the means projects used to achieve them did change. In addition to predictable small changes in scheduling, location, software titles, etc. there were broader shifts in strategy that occurred in a number of sites that deserve further comment. These changes involved shifting some authority and functions from the MTS office to individual school sites and differentiating procedures to meet the differing needs of teachers at the elementary and secondary levels.

Decentralizing management functions and responsibilities. There was evidence that MTS functions and responsibilities were being decentralized to provide more effective implementation. This occurred in the areas of staff development and support [all] and in the area of program coordination and decision making [C].

As originally designed, responsibility for each of the four major MTS functions -- management, training, curriculum and research -- was vested in a single individual, who was a member of the project management team. Understandably, most projects responded to this model by adopting a centralized management structure, which was often housed in a single project office. Services flowed out to the individual sites. For example, training was usually offered to large groups of teachers in a single location.

In some sites it became apparent that the project was not well served by this organization, and changes were made. Site-based coordinators were substituted for centralized coordinators [L]. Centralized, group training was supplemented/replaced by on-site, on-demand support [A,C,S]. Authority for ordering materials and equipment was shifted to teachers [C,M]. Participating teachers requested more frequent meetings to learn more about each other's activities and establish local support networks [A].

These examples suggest a trend toward the distribution of authority and responsibilities to local sites and individuals. This change represented a significant shift in organization for the MTS projects, and it argues strongly that effective management of technology (of the type characterized by these five projects) has strong site-based and individual-based components. (This suggests that the current general shift toward site-based management of schools may have positive benefits in the realm of technology.)

One research coordinator summarized the results of management decentralization in a site in which this trend had been very strong, "A major shift was a move from activities initiated by project staff to a school-based pattern of shared responsibility for initiating and arranging implementation activities. Project staff redefined their roles from project leaders to knowledgeable resources for school faculty and staffs. Project coordinators moved their headquarters to the school sites and concentrated on teacher access and development support on a day-to-day basis" [Cu/5].

Adapting elementary models to secondary settings. The other management change that occurred in many sites involved modification of first year procedures to be more responsive to the needs of intermediate-level teachers during the second year. Adaptations noted by the Research Coordinators included organizing planning by departments [C], and providing more meetings for sharing and learning from each other [A]. It is not surprising that some modifications were made since there are so many natural differences between the organization of schools at the elementary and secondary levels.

Management summary.

The MTS projects continued to focus on their original goals for technology despite extensive delays in obtaining fundamental project materials. They made appropriate changes in plans and procedures to implement the program more effectively. The principal adaptations were decentralizing authority and modifying procedures to accommodate differences between elementary and secondary settings. It remains to be seen how these changes will be modified further as implementation proceeds during year three.

STAFF DEVELOPMENT

Delays in the acquisition of hardware and software presented major problems for staff development. However, Training Coordinators found ways to make adjustments. In the end, almost all planned in-service training activities were conducted and were well-received by teachers.

Delivery of In-Service Training.

By rescheduling and reorganizing staff development activities, Training Coordinators were able to conduct most of the in-service workshops that had been planned. In fact, as it became apparent that there would be delays in hardware and software, plans were modified so that some staff development activities could take place in the absence of equipment. This was possible because most sites planned separate training sessions on hardware, on software, and on the site's particular approach to the implementation of technology. For example, training on writing across the curriculum and critical thinking skills was conducted in the absence of the computer and video networks [S]. Similarly, initial training regarding second language acquisition could be conducted without the presence of technology [L]. Training on student-centered education was integrated into training on computer operations, when anticipated additional equipment was not available on time at the high school [A]. Some sites had other equipment available that could be used to train teachers who were awaiting delivery of their individual equipment [C]. In general, Training Coordinators showed remarkable flexibility in accommodating delays, and staff development activities were conducted in a more timely manner than many other aspects of the projects.

Evaluation of In-Service Training.

Most all training workshops were evaluated, and the vast majority were judged to be effective by participants. Teachers' ratings of staff development and training activities were generally quite favorable. Research summary reports do not contain evaluative summaries of each training session, but the overall evaluation results that were reported were quite good [all]. Of course, the ultimate test of these activities will be whether they promote more effective instruction, but it is too soon to make a determination of this.

Impact on Teachers.

Another way to judge the effectiveness of training activities is to examine their impact on teachers. Research Coordinators reported that MTS in-service training had substantial effects on both the attitudes and the actions of teachers. Many of these judgments were based on surveys and/or observations; others were impressions that emerged in conversations and informal discussions. Research Coordinators reported on many different teacher characteristics, but the three variables that were the most frequently mentioned were changes in teachers' attitudes towards technology, use of technology, and "professionalism."

Attitudes towards technology. Teachers were asked to report on their own feelings about technology in different ways: what was the value of technology in education, what was the likelihood they would use technology, what concerns did they have regarding technology use, etc.? Their opinions at the beginning of the project were compared with their opinions after they had been involved for many months. While the specific questions were not the same in all districts, the direction of change was consistent. Teachers' attitudes and concerns about technology as an educational tool improved as a result of their participation in the MTS project [A,C,L,S].

Use of technology. Similarly, there was consistent increase in the amount of time teachers used technology, though the type of use varied depending on the thrust of the project. For example, in one district teachers increased their use of computers as aids to presentation and as management tools [C]; in another teachers spent more class time using computers as part of subject-specific lessons [S]. In many instances the increase in computer use was dramatic: "During the period between February and May, 1989, about 32% of teacher activities used technology. This indicates that the application of technology in teaching was doubled" [S/16]. "All full time classroom teachers used technology in teaching and the number of hours spent using technology has increased drastically between Fall and the end of Spring" [S/19]. The application of technology increased in the other projects, as well [A,M,L]. (Of course, technology use is not an end in itself. The true measure of the value of technology will be its impact on learning, and this will be measured in subsequent years.)

Increased "professionalism." Research coordinators used the terms "professionalism" and "professional development" to describe a wide range of changes in teachers' attitudes that included taking more responsibility for instructional planning, devoting more time to self-assessment and reflection about teaching and learning, improving skills in new educational technologies, exchanging information and expertise with colleagues, and assuming the role of "expert" in some area or discipline. The projects "offered teachers opportunities for professional growth" [S/31], and the teachers responded positively [all].

Staff development activities were designed to foster professional growth. A Research Coordinator summarized four key aspects of professional growth: "having discretion and exercising it to advance educational goals, continuous learning, collegial interaction, and assuming new roles" [Cu/25]. Each is worthy of further comment.

> **Discretion and responsibility.** In all the sites teachers were given a great deal of independence and responsibility for deciding how they would use technology [all]. This contributed to professional growth. In most sites teachers were given responsibility for choices within their own classrooms: "They have been given freedom in deciding which of the acquired technology they would use and, equally as important, how and to what extent technology would be integrated into their current instructional practices and curricula. In fact, this independence may

be part of what has sustained the teachers' positive attitude towards the project" [L/26]. In some places they also were given greater responsibility for project-level decision making with positive consequences: "Giving teachers their own software budgets and a voice in determining training and conference expenditures enhanced professionalism... In contrast, the district decision... to override teachers' preferences for certain hardware purchases diminished feeling of professionalism" [Cu/26].

Teachers as learners. Another aspect of professionalism is the recognition that practice is not static and one must be continuously trying to acquire new knowledge and techniques. At its best, MTS staff development fostered this attitude. Technology itself played an important role: "Unlike other new practices that typically require learning a particular strategy or subject matter, integrating technology into teaching is a huge, ongoing task that is never mastered because of the unlimited array of hardware and software and the constantly changing nature of both. As a result, teachers must become learners -- professionals who see ongoing development as an integral part of their career" [Cu/25].

There was evidence that this was occurring in all the MTS sites. The Research Coordinators reported that teachers were learning new skills and were thinking more about instruction as a result of their participation in the MTS program [all]. "Teacher talk and behavior suggests that teachers... think much more often about their teaching, and they think about it in different ways than they did before the project came to the school" [A/150]. Teachers were becoming more reflective, more inquisitive and more alert to issues relating to teaching in general and their own teaching behaviors in particular; this is part of the learning process.

Collegiality. Another element of professional growth in all sites was increased communication and sharing among teachers. As three Research Coordinators noted: "The participants at the three schools invested a great deal of time and effort in the... project. They relied heavily on the ... staff and each other and as a result increased their appreciation and respect for one another" [M/9]. "High levels of collegiality and collaboration were observed consistently during site observations" [L/49]. In fact, cadre teachers stretched 15-minute meetings into an hour or more so they could have greater opportunities to "share, learn and apply" information from one another [A/27].

Teachers as "experts." As noted above, teachers at all sites had already begun to assume new roles as experts and share their expertise with one another. Teachers were becoming site-based staff development resources, both formally and informally. "The project staff and principals are using this evolving group of teacher experts to conduct training sessions and/or demonstrations for their peers" [C/19].

Modifications to Staff Development.

Despite the favorable responses to most staff development workshops, Training Coordinators became aware of the need for changes in training focus over time. The major change was to provide more individualized, on-site support.

Individualized On-site Support. Training Coordinators modified their plans to be able to provide "on-demand" support and training to meet individual teacher's needs [A,C,M,S]. As teachers became more adept at using technology and began integrating it into their regular activities, their demands for assistance and support changed. They needed immediate solutions to day to day problems, and they needed continuing resources to support their professional growth. To address these concerns projects began to provide individualized, on-demand, on-site support, which allowed them to solve individual problems when they occurred at the school site.

The importance of these conditions was widely recognized:

> "Teachers indicate that more follow-up assistance should be provided to help them apply what they have learned." [L/iii]

> "Once teachers had some idea of how technologies could be used and a rudimentary sense of how to use a camcorder or computer, traditional workshops were replaced by more useful activities. ...Most importantly teachers now needed a very different kind of professional development opportunity: on-site access to expertise and time." [Cu/22]

> "It appears that having an on-site support person is beneficial in getting teachers to use technology." [S/15]

> "Teachers must move into technology at their own pace and in accord with their own teaching styles and professional development needs." [M/20]

One method used to deliver this type of support was to decentralize some of the MTS administrative structure and put skilled support staff at each site [A,C,L]. "School site coordinators... provide on-going and apparently more meaningful training to teachers" [L/38]. Another solution was to promote the development of "peer cluster support" [S] or "a cadre of teachers... with expertise in a variety of educational applications of technology" [C/19]. Coupled with an increase in communication among teachers, peer networks could provide the kind of support that appeared to be needed [C,L].

Impact of Staff Development Changes. Personalized staff development was well received. "During the second year, ... staff development was individualized and customized to fit the stated needs of each [teacher]. Teachers engaged in staff development activities that would directly affect the outcomes of their own projects. The participants were very complimentary... when they described this personalized program of professional development" [M/18]. "Almost all of the [school] teachers rated 'one-on-one assistance' and 'on-site support' effective in helping them use technology" [S/15].

Staff Development Summary.

In-service training, a critical project activity, was generally conducted on time and "on target." Teacher evaluations were favorable, and Training Coordinators appeared to be flexible enough to adjust to changing conditions (most notably delays) and changing needs. Furthermore, staff development appeared to have a direct positive impact on teachers attitudes and use of technology. There was widespread evidence of professional growth in a number of different areas.

During the second year changes occurred in the way training was delivered. The focus shifted from group workshops to individualized, on-site assistance to provide better support for teachers who were beginning to use technology on a regular basis. This change was accomplished by shifting some staff resources out to the local school sites and by encouraging teachers to become "experts" for one another.

The evolving model of site-based, individualized staff development was described by one Research Coordinator in the following manner:

"...the most useful resources are those available at their schools. These resources include: (1) a "techie" (who can be a student) who knows how various switches, buttons and plugs work; (2) colleagues who have used technology; (3) project staff headquartered in the school; and (4) journals, databases, and other readily accessible sources of information, as well as guidance on how to use these sources most efficiently." [Cu/22]

INSTRUCTION AND CURRICULUM

Each of the MTS projects was designed to have an impact on the content and/or the delivery of instruction. Although it is not always possible to draw a clear distinction between what is taught and how it is taught, particularly when new instructional tools are involved, the common practice of separating instruction and curriculum will be followed in this report. The distinction is somewhat arbitrary, but it is convenient for organizing the findings that were reported. The first section will examine research and evaluation findings concerning instructional changes: how teachers and students interacted. The following section will address changes in curriculum: what teachers and students discussed. It should be noted that not all of the Research Coordinators addressed these questions in depth during the first two years. Fewer findings were reported in this area than in most other areas, permitting fewer comparisons.

Instructional Changes.

