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ABSTRACT

This report describes the development and field testing of a federally funded model designed to integrate technology into the high school curriculum of students with disabilities. In this second phase of a 5-year study, six high schools located in four school districts were used to evaluate the model. The model is based on the premise that technology integration is a district- and school-wide process of organizational innovation, which requires a coordinated program among administrators, trainers, technical support staff, teachers, and students. A manual describing the model and providing materials and recommendations in each of the four interconnected domains (administrative, human resources, material resources, and instructional applications), was developed and distributed to participating sites. Results indicated the model of technology integration was a useful conceptual tool for schools undertaking or involved in the technology integration process and provided a framework for decision making and policy formulation. As a result of the evaluation, however, the manual was reorganized to concentrate on practical concepts useful to those planning and implementing technology use in the schools. The report describes the different domains of the model, provides analytical summaries of the field sites, and discusses the results of the technology survey and other substudies. (CR)

Final Report

Phase II

Evaluation of the Integration of Technology for Instructing Handicapped Children (High School Level)

Submitted to:

Office of Special Education Programs
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by:

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Chapter I

Introduction: Review of Research Questions and Methods

Chapter I. Introduction: Review of Research Questions and Methods

During the past decade, increased attention has been focused nationally on education, often associated with the sense that something is *fundamentally* wrong with our school systems, whose graduates are too often ill-equipped to undertake the challenges either of the workplace or of higher education. Furthermore, perhaps as many as 25 percent of all high school students fail to reach graduation. Not surprisingly, this has been a time, as well, of talk about a "revolution" in education, "paradigm shifts" and "restructuring." Underlying much of this talk is the recognition that the introduction of the computer as a normal educational tool has far-reaching implications that challenge some of the most fundamental methods and assumptions about the educational enterprise. Chief among these is the individualization of the instructional process, which enables students to explore information and develop skills at their own pace. The benefits of such individualization for mildly retarded and learning disabled students have been widely explored and documented. What has received much less attention, however, is the organizational setting itself, that is, the social and cultural factors that enable technology integration.

This monograph reports on a five-year research project, "Evaluation of the Integration of Technology for Instructing Handicapped Children (High School Level)," which was carried out by Macro International (formerly Macro Systems) of Silver Spring, Maryland, for the Office of Special Education Programs, U.S. Department of Education (Contract No. 300-86-0126). The findings of this research support the premise that the needs and opportunities for computerized technologies in special education programs are dependent upon the degree of "technology integration" that exists in schools and districts generally. This point is underscored by the mainstreaming (85-90%) of special education students, which necessarily entails the close linkage of the environments of regular and special education throughout the United States.

Our research develops and tests a model of technology integration as an *organizational process* that entails four interconnected domains: administrative, human resources, material resources, and instructional applications. This model is presented in detail in Chapter Two. The point to be emphasized here is that our approach is holistic, emphasizing the social and communication processes that enable technology integration to take place. The current discourse of "restructuring" notwithstanding, educators and policymakers frequently focus their attention in the arena of technology on equipment and its technical dimensions and possibilities. Such an approach, while seeming to emphasize practicality, fails to take into consideration that technology is never, in reality, an isolable *thing*, but is, rather, a social and cultural artifact that, depending on its degree of utilization, is both informed by and informing of social relations, including cultural understandings such as values and beliefs.

It is, then, of compelling, *practical* importance that educators attend to the social dimensions that enable and sustain "technology integration." In particular, we find ongoing, effective communication between teachers and administrators to be a crucial component. For example, the introduction of computer equipment into a classroom does not, *ipso facto*, imply its effective utilization by instructors.

In this study we present a model of technology integration that synthetically represents our finding that, rather than being simply another classroom innovation, integrated technology has at least three major and interdependent components:

- Organizational structure and process for integration: coordination of resources and activities, management functions, creation of proper operational conditions (including classroom conditions), positions and responsibilities.

- Organizational culture (for example, norms and attitudes) that incorporates beliefs and knowledge about technologies: awareness of resources, expectations that technology will be regularly and effectively used for instructional purposes.

- The practice of integrated instructional technologies in a full and complete manner: the organizational structure is actually used to obtain resources, applications are implemented in classrooms and elsewhere, and there is ongoing evaluation of current and future instructional applications. While many of these practices will be most easily seen in the classroom, this component is underdeveloped and irregular without the development of the first two components.

I. Technology Integration

The term "technology integration" requires some clarification before proceeding further, because of the diversity of meanings attached to it. Often, the term "technology integration" is used in a way that emphasizes the integration of computer methods into instructional programs per se. We employ the term here in a manner that includes, but is not restricted to instructional applications.

A. Technology

The term technology, used in an education setting, invokes thoughts of the multiplicity of computer-related technologies that have become available over the last few years. These include personal computers, computer networks, telecommunications, voice mail, the numerous computer peripherals used in both regular and special education, and the software that makes use of these technologies possible. These technologies are part of what we mean when we use the term technology. However, the term as we use it here, encompasses more than just the physical implements. In its broadest sense, technology refers to the full range of tools, activities, procedures and knowledge used to achieve particular functions. In the case of schools, the function is schooling (including the components of instruction, administration, evaluation, acculturation, and all of the other dimensions of schooling in today's complex conditions). With computer systems in particular, the technology itself has relatively high requirements for development, support, and management. Because of these requirements, technology integration is a complex task, requiring more than just the purchase of high tech machinery.

B. Integration

For some time schools have been acquiring computer-related technologies and teachers and students have been trained in the basics of the equipment's use. At first computers were seen as a subject in themselves, and courses were taught in computer programming. As computers have become more common in society and have gained a greater ranger of uses, educators have begun to realize that such technology can substantially contribute to the educational process. However, instead of just focusing on teaching about computers, technology must be incorporated into the schooling process in a regular, on-going, and central way. This incorporation is frequently referred to as technology integration.

In our model, technology integration is viewed as a district- and school-wide process of organizational innovation, involving many domains of school procedure and experience, and requiring a coordinated program among administrators, trainers, technical supporters, teachers, and students. A key recognition of this perspective is that integrating instructional computer technology involves far more than technical implementation.

Technology integration activities are pursued in different divisions and at different levels of the school organization by different players who pursue a variety of goals. The support that enables effective implementation of technologies by teachers and students comes from a range of staff and divisions. Although the goals of technology integration are at the core instructional, the structure of the school system and the processes within that structure which affect computer use may be more complex.

II. Technology Integration as Organizational Process

By definition, and in practice, technology integration must be an organizational issue. The term "organizational" suggests a process that is directly or indirectly affected by a variety of actors and forces, and which results from their interaction within a common enterprise. In this case the enterprise is schooling within a given district. The actors are different players in the school district, including both administrators and teachers. The forces mentioned include the wide variety of systems, structures, and constraints that drive and direct the actions and interactions of individuals within the school district. Because technology integration is an organizational process, it cannot be viewed as a linear, unidimensional activity. Instead, activities that relate to technology integration occur concurrently throughout the school system at different levels of the schooling process.

We particularly see technology integration taking place at two levels of schooling. First, at the level of school structure, integration means that the knowledge, resources, and values to easily apply computer technologies to instructional purposes are institutionalized, that is, they are a normal and accessible part of the school or district organization.

Second, in everyday action and operation, educators use the skills and materials to choose and apply computer technology in instruction when appropriate. Consideration of such tools is the norm, rather than the exception.