Has instruction changed at the MTS sites? Absolutely. The most obvious change was an increase in the use of technology by students and teachers. This was apparent from visiting the sites, and it was documented by the Research Coordinators, who described which technologies were used and how they were used [C, L, M, S]. To summarize some typical applications: computers were being used by students for word processing, tutorials, etc. [all] and by teachers as productivity tools [C,S]; videotapes and videodiscs were being used by students for producing their own videos as language enhancement tools [L] and by teachers as supplements to instruction [C,S]; instructional television was being used by teachers to supplement instruction [A,M]; telecommunications were being used by teachers to extend lessons beyond the limits of the local community [A]. There was ample evidence that new technologies were being used for instructional purposes by the majority of teachers (though the amount of use was less well documented).

Second, there was ample evidence that teachers were teaching differently as a result of their participation in the MTS project. Where the emphasis was placed on teachers as technology users, computers and other devices had become regular teacher tools [C]. Where the project addressed student-centered learning, "students were more actively involved in the learning process" [A/22, M]. Where Language Arts was the focus "the nature of language instruction itself has changed. Technology has helped create opportunities for more whole language learning" [L/51]. A common observation was that there was an increase in the amount of small group instruction and collaboration among students [A,L,M,S]. One Research Coordinator observed that the "social organization of the classroom" had changed to mimic the level of peer cooperation found in the technology lab [L/50].

It should be noted that changes in curriculum and instruction were not uniform across teachers. Some change was apparent among "most" of the participating teachers, but the degree of change differed from individual to individual. Research Coordinators reported that there were some teachers who were reluctant to embrace technology and/or make changes in their teaching style [A]. This occurred more often at elementary level than at the intermediate and secondary levels, because all the MTS teachers in the latter two groups volunteered to participate in the program. In contrast, all teachers in the participating elementary schools were expected to take part in the MTS program (with one exception [L]). Whether voluntary participants or not, wide teacher to teacher differences existed in the use of technology and the adaptation of the project's approach to education. While general increases in technology use were reported everywhere, there was no way to tell if the changes were significant from a practical or statistical point of view.

Curricular Changes.

Two types of curricular changes were reported: changes in the organization of the curriculum and changes in the scope of the curriculum. Furthermore, the production of curriculum units for dissemination had begun in some sites.

Organization. Many of the MTS projects reported changes in the way curriculum units were organized. The primary change was an increase in the amount of cross-disciplinary instruction. This occurred in the sites that focused on Language Arts or writing across the curriculum [L,S], as one might expect, and it also occurred in some of the other sites as well [M]. One explanation for the change is the ease with which computers can be used as word processing tools, coupled with the new statewide emphasis on broadening the scope of writing activities across the curriculum. Whatever the cause, the MTS sites increased the degree of multi-disciplinary work in their curriculum.

Content. An important "non-finding" was that none of the sites made technology a subject, per se. All opted to minimize the attention paid to technology itself, and to focus, instead, on how technology could be used as a tool to accomplish a larger goal. For example, in no case did a project institute a Computer Literacy course. Technology training was handled as an incidental part of other activities. Obviously, there had to be some increase in instruction on how to operate computers and other technology. However, this aspect of the project was kept to a minimum.

On the other hand, there was ample evidence that individual teachers were developing curriculum units that were entirely new to their schools. The MTS program "allowed teachers to expand the content of the curriculum" [M/9]. The lists of new curriculum units found in the research reports are extensive, and the interested reader should certainly review these documents. The new units included such things as: mechanics and robotics [A,L], Boolean logic [M], training students as peer editors [C], expansions of the curriculum in history [M], science [S], social studies [C] and earth science [M], etc. They involved such technologies as computers, videodiscs, hypercard stacks, camcorders, and instructional television.

It was not just the presence of the technology that was responsible for these changes. Each of the sites also was attempting to align instruction with the state curriculum frameworks, and they used technology where it was appropriate. Some of the observed changes were due to the curriculum re-alignment process, not to the technology itself or even the MTS project itself.

Curriculum Units for Dissemination.

In addition to their roles as research and development projects, the Model Technology Schools also were supposed to prepare curriculum materials for dissemination. While curriculum dissemination activities were not scheduled for completion until the third or fourth year of the project, they have begun already in most sites [A,C,M,S]. Teachers have been working on projects or specific curriculum units that may evolve into products for dissemination. Most of these curriculum units were still in the developmental stage, but they had been used with at least one class of students, and they were being incorporated into the teachers' future lesson plans. They reflected changes that have already occurred in curriculum at some MTS sites. Where specific curriculum units have not yet been developed, teachers recognized that it was time to begin the process [L].

Instruction and Curriculum Summary.

There was clear evidence that the MTS projects were having an impact on instruction and curriculum. Teachers were changing the way they taught, and they were expanding the scope of what they taught. There were more small group, collaborative activities and more individualized projects. The traditional boundaries between subjects were being broken down, most notably through increased attention to writing and language arts in many other subject fields. Changes were not uniform across teachers, and there was no way to quantify the extent of the changes or to measure the overall impact of the MTS projects on curriculum and instruction.

STUDENTS

Students should be the ultimate beneficiaries of any educational improvements brought about by the MTS program, and it clear from the project descriptions that each one was designed to have a positive impact on students. It is natural to ask what student benefits have occurred as a result of participation in the MTS project. However, one must remember that most projects were still in the implementation phase at the end of the second year, and all five sites were six months to one year behind schedule in one component or another, so it is premature to expect widespread impact on students. In fact, some of the projects had not yet begun to collect student outcome data, because they did not believe that a stable program of instruction had been achieved. As one Research Coordinator noted, "Reliable achievement data with comparison groups can be obtained only after the treatment has been developed, revised and implemented under controlled conditions for at least 5 months. The only reliable data that can be collected for year two is on the implementation process and methods for using the project interventions" [M/16]. Consequently, there is much less to report about students than there was about teachers. The discussion will be limited to measures of use, attitudes, and writing skill.

Students' Use of Technology.

As one might expect, students used technology to a much greater extent than before in all the project sites, even the one that focused on teacher use. For example, in one site the frequency of students' computer use increased 60% from winter to spring [S]. In another site students used computers approximately two hours more per week, on the average, at the end of the school year than at the beginning [M]. Furthermore, the types of technology students used and the range of things students did with technology were extremely wide [all].

Students' Attitudes toward Technology.

The students had highly positive responses to the technology. Not all projects tried to measure student attitudes, but those that did reported favorable results. For example, teachers reported that the project had a positive impact on students' classroom behaviors and study skills [M]. Other positive effects of technology use included attitudes towards school [S], attendance [S], and motivation for learning [L]. Furthermore, in the places where writing was emphasized, teachers reported that students who used word processors for writing and technology for language arts activities showed greater motivation for writing. [L,S]

Students' Writing Skills.

Writing samples were not analyzed in time to be included in the second year research reports, so there were no direct measures of writing skill. However, teachers reported improvements in writing. One Research Coordinator concluded, "word processing had the most impact upon students writing skills. Students became more interested in writing, had better editing skills, and produced works of better quality" [S/26].

Student Summary.

There were clear indications of positive student changes in each of the MTS projects. Though it is too early in the life of the projects to expect to find significant impact on achievement, there was ample evidence of improvement in attitudes toward t hnology, motivation for learning in technology related fields, and u of technology. Furthermore, preliminary impressions from some sites suggest that students' writing skills improved from the targeted use of technology.

PROCESS AND OUTCOME SUMMARY

Management. The MTS projects remained faithful to their initial goals and philosophy despite difficulties in acquiring hardware and software in a timely fashion. Changes were made to accommodate delays and to be responsive to the needs of teachers and students. The principal adaptations were decentralizing certain functions and responsibilities and adjusting first year procedures to accommodate differences between the elementary school and intermediate school contexts.

Staff Development. Though training schedules had to be modified in response to hardware and software delays, planned in-service training was provided in a variety of style and formats. Teacher evaluations were favorable, and the training had a measurable positive impact on teachers' attitudes toward technology as well as teachers' use of technology. Training procedures were changed somewhat during the second year to provide more individualized, on-site support.

Instruction and Curriculum. The MTS projects had a direct impact on instruction and curriculum. Instructional strategies were changed to incorporate more collaborative, small group interaction as well as more individualized work. Traditional subject matter distinctions were reduced somewhat, as more multi-disciplinary projects were undertaken. Foremost among these were activities that involved writing in many curriculum areas.

Students. There were measurable positive changes in students' attitudes toward technology, motivation for learning and use of technology.

RESULTS: FACTORS AFFECTING IMPLEMENTATION

This section will explore those factors that affected the implementation of the MTS projects and promoted or inhibited the achievement of desired outcomes. This discussion begins with factors identified by the Research Coordinators and concludes with a discussion of additional relationships identified during the present review of MTS sites and reports.

FACTORS IDENTIFIED BY MTS RESEARCH COORDINATORS

The implementation issues that were discussed most frequently in the MTS reports were: time to learn and practice new skills, access to technology, delays in acquisition, support from the principal, paperwork demands, staggered implementation, other school programs, and the nature of participation.

The Amount of Teacher Learning Time.

"The most precious resource of all is TIME. Without time to experiment, to practice, to make mistakes, and to learn, teachers are not able to maximize the benefit of staff development activities" [Cu/22]. These sentiments were widespread. The single greatest obstacle to implementation from the point of view of the teachers was the lack of time to do the things necessary to integrate technology into their instructional program [A,C,M,S]. "Several teachers indicated a need for ...more time to plan/experiment/explore on computers" [S/34]. "As with any innovation, the cost in terms of time were high and occasionally were perceived as excessive by the teachers" [M/9].

Teachers wished for additional time to do all the activities that were important elements of the MTS project, such as learning to operate the equipment, attending in-service workshops, practicing the skills they learned in in-service workshops, reviewing software, videodiscs and other materials, revising and developing new lessons, solving problems with equipment, trying out new ideas in class, developing projects and curriculum units, meeting and sharing ideas with other teachers, seeking out assistance from trainers, etc. as one teacher wrote, "Time to do more... I have great ideas... but it's just TIME" [A/33].

One district attacked the problem directly by creating new staff development activities that addressed the need for more time. "The new approaches... include providing loosely structured blocks of time for "hands-on" learning and creating opportunities for teams of teachers to create products (demonstrations, curriculum units), both with expertise available. Time remains the most valuable resource -- time to confer, advise and learn from colleagues" [Cu/37].

The Level of Teacher and Student Access to Technology.

A related problem for many teachers was gaining access to technology when they needed it [A,C,M,S]. Without convenient access to technology even the best staff development went for naught. "A majority of the teachers expressed the need for more equipment for each teacher/access to hardware being limited under the current set up" [S/34]. Similarly, the impact on students was limited by access to hardware. "It's fine empowering the student with these tools, but after six lab sessions we cut them off and say 'no more.' With only a few slots open for each teacher the need for additional resources becomes evident..." [A/27]. "The availability of hardware and software had the greatest impact on students" [M/17].

Project planners attempted to design innovative configurations of hardware that would maximize the opportunities for use. Some were more effective than others. For example, one site located most of its computers in the hallways throughout the school but placed one classroom set in a laboratory setting. At the beginning of the year demand for the lab was high, and it was often difficult to get access to the equipment. Over the course of the year demand shifted. Teachers began to make more individual and small group assignments and to send students out to the hallways to use the computers. This system seemed to be a more efficient way to use the technology [A]. In another school, each teacher received a technology work-station, and this effectively eliminated problems with access to technology for the teachers' uses [C].

However, not all initial configuration were as easy to use as anticipated. In one school a single classroom at each grade level was connected to the computer network and teachers explored different schemes for rotating classrooms to work on the computers. "The majority of the teachers felt that switching classrooms was ineffective. Many of them stated that switching rooms was inconvenient and time-consuming. A few mentioned that it was confusing and upsetting to the student" [S/36].

Obviously, it would be incorrect to recommend that all schools adopt one of the first two models of distributing computers and reject the third. The hallway arrangement worked because the school had adopted an approach to technology use that stressed individual and group projects. The teachers work-station model was effective in the case of a project that emphasized using technology as teacher productivity tools. The arrangement of computers has to fit with the patterns of use that will be found. It is probably safe to conclude that the greater the number of individuals who will use computers the greater the likelihood that access will be a problem.

Delays in Acquisition of Hardware and Software.

As noted above, all projects experienced some degree of delay stemming from a number of different factors: the lateness of the initial project award, the slowness with which district bureaucracies placed orders for equipment, the slowness of deliveries, unanticipated difficulties in remodeling facilities, hesitation among potential partners, etc. (See pp. 14-16 for a complete discussion.) These delays had a variety of different negative effects on project implementation as were discussed above. An unexpected result in one site was a shift from a bottom-up strategy for decision-making to a top-down model that could promote more "rapid progress in the acquisition and implementation of new technologies" [L/25]. At this point in time projects are six months to one year behind schedule due to various combinations of delays. The moral seems to be that "delays and technical problems are a fact of life in the world of rapidly changing technology... These are serious problems only when teachers expect otherwise" [Cu/18].

The Level of Principal Support.