Thus, in integrated conditions, school personnel routinely decide on the use of computers to meet the needs of individual students or program objectives. They have the competence to do so, and to execute their choice with accessible resources and support.

Given the nature of technology use in the schools that this model presents, the use of technology by students with disabilities can be seen as one element of a larger organizational process. Our experience shows that effective technology use by special education faculty and students almost always depends on the state of technology integration in the schools. Thus, as we consider technology use by special education departments, we must consider technology integration in the entire school system.

The characteristics of the technology itself plus the concept of technology as a tool for schooling define integration as an organizational issue and activity. In keeping with this understanding, the model developed here concentrates on the *system* of interactions, decisions, and activities that occurs in school districts.

III. Research Methods and Goals

Macro's multifaceted approach to this project has enabled us to examine technology integration both in its broadest terms and in its specific applications. Our research took place in two phases: first, the development of a comprehensive model of technology integration and an exploration of its implications, especially in the area of special education; and second, a period of evaluation of the model and its utility, when presented as a manual, to stakeholders and decision-makers in the technology integration process. During the first, formative stage, which extended from 1986 to 1989, we made a comprehensive review of the literature and consulted extensively with educators, administrators and industry leaders. Our research also included an ethnographic component, with observations and interviews in two districts and nine high schools. Our objective during this phase was to synthesize our findings about optimal technology practices in a model that would be both descriptive of the processes entailed and prescriptive for school systems involved in decision making about technology.

The second phase of the research, from 1989 to 1991, entailed the participation of four school districts and six high schools, in an evaluation of our model, through interviews of key personnel, observations of relevant events, such as technology committee meetings, the collection and examination of archival materials, such as technology newsletters and policy statements, and administration of a technology survey, to examine teacher attitudes and practices. A manual presenting the model and providing materials and recommendations in each of the domains was developed and distributed to key personnel in each of the participating sites.

IV. Presentation of the Model and Related Materials as a Manual

From its inception, Macro has viewed the project, "Evaluation of Technology Integration for Instructing Handicapped Students (High School Level)," as an opportunity to contribute to the research of technology use in education and to provide assistance to educators in meeting the challenges identified through that research. One result of this five-year study has been a manual targeted to educators for use in creating technology integration in their school system.

At the project's outset, Macro posited the need for a practical and applicable outcome for its research. While research can be extremely useful in understanding phenomena in the schools, school personnel often lack the time required to translate such research into practice. Thus, the manual we have developed explicates the principles of effective technology integration, helping those who plan and implement educational technology use to understand the myriad aspects of successful technology integration.

Inasmuch as we agree with Kurt Lewin that there is nothing so practical as a good theory, we have based our manual on an organizational model of technology integration. The model allows practitioners to consider technology integration as an interaction of activities and processes within a set of four distinct but interrelated conceptual domains. Understanding those domains and the interactions among them allows educators to create effective systems which promote technology integration.

The manual is not a cookbook; that is, it offers no simple recipes that will result in "the" perfect technology integration. Instead, it presents concepts the practitioner should consider which will influence the effective use of technology. It also offers conceptual tools a user can employ in creating the systems important to technology integration. In order that it be useful to the educator, the model was based on the principles of practicality, flexibility, and process orientation.

- Practical application was an objective of our research from the beginning of our project. The manual is targeted clearly to educators, particularly administrators, support staff, or teachers in a position to promote technology use. The manual is organized according to a set of conceptual domains in which the processes and activities important to each domain are explained and questions posed that can lead users to develop technology appropriate to their setting.

- Flexibility allows the model to be integrated with local goals and objectives. That is, in fact, an idea we emphasize throughout the manual. Desired change is more likely to occur if changes are based on the needs of the system in question. Thus, this model allows for flexibility by suggesting fundamental concepts and questions whose answers are appropriate to each site.

- Macro's model is process oriented, rather than linked to specific technology. Consequently, it can be applied to schools and districts without regard to their current implementation status--though it does allow users to evaluate the development of their implementation.

By using these principles as a guide in creating the model, we hope it will be replicable in most schools. The manual is a logical extension of the model, seeking to make accessible to the practitioner the ideas incorporated in the model. Those persons responsible for coordinating or directing computer use in the schools should be able to take this manual and help create an effective strategy and a definite plan for technology integration.

A. History

The Manual is based on a model of technology integration that has its roots in previous research conducted by Macro for U.S. Department of Education's Office of Special Education Programs (OSEP). This earlier research indicated that the effective utilization of educational technology is a process that engages actors at various levels and that requires the support of administrators. This work was complemented by research on planning for technology, also sponsored by OSEP, which emphasized the relationship between administrators and teachers as crucial. In the early months of the Technology Integration Project, Macro began to develop a model of technology integration. This model has undergone substantial development as we have continued research on technology use in the schools. Though the basic structure of the model has remained unchanged, our depth of understanding of that structure and the meaning of the interactions among its elements has increased.

The technology integration model became a foundation for Phase I of Macro's research on this project. The first year of research involved a case study approach using the model as a guide. This research substantiated the general conception of the model, and provided evidence of the nature of the activities and processes that occurred within schools as they sought to utilize technology.

Two activities that were initiated in the first year were expanded during the second year: (1) development and evaluation of a technology assessment mechanism (survey); and (2) updating and analysis of the Research Taxonomy. The third major research activity conducted was a survey of mildly cognitively impaired high school students in the two participating school districts. The survey focused on two principal constructs: analysis of student curricula, and analysis of instructional applications of computers, in both resource and mainstream classrooms. A secondary analysis of data provided by the Psychological Corporation was also conducted, to supplement the curricular analyses. The results of these research activities are reported in subsequent chapters of this monograph, especially Chapters II, IV and V.

During the third year, staff began applying their data to further developing the model. Its development coincided with preparation of the Phase I research report and a practical manual to be used by educators involved in using technology. The manual was created to provide a model of effective technology integration that could be replicated by schools in any district.

At this stage in the project's development, the role of the Manual was only partly understood, combining a number of elements of the research project. It was part research report, part conceptual explanation of technology integration, and part specific guide to technology use in the schools. These three themes were interwoven throughout the content of the manual. Once completed, it was distributed to administrators and teachers in our initial research sites as well as in three new districts we worked with in Phase II.

Phase II of the project was an evaluation of the Manual and the model's relevance to the schools. The Manual as a mechanism and the model it contained were to be evaluated over two years in terms of presentation, relevance, and usefulness. With the information gained during this evaluation, the Manual would be revised to better facilitate technology integration.

Phase II research resulted in a number of important insights into the model and the manual that communicated it. Among the insights gained are the following

- The manual's purpose as a conceptual tool must be explicit.
- The manual must be focused to a particular audience who can use its concepts to change the systems in a school setting.
- The manual's presentation should make concepts readily and easily accessible.
- The manual should provide resources for special educators, e.g., lists of software producers that specialize in special education materials.
- The manual should offer concrete examples to illustrate the principles and concepts presented.

During the final year of this project, Macro staff, with the help of its advisory committee, evaluated the manual for content and presentation. The general consensus of manual users and evaluators was that the content of the manual was useful, but that it was hard to wade through it. A number of people also commented that they were not sure what the manual's purpose was. Many people asked that we include step-by-step instructions for establishing technical systems, such as a LAN and a library circulation system.

From our discussions with those persons who used the manual, and those who didn't, it became clear that the major task for the manual's revision was to identify who the manual user would be, and prepare a manual targeted to those individuals.

Our research and the contributions of our advisors led us to revise the manual in the following ways.

- Target the manual's content to those individuals who are able to lead and create changes in the systems that affect technology integration.
- Reorganize the manual so that the presentation allowed for quick recognition of the purpose of the manual, while at the same time retaining the depth necessary to develop the concepts important to technology integration.
- Concentrate on practical concepts useful to those planning and implementing technology use in the schools. However, the emphasis is on conceptual application, not explanations of technical processes. Detailed descriptions of technical issues were deleted.

The development of this manual has extended throughout the length of the entire project. We knew from the beginning of the project we wanted to create something educators could use to improve the effectiveness of technology use in the schools. Though the process was a lengthy one, we feel we have created is a truly useful product.

B. Structure

The manual's structure is based on the model and on the recognition of its users' needs. It has been written with the idea that it would be used by someone who would be in a position to affect computer use throughout a school system, whether that is at the building or district level. For that reason, it is not aimed at teachers but at administrators and staff who have the responsibility to oversee technology use in the school building or district. Our experience suggested that these busy individuals require a manual that is easily accessible, as well as having the depth that someone interested in comprehensive integration needs. In addition, it had to be organized in such a way that a potential user could quickly identify if this was a useful tool for his or her organization.

The manual is geared to capture the attention of the practitioner, making the information in it accessible without sacrificing the depth necessary in considering technology integration. One way we accomplish this is by extensive cross-referencing. Whenever a term or concept is explained in more depth elsewhere in the manual, page numbers will follow it so readers can move to that section if they so desire. (In essence, this is a low-tech form of hypertext.) This occurs most frequently in the first two sections of the manual, which are designed as overviews.

To insure that this manual would have the best possible chance for use we have structured it in the following manner.

Easy Access —
- Introduction
- Overview
- Checklist

Depth —
- The Model In-Depth
- Resources

As this diagram illustrates, the manual has four main sections and an introduction that are divided into two general categories. The first allows the reader quick access to the purpose and concepts of the manual, while the second provides a detailed development of those ideas and resources for creating effective technology integration.

The introduction directly answers the following questions: What is the purpose of the manual? Why should I use it? How do I use it? This introduction comprises the first few pages of the manual in order to allow the reader to quickly determine if this is something useful.

The first section serves as an overview. It is designed to quickly capture the attention of the reader and demonstrate what the model is and how it might be useful. This section is cross-referenced to the rest of the manual, which allows the reader to quickly find any concept found to be interesting or important.

The second section is a checklist which allows users to evaluate the current development of technology integration in their school. It is also cross-referenced to the rest of the manual.

The third section contains the "meat" of the manual. It is divided into five subsections. The first develops the model and explains the principles that underlie effective technology integration. The other subsections each concentrate on a single domain and elaborate on the concepts, issues, and activities important to that domain.

The last section would normally be considered appendices, though they are presented here under the term resources. We have avoided the term appendix because we want to create the sense that the items in the last section can be valuable resources in technology integration, not just addenda we have added to the manual. The contents of this section are listed below.

A more detailed description of the manual contents follows.

Contents

Introduction

This section is found on the first few pages of the manual and is designed to answer the following questions succinctly.

- What is this manual?
- Why should I use it?
- How do I use it?
- Where did it come from?

Section 1: Overview

- A definition of technology integration as an organizational activity.

- A brief explanation of what constitutes each domain and how the domains are interrelated. These descriptions are accompanied by diagrams that illustrate different relationships between the domains.

- A case study draws readers into a situation they can identify with. It presents a series of situations common to a special education teacher that illustrate principles and activities that are important to technology integration. Throughout the case, there is discussion of ideas the case illustrates.

Section 2: Checklist

As mentioned above, this checklist provides readers with an opportunity to evaluate the current progression of technology integration in thier setting.

Section 3: Model of Technology Integration

Background

This section introduces the subsequent topics and outlines the discussion of the Model In-Depth.

Concepts

This section presents the concepts of technology integration, the model, and the principles that underlie the model.

- Definition and discussion of the following concepts

  - Technology
  - Integration
  - Technology Integration as an Organizational Process

- Presents the model and the concepts of the four domains, briefly describing what comprises each one. Then it explains in more depth how the domains are interrelated. It differentiates between direct and indirect influences among domains. This section presents a descriptive model and offers a prescriptive version of how the model could look.

- Here we explain the principles that underlie the model and the activities necessary to technology integration. These include

  - Leadership
  - Vision
  - Communication
  - Collaboration
  - Information Gathering
  - Flexibility

Instructional Applications Domain

This section concentrates on concepts important to the application of technology in the classroom.

- Considerations in organizing to enable computer applications in the classroom. These include issues such as how other domains enable instructional technology use and the special contribution teachers make in this process.

- Here we focus on teachers' requirements for applying instructional technology. While they have many, one of the most important we consider is time to plan technology use.

- Consideration in planning the implementation of instructional applications. This includes how to establish instructional goals, issues in assessing instructional possibilities using technology, sources of guidance in planning and using technology in instruction, and issues in evaluating particular applications.

- Issues in implementing and managing classroom computer technologies. These include planning lessons that incorporate technology use, organizing and managing classroom computer use, and evaluating instructional technology use.

Administrative Domain

This subsection describes the issues and activities important to the administrative domain.

- Discusses the importance of leadership and points out what form leadership should take in technology integration. It also discusses leadership roles and who fulfills them in an educational setting.

- Develops the concept of information gathering. Offers suggestions on different methods of collecting information and what types of information might be useful. It goes into some depth on the value of a technology survey and the how one might be used. The importance of a careful needs analysis is also discussed.

- Within this section the necessity of planning and the value of cooperative planning are discussed. Patterns of planning, the issue of centralized and noncentralized planning, and types of cooperation and collaboration are all considered.

- While the manual generally stays at a conceptual level, suggesting questions to ask and offering possible options, in this section it discusses two particular mechanisms: a technology plan and the computer or technology committee. Because technology plans and computer committees have proven to be such valuable and useful mechanisms to move and direct technology integration, we discuss them in some depth, including their content, purpose, and the processes that they help foster.

Human Resources Domain

- A presentation of the importance of creating and defining the appropriate roles necessary to technology integration. Particularly useful roles that research has documented are explained.

- All the elements that create a successful training effort are presented. We consider the questions listed below.

  What should training focus on? 1) The importance of developing a list of computer competencies based on the district's goals and 2) How to plan for the different levels of training required in a school district.

  How should training be delivered? This is a discussion of the elements important to actual in-service classes, including such concepts as methods, trainer characteristics, and scheduling.

  How do you promote participation in training? This section focuses on two important concepts in ensuring training reaches its target audience. The first is publicity. The second is the incentives that induce teaches to attend such training. A number of possible incentives are explored.

- The importance for technical assistance and the issues to consider in establishing such support are discussed.

Material Resources Domain

This section encompasses the physical aspects of technology integration, including hardware and software development, implementation, and management of physical resources.

- Suggests the steps required and concepts important in defining the purpose of technology use including obtaining information, needs assessment, feasibility, hardware placement, equity, etc. The end result will be a work plan for implementing technology use.

- Considerations in designing appropriate installations such as types of software applications needed and different hardware configurations.