The recognition that the principal is a critical actor in school-based change efforts is not new, so it should not be surprising that school principals had a strong influence on MTS implementation. Supportive principals became champions of the MTS innovations and gave added impetus to the program by incorporating technology planning into teacher evaluations [A], taking a leadership role in curriculum innovation [S], participating on school technology management teams [C], helping teachers develop intervention plans [M], etc. In contrast, new principals, unfamiliar with the purpose and goals of MTS were less encouraging of teachers [M], and some principals were even hostile to the project [L]. The conclusions reported at the "teacher centered" site generalize well to all five MTS projects: "Principals play a major role in setting the tone for the MTS project and promoting the use of technology as a set of teaching tools. Their leadership, support for teachers' technology integration, and management role in the project, as well as their own growing knowledge and visible uses of technology have strongly influenced project implementation..." [Cu/36].

The Extent of Reporting Requirements.

A certain amount of documentation is a reasonable component of any project, but there were times when paperwork became a burden to the MTS participants, taking time away from the real business of the project. One can speculate that the special, innovative nature of the project made participants unusually careful and cautious. From the state Office of Educational Technology to the districts to the project management teams, people felt a need to monitor things carefully. One consequence of this concern was the imposition of requirements for frequent reporting.

The greatest burden fell on Project Directors. In addition to the project planning documents and inventory and control records for monitoring purchases and donations, they were required to submit lengthy quarterly reports to the state Office of Educational Technology and year-end research reports to the Office of Educational Technology and the research consultant. These quarterly reports were often 30 - 50 pages long, containing detailed chronologies of implementation and descriptions of changes to program plans. At least one district added to the burden by requiring project staff to report all activities on a weekly basis to a project supervisor within the district.

By the second year it became apparent that projects did not need such careful monitoring. After some discussion with Project Directors, the state's reporting demands were reduced substantially. To date, district requirements have not been changed.

On the other hand, the project management teams often required detailed documentation from teachers. This included step by step reporting on the technology planning process in the form of personal learning plans [C] and classroom intervention plans [M]. In at least one case the teachers complained about the excessive paperwork [M]. (Steps are being taken to streamline the forms.) As projects begin to focus more attention on producing materials for dissemination, the potential exists for creating documentation requirements that teachers will find to be excessive.

The Use of Multi-Year Staggered Implementation.

The original model for implementation contained in the Model Technology Schools RFP suggested that elementary school activities begin in the first year, intermediate school in the second year and high school in the third year. One project adopted an alternative pattern of implementation that proved to be very effective [C]. At this site a small subset of the intermediate and high school teacher cadres were involved in the first year. They were given an opportunity to become familiar with the equipment and the implementation model being used at the elementary level. They also had a chance to begin planning for implementation at their own school a year ahead of time. As the Research Coordinator noted,

> "The concept of a "lead cadre" of six teachers in each school turned out to be one of the real strengths of the project Throughout the first year for [intermediate school], and the first two years for [secondary school], lead cadre teachers participated in all project staff development activities. With this head start, the lead cadre became true leaders in their schools and informed sources of information and experience for their faculties." [Cu/4]

A similar strategy evolved in another district, which began its planning process with a "seed" group of teachers at each site. "During the planning stage, an MTS core team was established at each of the three schools. Members of the team acted as a steering committee and were involved in planning and initiation of the program. The involvement of this small group of people who were interested in the program helped to motivate other members at each school" [S/13].

The Presence of Other School Programs.

Another factor that affected the implementation of the MTS projects (and confounded the research) was the presence of other programs in the MTS schools. In a few schools MTS was the lone innovation occurring during this time [A]; in other schools there were multiple, interrelated technology and curriculum change projects [S]. Most schools fell somewhere in between these two extremes: they already had two dozen computers but they were not widely used [C], or they had technology labs and some experience with a computer-based reading program [M]. Some of schools that had no other technology project when MTS began received other donations during the year, including a math and science network [A] or an additional set of computers [L]. In theory, all schools were also involved in the implementation of the revised state English-Language Arts Framework. Sometimes these efforts were complementary and boosted the effects of MTS; sometimes they competed for staff time and attention. In most cases it is impossible to disentangle the effects of one program from the effects of the other.

The Choice of Voluntary or Required Participation.

Some of the Research Coordinators noted the importance of self-selection among MTS teachers [A,C,L,S]. Researchers indicated that, as a group, teachers who volunteered to participate in the program were more motivated to work toward the MTS goals than those who did not volunteer to participate. "They chose to be part of this project knowing that it would involve extra effort but it was something they wanted to do!" [A/24]. "MTS teachers can be characterized as experienced professionals interested in becoming more effective teachers... [they] overwhelmingly identified the opportunity to learn about new instructional technologies and the opportunity to increase their teaching effectiveness as the two most important reasons for their participation in the project" [L/20]. "Working with a small group of teachers who were enthusiastic and highly motivated" was one of the important factors that affected the implementation of MTS [S/39]. Self-selection occurred primarily at the intermediate and secondary levels, but in one case it was also a factor at the elementary level [L].

MTS Implementation Factors Summary.

The Research Coordinators described a number of different factors that affected the impact of the MTS project on teachers, students, curriculum and instruction. Although they did not all describe the same elements, the degree of agreement was quite high. This agreement across sites presents a fairly convincing argument for the importance of the following factors to implementation of the MTS projects: the amount of learning time, the level of teacher and student access to technology, delays in acquisition, the level of principal support, the extent of reporting requirements, the use of multi-year staggered implementation, the presence of other school programs, and the choice of voluntary or required participation.

ADDITIONAL IMPLEMENTATION FACTORS

After studying the MTS sites, talking with members of the management teams, school administrators and teachers, and reviewing data from researchers, a number of additional factors were identified that helped explain the successes and failures witnessed so far in the MTS program. These impressions emerged primarily from comparisons across sites, and they should be added to the factors mentioned by the Research Coordinators. In fact, some of these items were mentioned specifically by one or two Research Coordinators, but not discussed by others. The issues include: the effects of high public visibility, the value of management flexibility, the need for clarification of goals, the need for more structure for teachers, the problem of choosing the best sequence for learning and acquisition activities, and the importance of district administrative support.

The Degree of Public Visibility.

Because of the statewide competition for the MTS awards, the high level of funding associated with each, and existing widespread interest in technology, the MTS projects received a great deal of attention from educators, researchers, community members and business leaders. In a very real sense, the MTS projects were like fishbowls, with interested people wanting to peer in at all hours. In fact, all sites had to adopt restricted visitation schedules to accommodate the barrage of requests for visits they received.

The "fishbowl" phenomenon had both positive and negative effects. At best it fostered a tremendous sense of excitement among program participants. It can be thrilling to participate in a project that is "on the cutting edge" of change, to appear on television and in the newspapers, to speak at conferences, etc. This kind of attention can increase teachers' motivation to become technology users. It can result in more effort being devoted to the project, and it can build a sense of community. In these ways high visibility contributed to the implementation of the MTS projects.

At the same time, putting people under constant scrutiny can create tension. Visitors can interfere with school activities. The pressure to commit more time to MTS activities can place a strain on other responsibilities. Overworked teachers can rebel at pressure to "go along with the program." Moreover, the sense of being in the spotlight and being subject to excessive review and evaluation can foster defensiveness. Staff members can waste time trying to prevent misstatement and correct misimpressions. Both the tension and the defensiveness engendered by the high visibility of the MTS projects interfered to some degree with the implementation of the projects.

It was not clear whether, on the whole, the "fishbowl" phenomenon helped or hindered the MTS projects. It was clear, however, that a heightened level of attention existed in all the MTS sites. Some project teams utilized the attention better than others, just as some coped with the pressures more effectively.

The Degree of Management Flexibility.

It is hardly noteworthy to say that flexibility is a good quality in a project manager. Yet, it is worth commenting on the degree to which the MTS Project Directors were confronted with unanticipated events and the success they had in adapting to them. The projects succeeded to the extent they did only because the management teams were able to make "mid-course" corrections efficiently. Project staff demonstrated flexibility in thousands of ways, including going to the warehouse and finding "missing" equipment [L], moving staff from the central MTS office to the school sites [L], borrowing computers from other sources when they were not delivered on time [A], enlisting high school students to make connectors that were taking too long to manufacture [S], designing a new teacher technology planning process [M], capitalizing on personnel from other agencies [M], restructuring planing activities at the secondary level [C], reallocating resources to accommodate unpredictable donations [all], changing research partners [M], collaborating with other programs that were taking place at the MTS sites [S], reorganizing training to adjust to delays in the delivery of computers [all].

The MTS projects were unusual because they involved so many changes in plant and procedures that are not typical of educational innovations. The atypical elements included large amounts of new equipment, retro-fitting and remodeling buildings, the use of untested technology, and the establishment of new types of working relationships with research organizations and industry (partnerships). Each of the projects began with a detailed five year plan, few passed the first five weeks without major changes. Their successes to date are a testament to the flexibility and creativity of the project management teams.

The Clarity of Goals.

Each of the projects adopted an approach to the use of educational technology and planned their program accordingly. (The earlier discussion of Project Approach listed the general goals of each project.) The terminology used by the projects included "student centered education," "critical thinking skills," "student proactive behaviors," "teacher empowerment," "technology projects," etc.

While these terms may have meaning for educational researchers, they did not always convey a clear message to the teachers, and the teachers' confusion interfered with project implementation. A few examples will illustrate the problem: a new research partner had to help the management team develop operational definitions for "proactive" behaviors [M], research and training partners from the same institution couldn't agree on the meaning of "student centered education" [A]; a telephone conference with three cognitive psychologists did not yield a single appropriate measure of "critical thinking" [all], teachers did not understand what would satisfy the requirement that they develop a technology "project" [A].

While jargon can be useful for discussing specialized concepts, imprecise language and unclear goals became obstacles to program implementation. Some of the Research Coordinators cited examples of this problem. "The results of the first year qualitative evaluation overwhelmingly suggested a need for a clear definition of the specific expectations of the teachers participating in the project" [M/1]. "A perceived lack of clear guidelines by which to judge their own performance and with which to plan and revise instruction...[was] a continuing concern of teachers throughout this project from its inception" [A/151]. "Teachers indicated that project administrators need to better clarify project goals and objectives..." [L/ii].

The Provision of Adequate Structure for Teacher Planning and Implementation.

At least three of the projects found it necessary to provide teachers with clearer plans, more well-defined procedures or more concrete expectations for their actions.

To understand this change the reader must remember that teachers were given a great deal of autonomy in all the MTS projects. The final choice regarding how technology was to be used in a particular classroom was left to the individual teacher. The original philosophy of many of the projects had been to provide training on the use of technology and its integration in education and then offer support while teachers pursued their own initiatives and developed their own curriculum units. This individualized approach was evident in all the projects. "Central to the project is the notion of grassroots development and diffusion" [L/4]. "The [project] has a 'bottom-up' design which insures that teachers will play an essential role in the development and implementation of the project" [M/17].

To their surprise, many of the projects found that teachers needed additional structure. They wanted a clearer definition of what they were supposed to do or what they were supposed to produce [A,L]. ("The teachers need to have a better understanding of the project's expectations for developing the required curriculum materials" [L/iv].) They wanted assistance in developing lessons that promoted desired student behaviors [M]. They wanted help in deciding what technology to apply and how to make it serve their needs [C].

To their credit the MTS management teams recognized these needs and responded appropriately. They developed a Classroom Implementation Planning process [M]. They clarified the meaning of student-centered education and what constituted a reasonable project to undertake [A]. They initiated a departmental planning process to establish a clearer context for Personal Learning Plans [C]. The projects facilitated the integration of technology in pursuit of their overall goals by providing specific planning procedures, etc. These changes helped overcome the reluctance of many teachers to make decisions regarding the purchase of technology, to take the lead in planning technology-related instructional activities, or to produce model lessons or curriculum units.

This presents a dilemma: how much structure should the project impose on teachers? One of the strengths of the MTS programs was the degree to which they gave responsibility over instructional planning to teachers and did not try to proscribe instructional and curricular changes. As was pointed out by the Research Coordinators, this approach promoted professionalism. On the other hand, when things were too unstructured or unclear teachers (and other staff) became frustrated. The Project Directors had to find the right balance between structure and freedom, and this was something that took time. In many cases the problems surfaced in the first year and actions were taken to solve them in the second.

An interesting parallel can be drawn between finding the right balance between independence and structure in program planning and striking the right balance between flexibility and rigidity in software design. One of the Research Coordinators observed that certain types of software packages had greater impact on curriculum. "An important characteristic of these packages is that they deal with a sizeable chunk of instruction, i.e., they are non-trivial. They gave teachers freedom to add or modify elements of the package, but also were thorough and specific enough in their curricular area as to assure teachers that academic 'objectives' were being met" [A/157]. Effective program plans have similar characteristics: they are non-trivial, they deal with sizeable chunks, they allow teachers adequate freedom to modify, but they are specific enough so teachers can know whether they've been accomplished or not.

The Sequence of Training and Acquisition Activities.

Project management teams faced a dilemma regarding the best sequence for obtaining technology and training people to use technology. The problem arises because choosing technology, learning about technology and using technology are interrelated activities, and it is difficult to pursue one with incomplete knowledge of the others. As one Research Coordinator explained it,

> "Becoming informed enough to make wise choices poses a "chicken-egg" problem for teachers. How do you know what you want when you know very little about technology? In fact, how do you even know what you want to learn more about? Moreover, there is a trade-off between investing time in learning more, so your decision is more informed versus delaying what is already a lengthy purchasing process." [Cu/13]

All management teams faced similar chicken-or-egg dilemmas. Choices about hardware and software should be driven by curricular and instructional goals. However, one cannot make reasonable choices about curriculum and instruction without knowledge of hardware and software to inform the decision. Teachers said "we don't know enough to make choices" [A/124], and project management teams had to select an acquisition/training strategy that accommodated this paradoxical situation.

The Level of District Administrative Support.

Although each of the districts pledged support for the MTS project as part of its initial application, they have not been equally responsive to the needs of projects once they were funded. A certain amount of tension is to be expected as an existing bureaucratic structure has to accommodate a new, highly-visible, and somewhat autonomous element. For the most part Project Directors were pleased with the assistance they received and the manner in which they were allowed to function within the district hierarchy.

However, all of these relationships were not equally conducive to the smooth operation of the MTS projects. Actions that enhanced MTS implementation included developing streamlined procedures for maintenance, purchasing, travel approval, etc., incorporating MTS goals into district goals and evaluation procedures, creating district technology support structures, promoting MTS staff to official district technology positions, coordinating resources between MTS and other programs, assisting in establishing partnerships with business and industry, and providing additional resources -- both financial and personnel. Actions that interfered with MTS implementation included replacing MTS project staff, transferring key school personnel from MTS sites, reorganizing management structure and reporting relationships, imposing excessive paperwork and reporting requirement, and subsuming MTS resources under broader technology efforts. It should be obvious that the former actions promoted project implementation while the latter hindered it.

Implementation Factors Summary.

The preceding section described a number of factors that affected the implementation of the five MTS projects. Briefly the factors were:

The Amount of Learning Time (How much time were teachers able to find for learning, practicing and incorporating technology-related skills into instruction?)

The Level of Teacher and Student Access to Technology (Were teachers and students able to use technology at convenient times and in convenient locations?)

Delays in Hardware and Software Acquisition (How long were activities postponed because necessary hardware/software had not arrived?)

The Level of Principal Support (How much direct encouragement and support did the principal provide to foster building-level changes?)

The Extent of Paperwork Requirements (To what extent did Project Directors, Management Team Members and Teachers have to divert time from other duties to comply with reporting requirements?)

The Use of Multi-Year Staggered Implementation (Did projects find ways to involve second and third year participants ahead of time to build a core of knowledgeable champions at the other schools?)

The Presence of Other School Programs (Were other programs operating in the cluster schools that either contributed to or interfered with the accomplishment of MTS objectives?)

The Choice of Voluntary or Required Participation (Did teachers volunteer to participate or were all staff required to be involved? Did this affect teachers enthusiasm for the program and their level of involvement?)

The Level of Public Visibility (How well did staff adjust to increased attention from parents, community, press, educators and industry representatives?)

The Degree of Management Flexibility (Was the Management Team flexible enough to adapt to delays and unanticipated demands on the project?)

The Clarity of Goals (Did teachers or staff have trouble understanding project goals and what was done to clarify them?)

The Provision of Adequate Structure for Teacher Planning and Implementation (What types of procedures were used to help teachers set and achieve goals for technology use? How clear were the expectations for teachers' actions?)

The Sequence of Training and Acquisition Activities (In what order did the project introduce technology to teachers and acquire hardware and software for teacher use? How much input did teachers have into acquisition decisions and how were they prepared to make informed judgments?)

The Level of District Administrative Support (Did the district administration support the project in useful ways or did they take actions that made implementation more difficult?)

RESEARCH UNIQUE TO A SINGLE SITE

The previous discussion does not exhaust the research conducted under the auspices of the Model Technology Schools program. In many cases the topics that were common to the five Research Coordinators were less interesting than the topics pursued singly. For this reason the following descriptions are provided. They briefly highlight some of the research that was not aggregated in the previous sections. For further information about any of these topics consult the research reports for year two or contact the Project Directors. Many of these research questions are the subject of long-term study and only preliminary results are available at the present time.

Alhambra: Teacher learning patterns and responses to training strategies. Researchers characterized teacher change along two dimensions -- technology integration and student-centeredness -- and proposed a four-stage model of involvement along the technology integration dimension. They described four types of in-service strategies and differentiated among teachers who preferred different types of support.

Cupertino: The process of implementation with an emphasis on the nature of changes in teachers. Researchers described how technology can enhance the professional growth of teachers. They also observed how ideas developed at one school can migrate to another.

Los Angeles: Project implementation and management, and student language acquisition. Researchers examined management issues within the context of a large school district as well as the use of technology to promote language production and acquisition among non-native speakers of English.

Monterey: A model for site-based implementation, and the relationship between student-centeredness of instruction and technology use on student proactive behaviors in different content areas. Researchers described the development of a model for site-based implementation of technology and developed instrumentation to assess student proactive behaviors.

Sacramento: Teacher and student classroom behaviors. Researchers conducted classroom observations and gathered extensive data on type of interaction between teacher and student, content of lesson, mode of instruction, use of technology, student task engagement, student on-task and off-task behaviors, etc.

SUMMARY AND CONCLUSIONS

This study was undertaken to summarize the results of the first two years of California's Model Technology Schools program. Research and evaluation reports from the five MTS projects were analyzed to provide answers to three basic questions:

HOW WELL DID THE MTS PROJECTS FUNCTION?

In the original Model Technology School Request for Proposals, the state indicated that the MTS sites were supposed to provide "technology-rich student learning environments for educational research, product development and teacher training." To date it appears that they are on the way to meeting this objective.

Management.

The MTS projects continued to focus on their original goals for technology despite extensive delays in obtaining fundamental project materials. They made appropriate changes in plans and procedures to implement the program more effectively. Two major adaptations involved decentralizing activities and authority and modifying plans to accommodate differences between elementary and secondary settings.

Staff Development.

In-service training, a critical project activity, was generally conducted on time and "on target." Teacher evaluations were favorable, and Training Coordinators appeared to be flexible enough to adjust to changing conditions (most notably delays) and changing needs. Furthermore, staff development appeared to have a direct positive impact on teachers' attitudes and use of technology. There was widespread evidence of professional growth in a number of different areas. Over time the focus of the in-service training shifted from group workshops to individualized, on-site assistance that provided better support for teachers who were beginning to use the technology on a regular basis. This change was accomplished by shifting some staff resources to the local school sites and/or by encouraging teachers to become "experts" for one another.

Instruction and Curriculum.

There was clear evidence that the MTS projects had an impact on instruction and curriculum. Teachers changed the way they taught, and they expanded the scope of what they taught. There were more small group, collaborative activities and more individualized projects. Some traditional boundaries between subjects were broken down, most notably through increased attention to writing and language arts in many other subject fields. Changes were not uniform across teachers, and there was no way to quantify the extent of the changes nor to measure the overall impact of the MTS projects on curriculum and instruction.

Students.

There were clear indications of positive student changes in each of the MTS projects. Though it is too early to expect to find significant impact on achievement, there was ample evidence of improvement in attitudes toward technology, motivation for learning in technology-related areas, and use of technology. Furthermore, preliminary impressions from some sites suggest that students' writing skills improved from the targeted use of technology in Language Arts.

WHAT MADE THE MTS PROJECTS FUNCTION AS WELL AS THEY DID?

The Research Coordinators and the author of this study identified a number of factors that affected the implementation of the MTS projects. These included: the amount of learning time, the level of teacher and student access to technology, delays in acquisition of hardware and software, the level of principal support, the extent of paperwork requirements, the use of multi-year staggered implementation, the presence of other school programs, the choice of voluntary or required participation, the degree of public visibility, the degree of management flexibility, the clarity of goals, the provision of adequate structure for teacher planning and implementation, the sequence of training and acquisition activities, and the level of district administrative support. These findings are consistent with with existing research on technology implementation (Stecher, 1984; Cline, et al., 1986; Watt & Watt, 1986; Cannings & McManus, 1987), and the factors identified in the MTS sites seem to play an important role in the implementation of a wide range of technology-based innovations. Other schools considering the application of technology on a large scale would be wise to attend to these issues.

A related question that was not specifically addressed in the research reports is: What elements of the MTS program model were the most important? It is too soon to know whether the overall MTS program will demonstrate the efficacy of technology in education, but it is not too soon to form impressions about the key characteristics shared by the five projects. This study provided clear information about some of the important components of the MTS model.

The most startling revelation may have been that technology was not the sine qua non of MTS. Instead, it appeared that two other components were just as important as technology to the functioning of the five projects. These components were the central approach or philosophy adopted by each site and the staff development emphasis incorporated into the MTS model.

Central Approach or Philosophy.

One of the things that facilitated program implementation was the existence of an educational philosophy or approach to focus activities and guide decision making. The approach affected the actions of teachers as well as program managers. As noted above, each project was required to develop a plan for technology use within a larger context defined by their approach or their central learning issue. This context was critical for helping the management team guide the project and for helping teachers integrate technology into education. In fact, when the technology was not available due to delays, the projects were able to continue with training focused toward their central educational goals [A,S].

The success of many of the MTS projects was not due primarily to technology (despite the name Model Technology Schools), but to the project's approach to education. In this respect it is a mistake to think of these sites primarily as "technology projects." This phrase places too much emphasis on equipment, and equipment was relevant only in the service of a broader educational goal[4]. Instead, MTS projects

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[4] In fact, projected budgets from the five sites for the first three years of the project -- the years of greatest hardware acquisition -- allocated an average of only 27% of the funds received from the State for capital outlays. While funds are often reallocated during the year so that (continued...)

should be thought of as "educationally-focused reform projects" that integrated technology into a program of training and curriculum change to serve a broader educational goal. The infusion of technology alone was not sufficient to accomplish the goals of most of these projects.

Staff Development Emphasis.

The second key to the effectiveness of the MTS program model was the emphasis placed on staff development. In the previous paragraph it was argued that MTS projects should be thought of as "educationally-focused reform projects" rather than merely "technology projects." Here the argument is made that staff development also was as essential as technology to the success of the MTS program.

The emphasis on staff development can be seen from the breadth and depth of in-service training that was provided, both from district staff and from outside experts. The list of in-service workshops conducted at each MTS site was extensive, and the variation in the kinds of in-service support was great [all]. This massive infusion of staff development was at the heart of the success of the MTS projects, and its importance should be recognized[5].

The Role of Technology.

If the central educational approach and the emphasis on staff development were critical elements of the MTS program, how important was technology? One Research Coordinator clarified the balance between these three elements: "What caused the perceived changes: the project's philosophy, the summer training, the technology? At this stage the answer is not clear but it appears to be a combination of all three" [L/22]. Technology certainly deserves credit, and its importance was probably equal to those of the central educational approach and the emphasis on staff development.

Acknowledging the importance of technology is only part of the story. It is also valuable to examine the role of technology in the MTS projects. Evidence from the sites indicates that technology played four key roles: a disturbance, a catalyst, an incentive, and an educational tool. Each metaphor reveals something about the way technology functioned within the MTS model.

> **Technology as a Disturbance.** One thing that technology did was to disturb the status quo. It allowed program planners and administrators to "shake the tree" and alert staff and students that changes were going to take place. More than either a printed bulletin or an announcement on the public address system, the presence of computers on the teachers' desks, in the principal's office, the library, the classrooms, etc. was a constant reminder that the educational enterprise was undergoing a change.

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[4](...continued)
actual expenditures do not match initial projections, the budget totals provide an indication of staff expectations regarding resource needs.

[5] The importance of staff development can also be illustrated in terms of resources. A much greater percentage of the projects' budgets for the first three years -- the time of greatest hardware acquisition -- was devoted to staff development and curriculum assistance than to capital outlays.

Technology as a Catalyst. A second function was that of a catalyst through which other reactions could take place. Technology became a focal point for discussions of student centered education, proactive learning, critical thinking, language acquisition, etc. The playing field was technology but the game was educational reform. "This project has catalyzed a feeling of renewal in an older teaching workforce. The teachers and principal... believe they are now in the technology mainstream, not outside looking in and falling behind as educators." [C/17]

Technology as an Incentive. Third, technology was an incentive, and a powerful one, for many teachers and students. For teachers the opportunity to become computer/video/laser-literate excited them, challenged them, renewed their interest in their profession, etc. As one teachers said, "I was and am still motivated about using the new technology with my students" [L/49]. A Research Coordinator summed up this effect concisely, "Technology generates excitement" [Cu/26]. The motivational effects on students have already been mentioned.