- Consideration in designing management systems necessary for effective implementation and continued use. These include:

  Defining roles: Clear assignment of responsibilities for activities within the material resources domain

    Operational management systems: Consideration of security, maintenance, and supplies.

    Administrative systems: Discussion of various systems such as inventory,access procedures, and equipment storage and distribution.

    User support systems: Reiterates importance of user support systems and gives special consideration to issues as seen through material resource domain.

    Evaluation: Consideration is establishing system of evaluation of management systems.

- Discussion of concepts to consider in actual implementation of technical systems. Selecting and acquiring equipment, special equipment sources for education, testing, documentation, training, installation, and follow up.

- A checklist is included of all the steps important in the process of designing and implementing technical systems for educational purposes.

Section 4: Resources

- A section devoted to technology information, including sources of information specifically targeted to special education needs.

- A list of companies that produce educational software, specifying also companies that target special education needs.

- The survey used in the technology integration project with instructions on how to use and interpret it.

- Sample record of a software inventory and evaluation database.

- Evaluation criteria for identifying and assessing appropriate instructional software.

- A matrix to help teachers and administrators select software appropriate to their needs.
- Fact sheets describing different types of software applications and their utility to curriculum areas.
- A list of computer competencies a district might require of its teachers.
- A description of the Evaluation of Technology Integration Project (High School level) that Macro International, Inc. conducted.
- Index

V. Evaluation Questions and Methods

Having developed a model of technology integration and the first draft of a manual by which to make it available to practitioners, Macro International took the research into a second phase, a two-year evaluation of practices and the model's impact at specific sites.

The first phase of the research revealed that technology integration is an organization-wide effort that engages several organizational domains. The move toward technology integration clearly entails change and innovation throughout the organizational structures and processes of school systems. At the same time, local conditions, including teacher interest, administrator-teacher interaction, school size and budget introduce a high degree of variability into the movement toward technology integration. We have evaluated our model in a way that incorporates consideration of these local conditions through a case study method.

Observations took place in four districts over a two-year period and included semi-structured interviews of key administrative and teaching personnel, follow-up monitoring via telephone to keep track of specific programs and developments, and the monitoring of such events as meetings of technology planning committees, augmentative technology teams, and technology fairs. Archival data, including technology plans, software evaluation forms, newsletters, and training workshop programs, were collected. Most interview subjects were interviewed twice, so as to note changes and track developments from one year to the next. While the position of the interview subject influenced the points emphasized in the interview, the four domains provided the framework for data collection. Examples of questions asked concerning each domain follow:

General Indicators and Specific Questions by Domain

Administrative Domain

Does technology planning involve individuals at various levels of the school systems?

- from various program areas?

Is there a committee which is responsible for technology planning?

- Describe:
  scope of work
  frequency, regularity of meetings
  leadership and support for committee
  limits of authority
  resources allocated
  range of representation in membership of committee

Is there an existing technology plan or is one in the process of being developed?

- scope of plan (school or district)
- how and by whom prepared
- what is the content of the plan
- what are the methods and scope of the plan's dissemination

Are there any projects or partnerships which provide support for technology integration already in place?

Are there formal mechanisms in place to support communication about technology integration?

- Is there a technology survey or systematic study of the status of technology resources, use and integration?

- Are needs analyses conducted, matching technology types and resources to current and future status?

- Are there forums or media to promote communication between teachers and administrators and across program areas (staff meetings, computer newsletters, liaison personnel)?

Human Resources Domain

Are there training programs available for teachers and other staff in the use of microcomputer technology?

range
philosophy
accessibility
schedule
organization
staffing
methods of instruction

Do staff use computers for purposes other than classroom instruction?

- describe

Have sets of computer competencies been developed and/or adopted by the district?

- Are these competencies directly linked to local instructional and curricular goals?
- Do the training programs available support the development of these competencies?

Is technical assistance available to teachers and other staff?

- what kinds?
- who provides?
- is it utilized?

Are incentives provided or participation enabled in

- formal training
- seeking technical assistance
- independent pursuit of knowledge and skills related to technology?

Do teachers believe that the training and technical assistance available adequately supports their use of computers in instruction?

Are there technology integration management personnel?

- What are other responsibilities if any of those who provide training and technical assistance?

Are individuals responsible for various technology integration functions formally or informally designated?

- Approximately how much of their time is devoted to technology integration support activities?

Material Resources Domain

What is the current availability of material resources in the district?

computers: number and type
locations of computers
amount of software
student/computer ratio
any new or unusual configurations?

Material resource acquisition

- budgets for hardware and software
- hardware selection procedures

What steps are taken to define and decide on technology to be used to meet particular needs?

- information gathering and analysis
- procedures to translate instructional needs to technical needs
- feasibility considerations and planning
- hardware acquisition procedures
- software acquisition procedures

How are decisions made about placement of material resources?

- Are explicit rules and criteria used to guide placement?
- Is consideration given to equity of access?

Management systems to control or support use of material resources?

- Operational management systems
  security
  maintenance
  supplies

- Administrative systems
  inventory
  records management
  access and provision to users
  storage and distribution of equipment and supports

Classroom Instructional Applications

In what program areas are microcomputers used?
    uses, frequency and prevalence of use in each area

What categories of software are in use?
    drill and practice
    tutorial
    simulation
    tool

Are procedures established to facilitate communication among teachers about classroom use of technology:
    for particular successful classroom applications?
    for individual students?

Do students have input into the process of making decisions regarding classroom technology use?

Has the curriculum been modified to allow for and support the use of microcomputer technology?

    Do teachers have input into these curricular modifications?

Are resources in place to help teachers identify and locate appropriate software?

    software reviews
    guidelines for evaluation of instructional design features
    technical assistance

    - how is new information incorporated into these resources?

Are resources in place to assist teachers in designing lessons which use computers effectively?

    model lessons
    other published materials
    communication with colleagues

Are resources in place to assist teachers when they do use computers in instruction?

technical assistance on-site?

Are resources in place to support teachers when they choose to use computers in instruction?
ease of access to computes in labs, classrooms, elsewhere?
availability of technical assistance?

Are specific classroom instructional applications of computers evaluated?
How is information resulting from the evaluation disseminated?

VI. Case Study Sites

A. Chittenden South Supervisory District

Chittenden South is a district located near Burlington, Vermont. It is a rural-suburban district serving a variety of distinctive communities. The high school has approximately 800 students. This district in general, and its high school in particular, are heavily invested in restructuring and programs to progressively improve the schooling process. A small but active district staff directly supports technology integration activities at school sites, and is proactive in identifying specific applications to their needs and programs.

Several programs have been initiated at the high school, including long-term development of a technology-based mathematics resource room, currently focused on remediation but aimed eventually to mix a variety of classes and individual students. Special education maintains a resource room with high levels of computer technology, and is explicitly focused at this time on the use of software applications to address the development of language skills in realistic social settings. State special education activities also appear to be promoting a concern with the contribution of technology. In addition, school and district staff recently submitted a major proposal for funding to integrate personalized instructional management systems software into instructional programs.

Staff in this school and district are very conscious of the importance of technology to the high school program. Although involvement and commitment vary, of course, across staff at Champlain Valley, there appears to be "no argument about the role of technology in restructuring.... There is widespread recognition that technology will be absolutely central if restructuring is to succeed."