Technology as an Educational Tool. Finally, technology offered new educational tools and opportunities [all]. Unlike reforms such as bonus pay, changes in scheduling or other incentives that might be offered to teachers, technology had direct educational relevance in new and exciting ways. It was a revolutionary medium that offered new possibilities in the classroom.

In these ways technology, too, was a key ingredient in the MTS mix.

HAS THE PROGRAM ACHIEVED ITS STATEWIDE GOALS?

Finally, it is worth considering whether the program as a whole is achieving its goals. In the RFP the state described six broad goals for the MTS program on a statewide basis. (See page 2.) Though much has changed since that document was written[6], it is worthwhile to examine the status of the program in light of its original purposes. The state's six objectives related to demonstrating technology use, developing training models, disseminating research on implementation, promoting the development of new products, determining facility standards, and disseminating results to policy makers?

It is clear that the first two objectives are being pursued actively. The primary efforts of the MTS sites have been directed toward training staff and integrating technology into education in meaningful ways. Models for training teachers to use technology have already begun to appear. However, because of the staggered implementation built into the MTS program and because of delays in acquiring hardware and software, it is premature to expect to know whether effective instructional strategies have been developed. At the conclusion of

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[6] The original legislative authority for the MTS projects (and other educational technology initiatives in California) expired on June 30, 1989. A new Educational Technology Act was passed by the legislature in September, 1989, though it had not yet been signed by the governor at the time this report was completed. One of the provisions of this act was to extend the authorization for the six MTS sites (renamed Educational Technology Research and Demonstration Schools). In addition, the legislation redefined the objectives of the program to a certain extent, mandated annual program evaluations and established evaluation criteria. Specific guidelines had not yet been established by the SDE for implementing the new legislation, so it is impossible to say what its effect will be on the MTS projects and the research agenda they were pursuing.

the third year the program will have been implemented at all three levels, and questions about the impact on student learning should be paramount.

Dissemination activities have begun already on a small scale in most projects, and they should accelerate in year three. According to most of the project proposals, dissemination efforts will begin in earnest the forth and fifth years of the program. This should include the dissemination of research on implementation and technology use as well as the dissemination of program results.

The remaining two objectives -- promoting the development of new products and determining facility standards -- have received less attention in the reports prepared by the Research Coordinators. It is clear that the Project Directors have a great deal of knowledge about facilities which they are planning to share in one form or another. Less has been written to date regarding the testing and development of new products that support state curriculum and instructional guidelines, though many of the business and industry partnerships involve the use of such products. It would appear that the MTS program has the potential to achieve these objectives as well.

In summary, it appears that activities related to all six MTS statewide objectives were being carried out by the MTS projects during the first two years of the program, though it is too soon to tell whether or not these objectives will be achieved by the time program funding is completed[7]. This situation is captured in the phrase that begins title of this report, "On the road toward..."

[7] It is an interesting paradox that one of the conditions that fostered effective adoption of technology in the MTS sites -- local autonomy to develop a unique overall approach to technology use -- also acted to diffuse the site's focus on the original statewide program goals. By granting the programs the autonomy to develop their own models, the state effectively created not one but five sets of program goals and not one but five sets of research and evaluation questions. This may make it more difficult to ascertain the overall effectiveness of the MTS program in future years. It created problems in the present study because the Research Coordinators were investigating different evaluation questions.

RECOMMENDATIONS[8]

It is far too early in the projected five-year life of the MTS program to draw conclusions regarding program impact and effectiveness. However, it is not too soon to identify potential problems, note unresolved issues and suggest changes to forestall difficulties that might arise in the MTS program and in MTS research and evaluation at the project- and statewide levels. That is the spirit in which the following recommendations are offered.

1. Each MTS project should be asked to identify important outcomes they hope to achieve that can serve as the basis for evaluation in future years. Moreover, the six sites should be asked to agree upon a set of common outcomes and ways to measure them that will provide a reasonable reflection of their accomplishments. This will permit state policy makers to assess the accomplishments of the MTS program, and it will allow local practitioners to judge what they might achieve if they adopted MTS practices. Outcomes may involve students, teachers, administrators, schools, districts, and communities; they need not be focused solely on achievement. However, in the absence of common MTS-defined outcomes in other areas, decision makers are likely to look to achievement data as the sole measure of MTS success.

2. MTS project management teams should review project goals and objectives and clarify any concepts or terminology that is not meaningful to participants. This should occur as often as new terminology is introduced or existing terms are re-conceptualized, and the new definitions should be disseminated to project participants and the SDE.

3. The state should clarify its request for information regarding the cost-effectiveness of MTS projects. In the present context, "cost," "effectiveness," and "cost effectiveness" are all undefined terms which can be interpreted in many different ways. The choice of approach for measuring cost effectiveness depends upon definition that is adopted and the purpose that the information is going to serve. The following are all legitimate "cost effectiveness" questions that could be asked about the MTS program; each would require a different type of analysis:

   Is one model of MTS more cost effective than another?

   Which MTS program components are the most cost effective?

   Which technologies are most cost effective in different curriculum areas?

   Is a technology-based innovation more cost effective than an alternative approach to educational improvement?

   How effective would an MTS project be if the size of the grant was changed?

   How much would it cost to initiate effective technology programs in other school districts?

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[8] These recommendations do not take into consideration changes in the legislation authorizing the MTS projects nor changes in SDE regulations regarding the operation of these projects that were under consideration at the time this report was prepared.

Guidance is needed lest the MTS projects produce widely divergent information that will have little value for the MTS programs themselves, for other technology-adopting districts or for state policy makers. It may be necessary for the state to hire outside consultants with more specialized expertise in this field to help formulate meaningful questions and to assist sites in designing data collection strategies. To date, none of the MTS sites has addressed cost effectiveness in a thorough manner, nor are they comfortable doing so.

4. Research Coordinators should pay specific attention to differences between the elementary and secondary levels in terms of implementation and technology use. This information will be useful to other program developers as well as policy makers.

5. As the MTS projects plan dissemination activities, they should realize that the lessons learned about implementing technology (and evaluating implementation efforts) are among the most valuable things they can share with other schools and districts. Rather than focusing dissemination efforts exclusively on technology-based lesson plans and curriculum units developed by teachers, the projects should also prepare to share information about acquiring technology, training staff, integrating technology into curriculum, and bringing about school-wide change, as well as the instruments they developed to evaluate these activities. Other districts will benefit greatly from knowledge of these procedures as well as information about specific technology-rich lessons and curriculum units.

6. If the state wants information about the effects of technology use on students, teachers, and schools[9], it should support the development of measurement techniques to assess key student and teacher outcomes. One of the difficulties faced by all the MTS projects is the lack of instrumentation to measure important results. If the state is serious about investigating the effectiveness of various technologies applied in different curriculum areas, it should consider helping to develop the measures that will be needed to assess the impact of these instructional and learning tools.

7. To maximize the value of the resources invested in MTS, the state should support annual or bi-annual discussions among policy makers, administrators, program developers, technology developers, staff development professionals, teachers, etc. about the role of technology in education and the implementation of technology-rich educational programs. Such exchanges might take place at a statewide conference arranged specifically for this purpose or at an alternative forum that would draw the appropriate audience. In either case, the key issues should be the role of technology in different models of schooling, the opportunities technology provides, the problems it creates, and the choices that are available. The discussions should highlight what has been learned in the MTS sites and what questions remain unsolved. These issues are of great importance to educators from other districts and other states.

[9] The new legislation that funds educational technology programs in the state aspires to very sophisticated understanding of technological applications and effects, such as "the enhancement of cognitive thinking skills as a result of technology-assisted instruction."

IMPLICATIONS FOR POLICY

The final issue to be considered is what has been learned from the first two years of the MTS project that is relevant for policy making. The same caveat that was offered prior to the presentation of recommendations is repeated here: the MTS project is only partially implemented; some lessons are apparent, but many will not be learned until the projects have begun to operate on a consistent basis and to conduct their dissemination activities. Some will only become apparent when the state supported project is completed after five years.

1. The strengths of the MTS model were threefold: requirements that technology infusion be framed in the service of a central educational theme, the strong emphasis on staff development, and the recognition that educational reform is a multi-year process. Future state educational program initiatives would do well to incorporate these notions wherever possible.

2. There were two primary weaknesses in the MTS model: the belief that basic research could be conducted in the context of a development and demonstration project, and the notion that site-specific independent research and evaluation efforts would produce generalizable conclusions about the statewide MTS program as a whole. One of the Research Coordinators made the first point succinctly, noting that MTS should not be thought of as a replicable intervention nor an experimental one [A/6], but as a demonstration project.

   Regarding the second weakness, if the state wants answers to particular policy-related questions regarding the overall MTS program, a single external evaluator should be hired to produce a summative evaluation of the program. Five or six independent researcher/evaluators can provide useful site-specific information, as they are presently doing, and they can conduct interesting research studies. However, to the extent that the state wants broad-based summative evaluation results to inform state-level action, they should consider using a single independent contractor to supervise the investigation.

3. It is too soon to assess the overall value of the business and industry partnership component of the MTS program. While the business and industry partnerships have been beneficial, they have also been unexpectedly time-consuming. For example, one site estimated spending almost one-third of a person-year on developing partnerships and obtaining donations. They received donations worth almost $150,000 for their efforts. However, this level of "success" is probably not replicable if large numbers of districts attempt to do the same thing. To date most of the partnerships involved donations of equipment in return for increased product visibility and entre to the schools. There were only one or two instances in which business and industry partners contributed something other than equipment, such as expertise to solve educational problems. The long-term benefits and costs of the partnership arrangements are still uncertain.

4. Consistency in project funding will improve the state's return on its investment. Despite the five year model described in the MTS design, annual political struggles were required to insure continued funding, and these battles sapped energy from the programs. The initial intent to provide long-term funding was laudable; in fact, it represents the sort of commitment needed to promote meaningful educational reform. However, the administrative and legislative reality has been less than laudable. If policy makers want to improve education then they need to

follow-through with funding commitments.[10] The MTS sites are already beginning to demonstrate the value of multi-year support to promote meaningful educational changes involving technology.

5. Initial estimates of the cost of realizing technology-rich environments such as those in the MTS sites on a large scale are quite high. Each MTS complex spent $1 million of state money on equipment and training during the first two years of operation (and many contributed substantial amounts of local funding, as well), and they still do not have enough equipment to meet the demands generated among teachers. It will be important to learn how much technology is needed to satisfy the demands of a school of excited, well-trained technology-using teachers, because this will provide a clue as to how much technology will be needed for other schools and districts to follow the MTS lead.

   Furthermore, the major expenses incurred to date by the MTS sites have not been in capital improvement, but in staffing to support technologically intensive changes. While capital costs may be expected to decline, it is not clear that staff costs will decrease. It will be important to monitor the success these sites have in becoming self-sustaining once the MTS grants are completed. This is a key component of the MTS experiment that will have significant implications for future educational policy.

6. In addition to those specific lessons that will be learned from the MTS program regarding educational technology, there may also be a general lesson about the value of development and demonstration programs as models of educational innovation. Much has been learned to date about technology use from systematic study of a small number of well-designed, well-funded, long-term demonstration sites. If the dissemination phase of the MTS program is effective (and this should be monitored closely in the final two or three years of the program), the state should be encouraged to use similar long-term demonstration/dissemination models for exploring other educational innovations, including other approaches to the use of technology in education.

[10] In light of recent changes in legislation, a similar comment should be made about the value of consistency in project goals and objectives. It remains to be seen how changes in the focus of the MTS program will affect efforts at the sites. However, past experience suggests that effectiveness will be reduced, at least in the short term.

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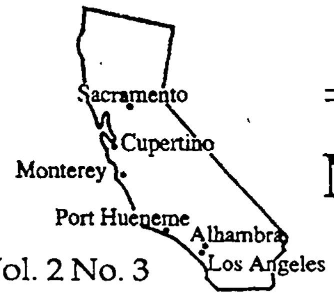
Note: Letters in brackets [] are used as shortened referenced in the text.

APPENDIX A:
CALIFORNIA'S MODEL TECHNOLOGY SCHOOL PROJECTS
18-MONTH REPORT



Vol. 2 No. 3 — 18-Month Report — Spring 1989

California's Model Technology School Projects

ONE AND ONE-HALF YEARS OF CMTS IN REVIEW

Ira Barkman, State Project Director

The task of educating our children and improving our schools' productivity is becoming increasingly difficult. Future jobs in a high-tech society will demand much higher skills than today's jobs—very few employment opportunities will be created for those who cannot read, compute and follow directions. As society becomes more complex, the amount of education needed becomes greater. Significantly expanding the use of all the video, audio, and digital technologies in schools is important to statewide curriculum reform and, in turn, to preparing students for the future.