High school staff and leaders are also heavily involved in the district activities that guide and support technology integration. The technology coordinator and the media specialist both serve on the district's technology committee. That committee is responsible for organizing training, suggesting policy, and outlining the philosophies of technology use for the district. The high school principal and other administrators also are well known for their interest and support in technology integration. Across the school, and through most of the district, school improvement remains the context in which computer use is discussed and implemented.

B. The Howard County Public School System

Howard County, located mid-way between Baltimore, Maryland and Washington, D.C., is an urban-suburban district that serves more than 30,000 students (28,865 Full-Time Equivalent). The central office maintains the primary management and direction of the schools. A district-level technology plan exists to guide the course of technology integration in Howard County Schools. A technology unit in the central administration prepared this plan, develops budgets based on input from program supervisors, provides services for repair, and coordinates with the staff development center to offer computer-related courses to teachers in the district. In addition, the district-level Communications Department provides technical assistance, including installation and networking. An Augmentative Communications and Technology team operates from the central office to support teachers in their work with children who have special needs. The special education program monitors computer equipment and is focused on providing resources to local departments.

These district-level arrangements may suggest a higher level of centralization in the administrative direction of technology use than is the case in reality. Our observations revealed sharply contrasting conditions between high schools. Moreover, the District has recently announced major budget cuts for FY92, which are likely to impinge on purchasing, the principal form of administrative influence over technology at the district level.

Two high schools, School X and School Z with enrollments of 1070 and 1175, respectively, have been participants in this study. School X has a technology-focused partnership with a large agrichemical corporation; the principal there also provides substantial impetus and leadership for technology development. As a result, this facility has adopted instructional technology as one of its mission foci, and has established various hardware systems and networks. Special education staff have access to a number of computers and use them frequently, particularly for language arts development and mathematics. While integration appears to be promoted through use of computer networks for internal communications, it appears that other aspects of instructional technology use are project focused and departmentally arranged.

School Z has not identified technology development as a priority, but participates in the general increase in equipment promoted by the district office. The Media Specialist there provides support and is working to clarify a role for the Media Center in technology integration. Access to equipment is relatively limited at this school, and the provision of support in the form of knowledge and consultation appears slight, particularly as provided to the special education program.

Staff at both schools perceive little coordination between the district level and their own technology-related activities in terms of operational management or actual implementation. Both schools have begun to use the services of the Augmentative Communications and Technology team, and each has utilized training opportunities at the central staff development center. That resource is generally well regarded.

C. Ridley School District

Macro's partnership with the Ridley School District commenced in January 1990. Ridley School District, near Philadelphia, Pennsylvania, is a small, urban district, with one high school, and strong community ties. Many of its graduates go directly into the local employment arena. Although an early user of computers, during the past decade little development of technology occurred in the high school.

In 1989, the district and the high school decided to bring their computer-related capability up to contemporary standards. The impetus for this came primarily from the district with input from the administrative leadership at the high school, particularly the assistant principal who oversees curriculum planning. Because of its very active schedule of technology development and integration, the district encouraged field contact and analysis by project staff, and indicated its desire to incorporate observations and findings within its own emerging program as appropriate.

Ridley School District has embarked on an ambitious program to develop and implement technology resources over a three year period. A district-level technology coordinator was hired, funds earmarked, and school leadership support obtained to meet the objectives. This effort is very much an example of planned change. Activities have entailed acquisition of material resources and development of structures to operate and maintain them, staff development, technology planning, changes in classes to incorporate new technology and computer applications, and coordination between district and school, administrator and teachers.

During the course of our partnership with them, Ridley staff has established computer labs, hired staff and trained teachers, and are developing curricula in several subject areas that take advantage of the new resources. Its recent emphasis has been on bringing technology into the high school. In the coming year, the focus will shift to the elementary and junior high schools. In 1990-91 the district has devoted most of its in-service training days to technology-related experiences, including an all-day technology fair.

Response to all this activity at the high school level has been strong. We have seen a marked change in the attitude of staff who originally feared the arrival of computers, while many teachers are expanding their knowledge of instructional technology's possibilities, as is shown by the capacity enrollment in summer instructional technology courses at the junior college.

D. Prince William County Public Schools

Prince William is a large district of more than 41,000 students in a rapidly growing area of northern Virginia. The school system joined the integration project in the fall of 1990 during our Phase II evaluation. During the same year, the district shifted from centralized authority to site-based management. This change has great implications for technology development at specific high schools, a fact recognized by staff and teachers, but one whose impact is in the early stages. At both the building and district levels, there is confusion about the roles individuals will play in the new order. While there seems to be a great deal of excitement at the building level about this change, school personnel still look to the district for much of their direction. In turn, district personnel are unsure what their new relationship is to the schools.

The special education program at the district level is involved with technology development for student records and information management. Other district programs vary in their promotion of instructional technology use. There is an instructional technology unit that provides maintenance and other support to schools using computer related technology. Under centralized control there was a district technology plan which was in effect from 1986 through 1989. Knowledge of this plan and its impact varies across the different programs and school buildings. Recently, the superintendent, under pressure from parents and the some schools, called for the creation of a new district technology plan. The instructional technology coordinator is developing this, although given the change to site-based management, no one is sure what effect it will have on the schools.

We are working with School A and School B. Each of these schools has available some computer resources including network systems for administrators or in labs. Interest is emerging for further integration of computer and other technologies, especially now that departments have responsibility for planning their program and proposing budgets for such resources.

At School B administrators have computer access, and some labs have been established, but a need for more stations both for regular and special education has been articulated. Planned development includes a recently established, innovative Learning Center approach partly based on computer technology, and a program designed to integrate computers and overall curricula across academic and vocationally oriented programs. Special education staff have a limited number of their own computers and access to labs, which they prefer not to use. They are extremely aware of technology's potential in education, and desire to establish their own computer lab.

School A has a number of labs and a history of technology use in the math and business departments, as well as increasing use of technology and technology access in the library. Some administrators are anticipating a future effort in technology integration. At that school, however, expectations of changes in enrollment that are likely to occur as a result of new facility building in the district is affecting the pace of new technology planning. Special education staff have access to labs and a limited number of their own computers.

E. Charles County

Charles County, Maryland, is a rural-suburban district close to the size of Howard County, that declined the opportunity to enter into partnership with us on the grounds that our model so closely matched their own plans for technology integration the partnership materials would simply be redundant to their own. Because our contact with Charles County, although brief, was also revealing, it merits inclusion in this summary report on district contacts.

In December, 1989, the district expressed an interest in working with our project, explaining that it was in the process of addressing its technology needs and program with a report and plan. In January, the appropriate Assistant Superintendent indicated approval for the district to participate and directed the district Library Media Specialist, with whom we had already communicated, to serve as liaison and contact with the district's technology committee. This group was responsible for the development of the district's report and for coordinating with the technology integration project. It was convened by the Assistant Superintendent to prepare a 3 to 5 year plan.

Materials were shared with the liaison for distribution to appropriate members of the committee and high school sites. After January, however, problems arose in arranging to work with specific schools and in communicating with the committee. On three separate occasions, project staff were to attend regularly scheduled meetings of the committee, between February and April. On each occasion the scheduled meetings were postponed; by late spring the postponements were indefinite, and to our knowledge no further committee meetings were held during the school year.

Our district liaison explained that these committee meetings had been postponed because of the pressure of other priorities related to school improvement generally. After showing the *Model* to selected members of the committee on an individual basis, the liaison indicated in a March meeting with us that Charles County would not need to participate in the project. Prior to that time, no indication of withdrawal had been given aside from the implications of the fact that the committee was not meeting.