How can schools better equip their students to be participating and productive citizens in an information-technological age? Considering questions like this prompted the State of California to begin the study of funding some Model Technology Schools (MTS) during the spring of 1986. As a result, five sites were selected and funded in 1987 from a highly competitive process. A sixth site has just recently been added because the program caught the attention of the Governor and some key legislators and funding was made available.

The California State Department of Education working in concert with the Educational Technology Committee (ETC) developed the specifications for the selection of sites to fund which would be a fair representation of the demographics of the state. The thirteen-member ETC, constituted by Assembly Bill 803, California's Educational Technology Act, advises the state regarding the use of funds annually appropriated by the State Legislature. Each project site consists of a complex of 2-4 schools that span the kindergarten through twelfth grades. Among the six sites, there is a diversity in student ethnicity, school organization, instruction strategies and emphasis, and type and configuration of technology. This offers the opportunity for a variety of research studies which will be invaluable to decision makers at the local and state levels. At some later date, the sites may serve as demonstration and training sites and educators will be able to visit and adopt or adapt the components of these projects to meet needs at their own schools.

The new learning environments created by the state reform effort and assisted by the infusion of new technologies into the classroom seem to all for instruction moving away from formal teacher-centered textbook learning to student-centered informal learning. This includes opportunities for students to learn experientially or to learn by doing. These environments are suited to cooperative learning strategies which show promise of being particularly effective with students who have been unsuccessful in traditional classrooms, while at the same time maintaining high achievement levels for their gifted and talented classmates.

Educational institutions are not taking advantage of technology to the same degree as the private sector. Much time and effort is wasted that could be spent more productively by utilizing technology in the classroom and in educational administration. Although California has been a leader in using technology in the classroom, technology must play a much larger role in enhancing the curriculum and improving the productivity of schools and teachers. Technology must be used to expand the teachers' ability to influence increased student learning.

The strength of the business and research partnerships is important to the success of the MTS program. In both instances, the experience thus far of contributions of expertise as will as products has been most gratifying. In one and one-half years, the total contributions is approximately $1.25 million. The state's partnership includes providing $500,000 annually for each of the six sites.

In addition to using technology to assist in the delivery of instruction, the schools must implement the new California curriculum frameworks to carry out California's reform effort. Both changes are monumental for most educators. At the middle of the second year, significant progress has been made. Each site continues its commitment to serve as a model that can demonstrate both curriculum reform and the effective use of technology so that technology can become a dynamic force in every school.

Inside- MTS Site Reports

District and Schools- Alhambra School District - *Emery Park Elementary School (K-8)*, 528 students, 25% Asian, 2% Black, 59% Hispanic, and 14% Other, eight language groups, 22% of students classified as Limited English. *Alhambra High School (9-12)*, 3,253 students, 55% Asian, 1% Black, 31% Hispanic and 13% Other, twenty-two language groups, 24% of the students classified as Limited English.

Management Team Members - *Project Managers:* Dr. Gary A. Carnow, Project Director; Mrs. Gail Lovely, Site Coordinator, Emery Park; Ms. Linda Meyer, Site Coordinator, Alhambra High School (AHS) *Curriculum and Training Support:* Dr. Cara Garcia, Pepperdine University, Mrs. Nancy Strouse, Pepperdine; Mrs. Eileen McClure, AHS; Ms. Charlotte Carden, AHS; Mr. Fred Steinbroner, Technical Facilitator *Research:* Dr. Terry Cannings, Pepperdine; Dr. Linda Polin, Pepperdine; Mrs. Nancy Strouse, Pepperdine *Site Administration:* Mrs. Barbara Randolph, Principal, Emery Park Elementary School; Mr. Frank Cano, Principal, AHS

Project Focus - The focus of the Alhambra Model Technology Schools Project is student-centered learning in a technologically-rich environment. Student-centeredness refers to the power of choice, self-control, and self-monitoring that students apply to their education.

Project Status - The elementary project is in its second year of funding exploring technologies including computer (home, lab, hallway and classroom), video, telecommunications, laser discs and satellite reception. The project is marking the progress of students and teachers through three stages of learning: as a novice (beginning role), as an intermediate (exploratory role) and as a sophisticate (ready to share knowledge with others). Empowering students and teachers involves the adoption of new classroom practices including cooperative learning and the use of integrated language arts throughout the curriculum. A home-school component trains parents in the use of computer technology and checks-out fifteen computers for week-long periods. Along with the computers, we check out FrEdWriter and through our home license with LCSI, we check out both Spanish and English versions of LogoWriter.

At Emery Park, we refer to last year as our "acquisition year." This year is our "integration year." Next year is our "product development year." We anticipate modules and technical reports that will describe the project and our major findings. We will identify "pieces" that can be transported to other sites.

The high school project is in its first year of funding. The size of the high school has required us to phase in the project with cadres of teachers joining the project as we progress. Cadre I (thirty teachers) are hard at work exploring the possibilities of Writing Across the Curriculum in a Macintosh Lab environment. A Math and Science Cadre (an additional thirty teachers) are working in an IBM supported teacher demonstration project. A token-ring network links all math and science classrooms to a file server and features software such as Microsoft Works and Math Exploration Toolkit. Large-screen monitors are used for teacher and student demonstrations. A Tandy supported laptop project has placed laptops in the hands of two classrooms of eleventh-grade students who are using the "electronic notebooks" to organize classwork, reports and to "chat" live on a district bulletin board.

The high school is currently installing a HyperMedia lab for students to explore and create stackware in a series of workstations including interactive authoring, videodisc, sound, desktop video, imaging and presentation areas.

Visitation Schedule - We have scheduled two visitation days for May 19, 1989 and May 24, 1989. Additional visitations will be scheduled in Fall. Please call either site for visitation times and to reserve a space. Emery Park (K-8), call Gail Lovely at (818) 308-2632 or Alhambra High (9-12), call Linda Meyer at (818) 308-2246. For general project information contact Dr. Gary Carnow, Project Director, Alhambra Model Technology Schools Project, 15 W. Alhambra Road, Alhambra, CA 91801, (818) 308-2622

Alhambra MTS Project Team (left to right): Tony Ortega, Assistant Principal, AHS; Linda Meyer, MTS Site Coordinator, AHS; Eileen McClure, Training, AHS; Barbara Randolph, Principal, Emery Park, Gail Lovely, MTS Site Coordinator, Emery Park; Dr. Cara Garcia, Training and Support, Pepperdine University; Nancy Strouse, Research and Training Support, Pepperdine; Dr. Terry Cannings, Research, Pepperdine; Charlotte Carden, Curriculum, AHS, Dr. Gary Carnow, Project Director; Fred Steinbroner, Technical Facilitator. Not pictured: Dr. *Linda Polin, Research, Pepperdine*, and Frank Cano, Principal, AHS.

Districts

The Cupertino-Fremont MTS Project is a partnership between the Cupertino Union School District and the Fremont Union High School District.

Management Team Members

The director of the project is Harvey Barnett. Cynthia Nichols and Joseph E. Sluga are coordinators of curriculum and training. Stanford Research Institute represented by Dr. Mimi Sterns, Steve Schneider and Susan Hanson manages the project's evaluation.

Schools

Garden Gate Elementary School (K-6); Diane Means, principal; 379 students--101 Asians, 24 Blacks, 4 Filipinos, 32 Hispanics, and 218 Whites. Kennedy Junior High School; Larry Curb, principal; Jack Miller, coordinator; 687 students-- 180 Asians, 8 Blacks, 1 Filipino, 18 Hispanics, and 470 Whites. Monta Vista High School; Janine Stark, principal; Rich Knapp, Joanne Barber, and Bill Richter, assistant principals; 1511 students--9 American Indians, 417 Asians, 14 Blacks, 12 Filipinos, 32 Hispanics, 2 Pacific Islanders, and 974 Whites.

Project Focus

The goal of the Cupertino-Fremont MTS Project is to empower teachers, by providing them appropriate access to technology, to increase their productivity and to enhance their methods of classroom delivery through the use of technology-assisted strategies. In the area of productivity, project teachers use Macintosh and Apple IIGS computers for word processing, grade book management, general data base management, spreadsheet analysis, and graphics generation. Technology-supported classroom activities include large group HyperCard-based lessons presented with a Macintosh and an LCD screen; science lab experiments supported by macro camera-assisted demonstrations, camcorder/VCR activities, and Hyper-Card-controlled video disk presentations; computer assisted instruction and productivity training for students in networked Apple //e, IIGS, and Macintosh labs; programming for students in a networked Macintosh lab, camcorder/VCR/video editing station-supported teacher and student productions; and student-generated desktop publications with Macintosh computers and LaserWriter printers.

Project Status

The project focused on Garden Gate Elementary during its first year (87/88) but included a cohort of six teachers from the other two project schools. Each teacher prepared a Personal Learning Plan which determined what equipment, courseware, and productivity software each purchased and formalized the teacher's goals for putting the new technologies to work. Project staff facilitated these processes, serving as resources for writing the plans, for equipment and courseware selection, and for training, once purchases began to arrive. Through the use of various assessment instruments, project staff determined specific training needs as they arose and met those needs by developing a training calendar that included workshops, seminars and classes. Teachers earned credit on the salary schedule for participation in those activities that occurred after the school day.. As the teachers received their equipment, materials, and training, they began infusing technology into their preparation and classroom strategies.

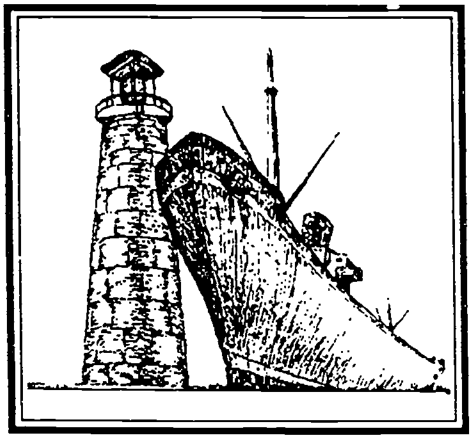
(seated l-r) Steve Schneider, Cynthia Nichols, Terri Rose, Joseph E. Sluga with Harvey Barnett (standing)

The second year of the project (88/89) brought continuing support to the Garden Gate staff and Cohort I at Monta Vista while Kennedy Junior High became the acquisition school. Kennedy staff met by department to establish Department Technology Plans which determined what equipment, courseware, and productivity software each department would purchase. Then, individual teachers formulated their Personal Learning Plans as the Garden Gate teachers had done the year before. Kennedy also established a twenty-two station networked Apple //e lab (with a Macintosh II file server) in an existing classroom and an eleven station free-standing Apple //e lab in the Guided Learning Center. MTS Staff continued needs assessments and the training schedule project wide. Garden Gate teachers meet often to update Personal Learning Plans and to plan and create replicable classroom products (activities, lessons, and units) with an eye toward dissemination in the third year. Monta Vista High School added a second cohort of six teachers. This spring the Monta Vista staff developed Departmental Technology Plans and Personal Learning Plans to prepare for its acquisition year (89/90).

Vistations

You may secure more information or schedule visitations by contacting Harvey Barnett via AppleLink (K1374), by facsimile at (408) 255-4450 or at the address and phone below.

Harvey Barnett, Director, Cupertino/Fremont Model Technology Schools
10301 Vista Drive, Cupertino, CA 95014 (408) 252-3000 x481



Schools- Blackstock School (grades 6, 7, 8) enrolls 870 students, 79.4% are minorities (.05% American Indian, 7.5% Black, .1% Pacific Islander, 5.7% Asian, 51.1% Hispanic, 14.5% Filipino, 20.6% Other Whites) These figures resemble the district demographic profile.

Management Team Members- Hueneme MTS team members are: Dr. Ronald Resigno, Superintendent; Dr. Richard Miller, Assistant Superintendent, Mr. Thomas Haas, Principal; Dr. Donald Cody, Evaluation Coordinator; Ms. Nikki Davis, Support Coordinator; Mr. Dennis Powers, Ms. Joann Borchard, Ms. Susan Richardson, and Mr. Steve Carr are Trainers.

Project Focus- The Hueneme MTS focuses on the basic teaching act: student-teacher interaction. Simply stated, the project intends to demonstrate that intelligent use of technology significantly improves both the quality and quantity of student-teacher interactions. Used here, improved quality means interactions involving higher order thinking skills and, most often, the interactions are motivating as well. Quantity is self-defining.

HMTS evolved from a technology development program begun several years ago, resulting in the E. O. Green Junior High School, "Smart Classroom." It began operation during the 1987-88 school year. The first step in the HMTS project is a second generation eighth grade "Smart Science Classroom" being assembled at Blackstock Junior High School.

Project Status- The current project room includes thirty-six individual learning stations. The heart of the instructional technology system is an interactive computer network which delivers the curriculum to the students in a highly individualized way. The curriculum is assembled from numerous curriculum suppliers who use dissimilar technologies. Mixing curriculum packages from different companies and then managing them electronically in a single seamless coherent system is the project's major technology achievement. Open electronic architecture makes it possible to add and modify electronic curriculum as needed.

Each student station receives visual, aural, verbal and numeric information from a computer linked network of central data bases. In addition to interconnected and individual stand- alone computers, the hardware includes a microwave satellite dish, video cassette recorders, color video camera, interactive laser disks, CD-ROM, telephone modems, touch screen, publication scanners, bar coding, graphics printers, and robotics.

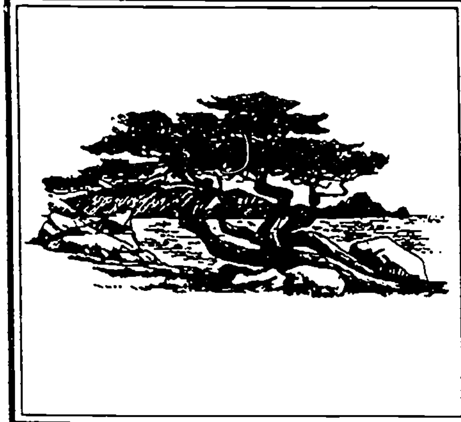
The Hueneme strategy uses instructional technology wherever and whenever it is demonstrated as effective or more effective than traditional methods. This approach frees the classroom teacher from lower level activities and allows him or her to teach in the most personalized way possible. Clerical chores, record keeping, routine test scoring, monitoring student effort and time on task, attendance, and maintaining individual student records are all automatically done by machines. The teacher remains in control and informed about individual student progress.

A comprehensive profile is maintained, minute by minute, on each student. The student profile assesses each individual's learning style, tracks individual progress, diagnosis, and prescribes the next pertinent learning task; and then, the management system delivers the appropriate curriculum segment to each student at the precise moment it is needed.The Hueneme District expects higher performance and higher morale from both the participating students and the involved teachers. They also expect students to become better learners and become more socially adaptive as a result of a personalized education made possible through technology. Subsequent HMTS phases expand the process to grade eight reading/ language arts/literature, math, social studies, and industrial arts. Next, these courses will extended into grade seven, and then into the elementary and secondary schools.

Visitations- Interested visitors should contact Dr. Richard Miller's office at (805) 488 3588.

(l-r) Nikki Davis, Dr. Richard Miller, Tom Haas, Dr. Don Cody

Dr. Richard Miller, Director, Hueneme Model Technology Schools (805) 488-3588
Hueneme School District, 205 N. Ventura Road, Port Hueneme, CA 93041



Monterey Peninsula Unified School District

School Information:

School	Principal	Grade	Total	Asian	Black	Hispanic	White	Other
Manzanita	J. Lamb	K-5	384	15%	43%	15%	15%	12%
Ord Terrace	R. Smith	K-5	591	13%	27%	15%	37%	8%
King	R. Breding	6-8	644	11%	33%	10%	40%	6%

District

Monterey Peninsula Unified School District

Management Team Members

Management: Gerry Montgomery, Director; Kam Matray, Training Coordinator; Bill Bear, Curriculum Coordinator; John Cradler, Research Coordinator.

Project Focus

The major purpose of the Project is to develop a model for the cost-effective implementation of educational technology at the classroom level. This is accomplished through the implementation of a school-based decision making approach which systematically integrates a variety of technologies into curriculum and instruction. The instructional strategies in the project emphasize the development of "proactive behaviors" of students across the curriculum areas. "Proactive behaviors" include student demonstration of higher order thinking skills and interest in school. Academic skill acquisition is enhanced through the integration of educational technology into the core curriculum areas.

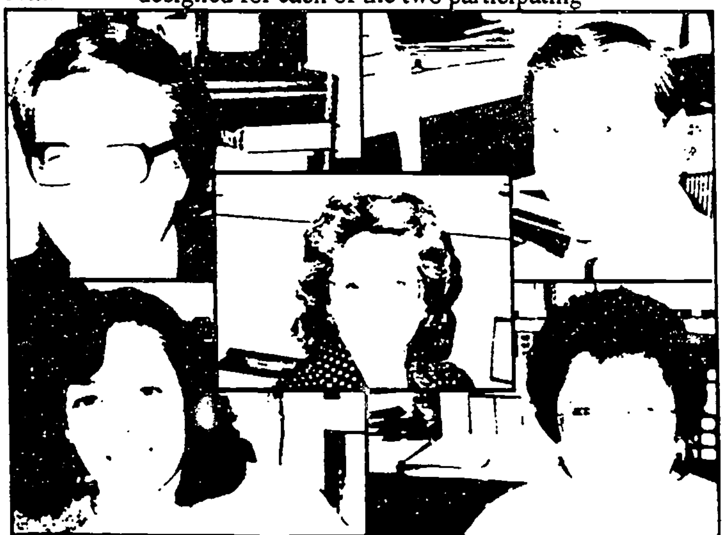
A secondary purpose of the Project is to implement a computer-based school management system. The three components of this system will facilitate intra-district administration of student information, increase teacher productivity and improve home-school communications and relations.

A long range goal for MMTS is to develop, validate, and disseminate specific cost-effective classroom technology-based and student-centered intervention programs and practices with specific guidelines for other districts on how to adopt or adapt them.

Project Status

The Research and Evaluation team, with the MMTS staff, project teachers and other district staff, devised a coordinated planning process to facilitate the development of operationally defined and targeted Classroom Intervention Plans (CIP). Each teacher, individually or as part of a team, developed a CIP which clearly describes student needs, technology and/or student centered intervention objectives and strategies, implementation activities, necessary professional development, materials, anticipated dissemination products, an activities time line, and estimated costs.

The planning process motivated and stimulated innovative uses of technology to foster proactive behaviors while at the same time addressing individual student needs. Over 50 such projects have been designed for each of the two participating elementary sites and the middle school. The CIP process has involved the systematic application of a variety of technologies to include: instructional television, computers, interactive laser-disc, calculators, and telecommunications. The CIP projects target specific student populations including Special Education, bilingual, low achieving, GATE, and regular education students.



clockwise from top left: John Cradler, Bill Bear, Pam Yoshida, and Kam Matray. Director Gerry Montgomery (center)

The MMTS is nearing the completion of the second project year. The original design was for a school level phase-in over three years beginning with elementary and ending with senior high. Year one was the planning and development year for the two project elementary schools. The evaluation showed that there was an increase in teacher awareness of student-centered teaching and the application of educational technologies into the curriculum. This second year has seen the development of CIPs at both the elementary and middle school level with the elementary CIP implementation phase approximately two months ahead of the middle school. The middle school phase-in has proceeded at a slightly more rapid pace than originally envisioned.

If funding continues beyond June 1989, the elementary and middle schools will continue this implementation phase during year three. The senior high will plan and develop their CIPs in the fall and begin implementation in the spring semester. It is anticipated that some elementary and middle school CIPs will be packaged and ready for dissemination next fall.

Aditional information

For further information or to arrange a site visit, please call, or write to Ms. Gerry Montgomery at the address below.

Ms. Gerry Montgomery, Director, Monterey Model Technology Schools (408) 899-1517
Monterey Peninsula Unified School District, P.O. Box 1031, Monterey, CA 93942

Model Technology Schools Project of Los Angeles

Los Angeles Unified School District

District and Schools- The Model Technology Schools Project of the Los Angeles Unified School District includes four year-round schools in the Bell Complex. The schools are Corona Avenue School (K-5), Loma Vista Avenue School (K-5), Chester W. Nimitz Junior High School (6-8), and Bell High School (9-12).

The total enrollment in the Project schools is approximately 11,248. This total is based upon an enrollment of 2,095 at Corona; 1,709 at Loma Vista; 3,475 at Nimitz and 3,969 at Bell High. The ethnic composition of the combined student population in the four schools is: 93% Hispanic, 5.0 % White, and 2.0% Other Minority. Corona and Loma Vista average 54% Limited English Proficient (LEP) students in grades K-4 and 34% in grade 5. Nimitz averages 14% LEP students in grades 6-7 and 11% in grade 8. Bell High averages 12.3% LEP students in grades 9-11 and 10% in grade 12.

Management Team Members- The Project Management Team consists of Helen Kelly, Project Director; Ted Snyder, Training/Curriculum Coordinator; the four school principals, and the three site coordinators. The site principals are Ed Losch, Corona Avenue School; Ricardo Sosapavon, Loma Vista Avenue School; Guadalupe Simpson, Nimitz Junior High School; and Mary Ann Sesma, Bell High School. The site coordinators are Michele Parga, Corona Avenue School; Joan Harman, Loma Vista Avenue School; and Diane Greer, Nimitz Junior High School.

Project Focus- Since many students in the Project schools have a home language other than English and need to improve their listening, speaking, reading, and writing skills in English, it was decided to focus on and emphasize the English/ Language Arts portions of the curriculum. It was always clear that a Project which has significant impact upon students' capabilities in language arts could have far-reaching, positive consequences across all other curricular areas. We have, therefore, attempted to create bridges to all other areas of the curriculum whenever it was possible and practicable.

Project Status- Currently the Project's Development Team teachers and students are using a wide variety of technologies in several areas of instruction in an attempt to provide an extremely high level of visual, auditory, kinesthetic, and cognitive stimulation which may be minimal in our inner-city students. The technologies being utilized in this Project feature computers which are used to provide access to software and courseware, and to control and interact with a host of peripheral devices. These devices include printers, videodisc players, cd-rom players, networks, modems, graphics scanning devices, video digitizers, special measuring devices, color video display monitors, and video cassette recorders. The video production component includes color video cameras, video cassette recorders (portable and stationary), editing source and record video cassette recorders, editing controllers, audio dubbing equipment, audio mixers, and special color video display monitors.

In the process of infusing the technology into instruction, each teacher who volunteered to participate as a member of a school site Development Team received a baseline of training. This baseline included training on the various technologies, State and District curricula, and methods of integrating the technologies into instruction. The training program, together with the infusion of technology at each school site, has made it possible for us to empower teachers for more effective instruction. This, in turn, has made it possible for the teachers to empower students as they embrace the tools of technology and the highly-motivating instruction.

The Project was designed to be fully implemented in three years. The two elementary schools were implemented the first year, the junior high in the second year, and the high school will be implemented in year three. We are currently completing the second year of implementation.

Visitations- Visitations to the Project schools will be limited because of the ending of this academic year, but we will be able to accommodate an expanded visitation schedule beginning in August, 1989. If you wish to visit a Project school in the Los Angeles Unified School District, please call the Project Director, Helen Kelly, at (213) 560-2481 to make the necessary arrangements.

Mrs. Helen Kelly, Director, Bell Complex Model Technology Schools (213) 560-2481/2482
Los Angeles Unified School District, Bell High School, 4328 Bell Avenue, Bell, CA 90201

CUE Conference Edition

Be sure to attend the sessions presented by the six California Model Technology Schools. On Friday, you can review project status and on Saturday, you will be able to observe specific examples of technology implementation.

District- Sacramento City Unified School District

Schools- The Sacramento Model Technology Schools Project involves three schools—Edward Kemble Elementary School, C.M. Goethe Middle School, and Luther Burbank High School. Located in south Sacramento within approximately two miles of each other, this cluster has a total enrollment of approximately 3,000 students. Nearly 80% are from minority families with Blacks comprising about 46% of the total population; Hispanics, 22%; Whites, 19%; Asians, 12%; and American Indians, 1%. Over 50% of the students served by the project come from families receiving AFDC, and the transiency rate at all schools exceeds 70%.

MANAGEMENT TEAM MEMBERS:

Director:
Barbara Warner

Training Coordinator:
Carol Bly

Curriculum Coordinator:
Nancy Wai

Research Coordinator:
Dr. Eleanor Chiang

Principal, Edward Kemble Elementary:
Rovida Mott

Principal, C.M. Goethe Middle School:
Dr. Mario Soberanis

Principal, Luther Burbank High School:
Laura Broussard

Project Focus- Designed to utilize technology in all of its facets, the Sacramento Model Technology Schools Project includes an information resource center, classroom student and teacher workstations, an authoring workstation, administrative workstations, and home based programs at each site. The curriculum thrust within the project emphasizes critical thinking skills and focuses on writing across the curriculum.

Technology training has addressed the use of a wide variety of hardware (computer, video, and communications) as well the use of specific software packages. Representatives from all three sites have also participated in a video production course. In addition, teachers have become familiar with the state framework and model curriculum standards in language arts and have received instruction in curriculum development. Training has also included IMPACT training (critical thinking) and many workshops on the writing process.