The Library Media Specialist reported that the *model* was seen to be useful, and he gave specific feedback regarding the manual. He reported, however, the feeling that the district had successfully utilized a similar approach and therefore did not believe there would be much mutual benefit to collaboration. He scheduled project staff to speak to the committee as a whole in order to discuss the matter further, but, as reported above, these meetings did not occur.

The committee's report and plan was completed in February and approved in March. They appear to have solicited a great deal of information from schools and teachers in the county regarding computer-related technology use and future needs, including issues of software selection and management, teacher training, procedures for operational management, and other factors. Recommendations were given, especially options for future equipment acquisition and required budgets for 3-, 4- and 5-year plans. Recommendations also outlined an important ongoing role for the committee, as software clearing house, for oversight and evaluation of instructional technology, as information broker, and site of problem solving for technology-related matters.

While the committee's recommendations were accepted, funding has been a problem for this district, as it has elsewhere. For example, at the current rate of installation of MS-DOS networks, some three per year, it will take ten years for the schools to be fully equipped, a rate well behind the envisioned schedule.

Funding difficulties are exacerbated by a tendency in this district to fund hardware acquisition for the Computer Education Program at the expense of other programs, which often have differing needs. While Computer Education emphasizes MS-DOS networks, science teachers, for example, want stand-alone computers and Social Studies teachers would like to move into laser disc technology. The committee's recommendation that funding be set aside for different programs has been ignored.

Chapter II

A Model of Technology Integration

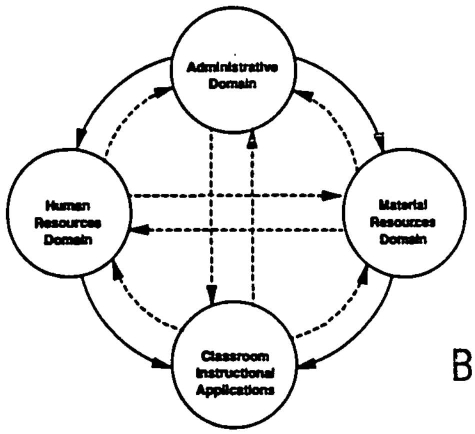
In the early stages of our project, we developed a model of educational technology integration as an information process involving four interrelated domains: **administrative** (decision making about computer technology acquisition and instructional use), **human resources** (staff training and technical support), **material resources** (hardware and software acquisition and implementation) and **instructional applications** (classroom uses of microcomputer technology within instructional programs). As a process, technology integration takes place through time, in an ongoing manner that requires continuing steps of decision making, application and evaluation. A "domain" represents a focused sector of issues and activities within this process. This process incorporates information in the sense that each domain receives (is "informed" by) inputs and transforms them to produce some different output. While the activities represented by the domains may overlap in the structure of the organization, the domains themselves may be defined in terms of their distinctive output of information and action.

This model differs, however, from structurally-based models that emphasize conventional, hierarchical patterns of organization: from school board to superintendent to principals to teachers to students. Our model's administrative domain, for example, is not coterminous with those who are designated as professional "administrators," but encompasses, more broadly, those activities and issues that result in administrative outputs, that is,
determining decisions with respect to technology use in classrooms.

The model is graphically represented in Figure 1. The solid arrows indicate determining outputs. Thus, the Administrative Domain (I), provides information that directly affects the Human Resources Domain (II) and the Material Resources Domain (III), These latter domains, in turn, largely determine the procedures and practices available for the support of the Classroom Instructional Applications Domains (IV). The broken arrows that progress from Instructional Applications to Human Resources and Material Resources, and from these latter domains to the Administrative Domain represent the feed-back processes that constitute part of the in-puts available to these domains.

FIGURE 1

CONCEPTUAL MODEL OF THE PROCESSES IN TECHNOLOGY INNOVATION AND INTEGRATION
Direct and Indirect Linkages



One important implication of this model is that it identifies the linkages between administrative processes and computer applications as indirect. Thus, while administrative decision making produces effects in human and material resources, this does not in itself guarantee results in instructional applications. Even with all the hardware, software and training imaginable at their disposal, teachers may resist changing established routines to incorporate computerized methods into classroom instruction. Nonetheless, continuing change in other domains will create incentives as well as pressures on instructional staff to incorporate the technology over time.

Even the secondary feed-back linkages between instructional applications and administrative processes are generally indirect. Without a detailed awareness of classroom experiences and needs, activities in the human and material resources domains are uninformed in this most important respect and are thus likely to produce ineffective and undesirable out-puts.

Finally, it should be noted that direct, if generally infrequent, linkages **can** exist between domains which are otherwise only indirectly connected. For example, staff may find access to material resources on their own initiative, or through local, fund-raising efforts, a process indicated by the broken arrows linking these domains. Similarly, some administrative decision makers may involve themselves directly in monitoring classroom activities, a process represented, again, by broken arrows directly connecting these domains.

Macro's model emphasizes the dynamic aspects of domain interrelationships, rather than the domains as relatively unitary components within a set structure. It is this dynamic emphasis that enables the model to address issues pertaining to technology integration among districts or schools that differ organizationally and compositionally. By representing technology integration as a structured process of information flows and feed-back, the Macro model not only provides a basis for describing and analyzing actual situations, but also implicitly charts a course toward the development of schools and districts as dynamic, highly sensitive systems of information flow and organizational processes.

I. Developing a Research Taxonomy

Before discussing the domains individually, it may be helpful to note that our research model provided a particularly useful framework for conducting the initial, intensive literature review that guided model development in the early stages of our research. The model's four domains (administrative, material resources, human resources and instructional applications) provided the initial categories for organizing the literature search. The examination of published literature enabled us to identify numerous sub-categories in each domain (for example, in the Administrative Domain: degree of centralization, cross-program collaboration, and leadership style and practice).

The research framework was further developed by identifying specific research questions investigated in the literature, hypotheses tested, and whether each was supported, refuted or "qualified" in some way by the investigations. Results of this review were synthesized in accordance with the following outline:

I. DOMAIN [Roman numeral, major section heading]

A. Subcategory [capital letter, research areas]

RQ: Research question

H#: Hypothesis [numbered]

D: Direction or results for specific research study (cited)

D values include:

S: Supported

R: Refuted

Q: Qualified (When the results of a study qualify the hypothesis an explanation is provided.

A small portion of the taxonomy's section on Instructional Applications is provided to illustrate the utilization of this method in the development of the domain descriptions:

IV. INSTRUCTIONAL APPLICATIONS -- Classroom Approaches and Uses

A. Computer-assisted instruction (CAI)

A-1. General CAI

RQ: Is CAI an effective instructional method?

H1: CAI is an active learning process, whereas traditional instruction tends to be a passive experience for the student.

S: Chambers & Sprecher, 1980
Q: Okolo, Rieth, Polsgrove, Bahr, Yerkes, 1987; Carlson & Silverman, 1986 [O]: CAI can also be a passive experience for students. It is up to the teacher to create an active learning environment, even on the microcomputer.

H2: CAI is effective due to the ability to individualize instruction.

S: Jamison, Suppes, & Wells, 1974 [M]; Dell & Aguilera, 1986; Okolo, Rieth, Polsgrove, Bahr, Yerkes, 1987; Robertson, Ladewig, Strickland, & Boschung, 1987.