Research is being conducted in both the cognitive and behavioral areas, and graduate students have been trained to collect data in the classrooms. In addition, four other projects are being conducted by independent researchers. A variety of baseline data has been collected, and this collection process will continue through the years to insure the adequacy of information and the accuracy of the results.

Project Status- At Kemble, teachers are further developing their skills as they create technology-integrated, thematic instructional units. Teachers at Goethe have participated in a variety of training sessions throughout the year. while site capital improvements have been taking place. A core of teachers and administrators at Burbank has been working to complete their site plan.

Visitations- Visitations are being done on Wednesdays. Groups desiring to visit the Sacramento MTS Project may write or call the project office listed below.

(l-r) Research coordinator Dr. Eleanor Chiang, director Barbara Warner, training coordinator Carol Bly and curriculum coordinator Nancy Wai.

Ms. Barbara Warner, Director, Sacramento Model Technology Schools (916) 454-8669
Sacramento City Unified School District, 4701 Joaquin Way, Sacramento, CA 95822

California Model Technology Schools

Partners in the success of the Model Technology Schools Project

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Egghead Software
EISI, Educational Industrial Sales Incorporated
ESC, Educational Systems Corporation
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First Byte Inc.
Fosselman's Ice Cream Parlor
Fremont Union High School District
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GM Communications
GTE/GTEL of California
Hartley Software
Hueneme Elementary School District
Humanities Software
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Inacomp Computers, Covina
Jonsson Foundation
KQED, San Francisco
Lawrence Livermore Laboratories
LCSI, Logo Computer Systems, Inc.
Learning Company
LEGO Systems, Inc.
Lego Educational Systems, Inc.
Logo Computer Systems, Inc.
Los Angeles Educational Partnership
Los Angeles Unified School District
Mau, Haidet, Hyde, and Schroeder, Architects and Planners
MECC
Media Learning Systems
Microsoft
Midwest Publishing
Mindscape
Monta Vista High School
Monterey Peninsula Unified School District
National Geographic
Optical Data Corporation
ORT House
Pacific Telesis
Pepperdine University
Pinpoint
Pioneer Communications of America, Inc.
Priority One Electronics, Chatsworth
Random House
RETAC
Sacramento Educational Cable Consortium
Sacramento Unified School District
Scholastic Software
Silver Burdett & Ginn
Software Management Service
South Coast Writing Project, Graduate School of Education, UCSB
Southwest Regional Laboratory
Studio Spectrum, Inc.
Styleware Software
Sunburst
The T-Shirt Clinic
Tandy Corporation
Teaching Technologies - A Division of M.W.E.I.
Tom Snyder Productions
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University of California, Davis
University of Southern California
VELAN
WASATCH Educational Systems
Whitney Educational Services
Whittier City School District, Orange Grove Ave. Elementary School
WICAT Educational Systems

California State Department of Education, Educational Technology (916) 324-7241
721 Capitol Mall, Sacramento, CA 95814

Cupertino School District
10301 Vista Drive
Cupertino, CA 95014

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APPENDIX B:

FRAMEWORK FOR REPORTING MTS RESULTS

Final Research Questions

Second Year MTS Research Report

1. Questions About Implementation:

   a. To what extent was the MTS project implemented as planned? (including such things as philosophy/goals, capital improvements, hardware and software acquisition, other materials, training, curriculum development, partnerships, etc.)
   b. Which implementation strategies were used and how successful were they?
   c. Which factors affected the implementation of the MTS project?

2. Questions About Curriculum:

   a. What impact did the MTS project have on the content of the curriculum?
   b. What impact did the MTS project have on the organization of the curriculum (e.g., multi-disciplinary projects, etc.)?
   c. What types of curriculum materials and instructional technology products were developed as part of the MTS project?
   d. In what ways, and to what extent, was technology integrated into the curriculum?

3. Questions About Instruction:

   a. What impact did the MTS project have on instructional practices?
   b. In what ways and to what extent was technology used in instruction?
   c. How did changes in instruction affect other aspects of the MTS project?

4. Questions About Students:

   a. How did the MTS project affect students' behaviors (attendance, classroom interactions, products, learning styles, etc.)?
   b. How did the MTS project affect students' attitudes?
   c. How did the MTS project affect students' achievement?
   d. Did the MTS project promoted equity of access to technology?
   e. Which elements of the MTS project had the greatest impact on students?

5. Questions About Teachers:

   a. How did the MTS project affect teachers' behaviors (planning, management, productivity, etc.)?
   b. How did the MTS project affect teachers' attitudes (regarding technology, regarding learning and instruction, regarding students, etc.)?
   c. How effective were MTS staff development activities?
   d. Which elements of the MTS project had the greatest impact on teachers?

6. Questions About Other Staff:

   a. How did the MTS project affect other school staff (administrators, office staff, classroom aides, etc.)?
   b. Which elements of the MTS project had the greatest impact on other staff?

7. Questions About School Management and Organization:

   a. How did the MTS project affect the relationships between administrators, teachers, students and other staff (roles and responsibilities, lines of authority, methods of communication, etc.)?
   b. Which elements of the MTS project had the greatest impact on school organization?

8. Questions About School/Community Relationships:

   a. In what ways were parents involved in the MTS project?
   b. What impact did the MTS project have on parents?
   c. What impact did the MTS project have on other community organizations and businesses?
   d. How did other community organizations and businesses affect the MTS project?

Final Outline for the

Second Year MTS Research Report

Please organize your report according to the following format.

I. MTS Goals and Activities. A brief discussion describing the MTS "treatment." This includes the philosophy or goals that guide the program and a chronology of the equipment that has been acquired and the staff development that has occurred. In other words, what are the MTS "inputs" that have caused the changes you've been studying. Much of this information can be drawn from existing sources. For example, the concise descriptions from the convention issue of the Newsletter contain good overall project descriptions. A timeline of important technology and training interventions would be particularly helpful. (Suggested length: 2-3 pages.)

II. Procedures. It will probably be clearer, more concise, and more natural to have a single discussion of data collection and analysis at the beginning of the report. However, you should use your own judgment about whether to have a single discussion of procedures or to have separate discussions relating to each research question. In either case you should include all the issues that are normally addressed when describing research and/or evaluation procedures: sampling, instrumentation, data collection, and analysis. You may wish to discuss data analysis in general terms at this point, and add specific supplementary comments about statistical techniques as you review each of results. The procedures section should contain the following information. [Note: A quantitative example was chosen to illustrate the format, but the outline should apply equally well to qualitative data.]

A. Data Collection (e.g., Both direct and indirect measures of students' attitudes were obtained. The former included a standardized measure of student attitudes toward technology and a district-developed questionnaire on school satisfaction. Indirect indications of students attitudes were drawn from data on students' choice of activities, as well as changes in attendance, discipline problems, and vandalism, etc.)

1. Sampling (e.g., Information on attitudes was gathered from all students in classrooms of cadre teachers, and from all students in a random sample of non-cadre teachers, etc.)

2. Instruments (e.g., The Stecher-Washington survey of pupils attitudes toward technology was one measure that was used. In addition, etc.)

3. Administration (e.g., Stecher-Washington surveys and district-developed questionnaires were administered in the fall and spring of the second project year, etc.)

B. Data Analysis (e.g., Surveys and questionnaires were analyzed using standard quantitative procedures. Frequency counts, means and standard deviations, as appropriate, were computed for each survey item. The Stecher-Washington survey produces three sub-scale scores: interest, information, and intuition, but only interest and information were deemed to be relevant to this project, etc.)

III. Research Results. This will be the lengthiest part of the report. Address only those research questions for which you have meaningful data. I realize that no project will have answers to all the question. Please use the following format for each research question you respond to:

A. Question. (e.g., How did the MTS project affect students' attitudes?)

B. Data Analysis [optional]. You may find that some discussion of data analysis is appropriate for each research question. If specific analyses were conducted to answer a particular question, they should be described at this point. (e.g., A dependent samples t-test was used to test the significance of the pre-test to post-test differences in S-W sub-scale scores across classes and an analysis of variance on post-test minus pre-test difference scores was used to examine between-classrooms differences. Item means were calculated for each question on the district-developed questionnaire, etc.)

C. Results. Here is where you answer the question. Be as direct as possible, and state things at an appropriate level of generality, i.e., don't say "positive impact on students' attitudes" if you all you have are responses to one item about liking computers drawn from a student survey. (e.g., The project had a significant impact on students' interest in and information about technology. There was a statistically significant difference between students spring and fall scores on the Stecher-Washington interest and information scales indicating overall improvement in attitudes toward technology. At the same time, there were significant differences between student scores in two of five classes. This is evidence of strong classroom effects that may be associated with teachers or with the particular group of pupils assigned to a teacher. Other indirect measures of attitudes also improved over the course of the year, etc.)

D. Discussion. The discussion/implication section gives you an opportunity to clarify the meaning of the results. This might include comments, of whatever length you feel is appropriate, about the interpretation of the findings. What other information or caveats should be considered when reviewing the data? What do the results mean in terms of the MTS project? How can you explain or illuminate surprising or unanticipated results? Let's be cautious not to over interpret the results. (There will be a final section at the end where you can speculate on the implications of the research, if you feel that is warranted.)

(e.g., The Stecher-Washington survey addresses two aspects of students attitudes -- students' interest in and information about technology -- and the significant growth on this scale provides strong evidence of the impact of the MTS project in this domain. There was less evidence of change in the indirect indicators that might be associated with improved attitudes. However, such changes should occur slowly, and one might not expect to see significant difference over such a short period of time. These measures will be monitored during year three to look for evidence of the cumulative impact of MTS, etc.)

IV. Implications/Recommendations. If you feel it is warranted you may also discuss what you and the project staff think the information means for the MTS project and for education.

By the way, if you are planning to collect data to answer a question at some future date, you may want to indicate the data sources and the time at which you anticipate being able to provide relevant results. Think about both short-term (summer and fall) and long-term (at the end of year three, four and/or five) activities. It would be nice to say that we will have information to answer certain questions in another year (or two), if the project continues as planned.

It is not necessary for you to include <u>all</u> of your findings in this report. There should be a place for all the results you think are important, but there may not be a place for every single finding.

Attached you will find a summary of the research questions I would like you to use to organize your report. In addition, there is a summary sheet you might use to indicate exactly which questions you have data to address and which you do not.

Second Year MTS Research Summary Sheet

________________ MTS Project

RESEARCH QUESTION	WERE DATA COLLECTED TO ANSWER THIS QUESTION? YES	NO

QUESTIONS ABOUT IMPLEMENTATION

a. To what extent was the MTS project implemented as planned? (including such things as philosophy/goals, capital improvements, hardware and software acquisition, other materials, training, curriculum development, partnerships, etc.)
b. Which implementation strategies were used and how successful were they?
c. Which factors affected the implementation of the MTS project?

QUESTIONS ABOUT CURRICULUM

a. What impact did the MTS project have on the content of the curriculum?
b. What impact did the MTS project have on the organization of the curriculum (e.g., multi-disciplinary projects, etc.)?
c. What types of curriculum materials and instructional technology products were developed as part of the MTS project?
d. In what ways, and to what extent, was technology integrated into the curriculum?

QUESTIONS ABOUT INSTRUCTION

a. What impact did the MTS project have on instructional practices?
b. In what ways and to what extent was technology used in instruction?
c. How did changes in instruction affect other aspects of the MTS project?

QUESTIONS ABOUT STUDENTS

a. How did the MTS project affect students' behaviors (attendance, classroom interactions, products, learning styles, etc.)?
b. How did the MTS project affect students' attitudes?

RESEARCH QUESTION	WERE DATA COLLECTED TO ANSWER THIS QUESTION? YES	NO

c. How did the MTS project affect students' achievement?
d. Did the MTS project promoted equity of access to technology?
e. Which elements of the MTS project had the greatest impact on students?

QUESTIONS ABOUT TEACHERS

a. How did the MTS project affect teachers' behaviors (planning, management, productivity, etc.)?
b. How did the MTS project affect teachers' attitudes (regarding technology, regarding learning and instruction, regarding students, etc.)?
c. How effective were MTS staff development activities?
d. Which elements of the MTS project had the greatest impact on teachers?

QUESTIONS ABOUT OTHER STAFF

a. How did the MTS project affect other school staff (administrators, office staff, classroom aides, etc.)?
b. Which elements of the MTS project had the greatest impact on other staff?

QUESTIONS ABOUT SCHOOL MANAGEMENT AND ORGANIZATION

a. How did the MTS project affect the relationships between administrators, teachers, students and other staff (roles and responsibilities, lines of authority, methods of communication, etc.)?
b. Which elements of the MTS project had the greatest impact on school organization?

QUESTIONS ABOUT SCHOOL/COMMUNITY RELATIONSHIPS

a. In what ways were parents involved in the MTS project?
b. What impact did the MTS project have on parents?
c. What impact did the MTS project have on other community organizations and businesses?
d. How did other community organizations and businesses affect the MTS project?