Q: Isenberg, 1985; Johnson, Johnson, & Stanne, 1986: It may be that too much emphasis has been placed on individualistic modes of learning with CAI to the detriment of cooperative group structures. Justen, Adams, & Waldrop, 1988: Group CAI is just as effective in regard to achievement as individual CAI, for college students on drill and practice tasks.

Thus, the domain descriptions that follow represent an effort to utilize and to integrate the findings of researchers on technology and education in a number of domains. This is important to note, because at first glance the domain descriptions may appear to represent simply a "common sense," logical elaboration of the contents and implications of each domain.

II. Administrative Domain

The administrative domain includes those arrangements provided at district and school levels for the organizational and communicational processes that pertain to decision making about technology integration. This is the domain that determines the material and human resources that are to be made available for instructional applications of technology, including those in special education programs. Key variables within this domain for the integration process include: degree of centralization, extent of cross-program collaboration, extent of communication arrangements pertaining to technology planning and use and leadership style and practice.

Degree of Centralization. Much of the literature on administrative practices and technology integration emphasizes issues of centralization and decentralization of decision making. "Centralization" refers to the locus of control residing with school administrators, district officials, a designated technology coordinator, or a school board. "Decentralization" refers to the locus of control residing with departments and teachers. This variable, then, can represent the level of collaboration and communication that takes place between administrators and teachers in decision making about computer resource acquisition, allocation and planning. From our research and other findings, the point to be emphasized is that planning, wherever the locus of control, seems essential to the successful integration of technology into the curriculum (Bingham, 1984; Vakos, 1986; Carlson and Silverman, 1986; Hanley, 1987). Moreover, successful planning that results in increased uses of instructional applications requires the significant participation of teachers in decision making about computers (Hanley et al, 1983; Okolo et al., 1987).

Communication breakdowns between teachers and administrators surface frequently in ethnographic research at our field sites. A high school English teacher, for example, speaks of her frustration on trying to obtain computers for instruction after being impressed by the possibilities demonstrated at a training session. She was told by her department supervisor that it was not possible to obtain any equipment. She then wrote to the district's technology coordinator. He referred her back to her supervisor. She later learned that the supervisor was mistaken that computers were not available, having misunderstood a memorandum that had to do with the district's attempts to track computer specifications. She returned, therefore, to her supervisor, who once again referred her back to the district coordinator. Eventually she gave up the effort, embittered by this experience. This account reports not only a high number of bureaucratic errors. It speaks of the frustrations entailed when communicating in an innovative process where individual agenda takes the place of careful planning.

Cross-program Collaboration. The planned collaboration of computer resources across program areas (including special and regular education) leads to greater utilization of available resources (Hanley et al., 1983). The frequent struggle of special education administrators and teachers for inclusion in school and district planning has a particular relevance here, where collaboration on technology has been shown to reduce special education's isolation generally (Macro, 1987). The disadvantaged position of special education surfaced frequently in our observations. As one educator neatly summed up when explaining that the computer made available to her students does not run much applicable software: "I'm a special ed teacher and I get what's left over."

Extent of Communication Arrangement. Technology planning and oversight committees appear to provide a vital communication linkage among stakeholders in the technology integration process. Planning committees often are charged with developing systems for the evaluation, selection, and acquisition of hardware and software. In some districts, such committees are central players in restructuring efforts and curriculum development. Another structure that may enhance coordination between decision-making and special education staff is the augmentative communications technology team, usually a district level group. Recently, such groups have become more common. Often, the team will be built around a core set of staff: speech therapist, occupational therapist, special education teacher and a technical ("techy") person who has a broad familiarity with hardware and software capabilities (Blackhurst, 1990). They also may have the authority to draw on other persons, e.g., medical, mental retardation and other experts, as needed for specific cases.

Leadership Style and Practice. Personality characteristics, administrative monitoring of instructional applications, philosophy statements and policy guidelines are aspects that speak to issues of leadership style (Macro, 1987; Beach and Vacca, 1985; Johns Hopkins, 1988). Of these, the need for a philosophy statement merits emphasis here, because the very process of crafting such a document can serve to set in motion those communication processes and organizational steps that will enable technology planning and integration to take place.

III. Human Resources Domain

The human resources domain represents those arrangement that exist to provide training and technical support for staff responsible for classroom implementation of computer methods.

Personal responses to technological innovations often are expressed in, and mitigated by, activities in this domain to train staff and to define new roles and expectations.

Training. Staff training is an essential component of successful instructional applications, yet the OTA reported as recently as 1987 that as many as two-thirds of the nation's teachers had received no computer training at all. The remaining third, on average, had received less than ten hours of training (Office of Technology Assessment, 1988). Research supports the effectiveness of an approach to such training as a long-term, continuous task, rather than one that is short-term or periodic (Hanley, 1987). Special education teachers in general may have had even less experience with computers than mainstream teachers.

Training opportunities are most useful and attractive if they evolve to address the particular levels of knowledge and skills of staff as the integration process progresses. Concurrently with that evolution, clearly identifying the changing competencies that become expected of staff over time appears crucial in at least two respects. First, identification provides a solid and tangible set of requirements that teachers may address and attain while removing the anxiety associated with any ambiguity of evaluative factors. Second, formally requiring needed competencies is part of institutionalizing the instructional use of technology.

Expectations about competencies might be directly linked to credits or recertification points assigned to completion of in-service training. Other incentives also appear to be important in encouraging and enabling teachers to gain appropriate skills in instructional technology. These include programs to loan computers to faculty or to help them in purchasing equipment for home use compatible with that at school; arranging for substitute teachers; organizing training sessions so that instructors do not feel they are falling behind with their class; flexible scheduling of training sessions; and identifying the role of mastery in instructional technologies for teachers' career development tracks.

Active Leadership. In the schools that are participating in our field research, an active program of training opportunities sends a signal to teachers about commitment to the use of instructional technology. Where such opportunities are unclear, difficult to attend, or missing, or not combined with the decision making to support the integration process, staff can feel abandoned. A special education teacher interviewed in our study angrily describes himself as going it alone in the acquisition and introduction of computer technology in the classroom. While he has "seen what computers can do," he finds special education administrators to be still in the "horse and buggy days." Leadership thus also plays an important role in developing human resources, and requires activities that educate and draw in the diverse sectors of the school into a comprehensive program.

IV. Material Resources Domain

This domain encompasses the physical aspects of technology integration, including hardware and software development, implementation and management. Coping with equipment and supporting instructional applications often seems to be a difficult task for schools, perhaps simply because it is easy to focus on the technical aspects and not the central tasks of this domain. These primary functions are to provide the infrastructure that enables and supports teachers in their instructional use, on the one hand, and to express and promote the philosophy of instructional technology use developed by school and district leadership, on the other.

The former activity requires many considerations, including acquisition, installations and placement, provision of information about software and appropriate configurations, technical support to teachers and students, and maintenance or logistical efforts. In the latter role, technology coordinators are representing the educational leadership in the school system, and as such must themselves be well integrated into the instructional purposes of school organization.

Hardware Acquisition. Many of these material resource management activities are complex. For example, hardware acquisition usually requires knowledge about funding sources, awareness of expansion issues and sensitivity to allocation issues. Part of the task here is identifying funds from federal, state and private sources that may be available, especially for computers for at-risk students (Doyle and Whalley, 1986). Compatibility issues also need to be addressed, because the presence of incompatible hardware within a site may complicate and delay technology development (Lathroum and Chown, 1988).

Computer placement is generally either to laboratories or classrooms. Restricting computers to classrooms has been shown to result in lower use (Becker, 1984). On the other hand, placement in classrooms results in greater equity in the use of computers by special education students. The Office of Technology Assessment reports that there is an average of only one computer for every thirty students in U.S. schools. Until equipment is more easily acquired and accessible, placement will be an important issue that should reflect the instructional goals of particular schools and districts.

Software Selection. The review of software for instructional uses is a complex task that is best approached in a systematic way. Committees, media specialists, or departmental groups each may play the central role in identifying and maintaining information about software. In the absence of designated positions or a review process, teachers tend to rely on word-of-mouth recommendations (Morariu et al., 1986).

We and other workers have identified many features that are especially desirable in instructional software. These can include a close connection to the curriculum, adjustable difficulty levels, the ability to change specific questions or problems, and the ability to modify the type of feed-back received by the student (Bitter and Wighton, 1987; Eisner, 1986). For the students with learning disabilities, software packages should include amble self-monitoring activities, for example, stating instructional goals (Haynes et al., 1985). Special education should be "learner fit," that is, able to be tailored to the needs of individual students (Morariu et al., 1985).

A key element of this task appears to be establishing information resources, procedures that teachers can easily follow, and assistance to staff, in identifying applications that meet their instructional concerns. In addition, opportunities for teachers to share their software experiences with other staff, as well as to attend conferences, enhances those individuals' awareness of suitable programs. Thus, with both hardware and software implementation and support, the central problem in material resource management is to create ongoing processes and resources that actively support teachers in their efforts to integrate computer-related technology into their daily pedagogical routines.

V. Instructional Applications Domain

This domain is concerned with the actions taken by teachers to utilize computers within their classes and instructional programs. The applications domain is where the quality of the school's and district's organization and delivery of technology support is put to the test. Not surprisingly, effectiveness has been a strong emphasis in research on applications. Research and practitioners consider computer methods of instruction desirable for a variety of reasons, ranging from its demonstrated effectiveness for certain kinds of instruction to its ability to liberate instructors from mundane and repetitious tasks. Without proper planning and support, however, these desirable objectives are difficult to attain.

The effectiveness of computer methods for special education is especially compelling, because they foster the delivery of individualized instruction (Jamison et al., 1974). Computer-managed approaches to Individual Educational Plans have been shown to be highly effective in facilitating the identification of goals and objectives, as well as in fostering their actual use by special education teachers (Enell, 1984).

Educational Effects. Computer methods have been shown to reduce the time required for a student to master a task, to engage students' attention for longer periods than does traditional instruction, to improve student self-confidence and, among some students, to improve motivation and self-discipline (Hanley, 1987; Eisenrauch, 1984; Roblyer, 1988; Cosden et al., 1987; Becker, 1986). Despite the individualized focus of much computer work, computers have also been shown to foster mutual support among students (Larson and Roberts, 1986; MacArthur et al., 1985). Although studies of the effectiveness of computer instructional applications in the past have shown mixed results, there is a growing acceptance that these applications do make unique and positive contributions to schooling (Roblyer et al., 1988).

Various Methods. The varieties of computer methods include word processing, drill-and-practice, tutorials, simulations, educational games, and programming. Drill-and-practice has received extensive research attention. It is employed in the instruction of mathematics, spelling, and reading skills. In special education, where repetitive drill has been a familiar technique, it would seem to be an obvious choice, although recent usage appears to be moving away from those applications. There are some special features that need to be included in applications for special education uses. Students with learning disabilities may have difficulty assessing what they have learned during a given session, so programs that provide "elaborated" feed-back may be required (Haynes et al., 1984).

Word processing has been used to teach writing skills. It clearly increases the quantity of writing done, but, as MacArthur and Schneiderman suggest (1984), not necessarily the quality. The ease of revisions, however, may enable some students to focus on their writing tasks more creatively (Ellis and Sabornie, 1986). Technological advances, such as voice synthesizers and interactive videodiscs, now are improving the accessibility of computers to special education students, where some have had difficulty in using keyboards and manipulating the cursor.

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Chapter III

Analytical Summaries of the Field Sites

Chapter III. Analytical Summaries of the Field Sites

Having developed a model of technology integration, as well as a manual by which to make it accessible to busy practitioners, Macro embarked, in 1989, on Phase II, a two-year evaluation study. During Phase II, Macro presented the Manual and supporting materials to schools and districts, observed the process of implementation as materials were applied in technology integration efforts, and evaluated both the impact of the model on those efforts and the utility of the model (as presented in the Manual) to participants. Schools and districts were selected to represent diverse characteristics, including level of technology development, size, and socio-economic setting.

Four sites were selected for observations during the Phase II study: Howard County Public School System, Ridley School District, Prince William County Public Schools and Chittenden South Supervisory District. The model's four domains (administrative, human resources, material resources and instructional applications) provided the framework for data collection. Research methods included both qualitative and survey methods. Chapter IV reports on the results of the Technology Assessment Survey, an instrument that was developed during Phase I and modified during Phase II. This chapter reports on Phase II's qualitative findings, which have been derived from semi-structured interviews with key informants, site observations and examination of archival materials.

The most general finding from Phase II is that the technology integration model provides a framework that is useful both descriptively and prescriptively to the process of technology integration within high schools and school districts. Descriptively, it enabled the field researchers to access quickly and with little disruption the organizational data that enabled project analysts to construct a coherent picture of the state of technology integration in any given site. Prescriptively, it empowered stakeholders and decision makers at these sites by enabling them to do the same, that is, to assess the processes of technology integration within their own schools and districts. These benefits extend to special educators, as well, by providing a comprehensive framework by which to assess their departments' participation and opportunities in the technology integration process.

Analysis of technology integration at the diverse sites selected for Phase II have yielded a picture of the diversity of practices within each. The model's emphasis on process and, most especially, on communication between administrators and instructors, provided a powerful framework for identifying the factors within each that are indicative of the level of technology integration. While these qualitative studies do not yield results that are statistically generalizable to other schools and districts, they do demonstrate the utility of the model by which they have been derived as an heuristic device for the analysis of technology integration in educational settings generally.

I. Howard County

Howard County is an urban-suburban district that serves more than 30,000 students. As mentioned above (Chapter I), despite the existence of a central-level Microcomputer Supervisor, a five-year technology plan, and the provision of computer-related courses by the district's Staff Development Center, Howard is a district that can be characterized as decentralized in its approach to technology integration. In practical terms this means that conditions and approaches do differ markedly from school to school. Our field research has included two sites that illustrate this diversity.

A. High School X

The edifice of School X is approximately 30 years old. It is primarily a one floor building with a few classrooms housed on the second floor. The media center is a recent addition. A few years ago School X underwent a renovation to bring it up to current standards. The 1990-91 enrollment was 1,070, including 45 Level 4 students.

According to the principal, the students at the high school range from "kids who live on estates and drive Jaguars to school, to kids who literally don't know where their next meal is coming from." Social groups at the school tend to form on the basis of socioeconomic status. The principal notes that many of the students in the lower socioeconomic groups tend to drop out at age 16, even with the availability of Vocational-Technical programs. Drug involvement is reported to be a problem among these students.

At the start of Macro's Technology Integration Project, in 1986, computer management and implementation at the school were very decentralized, with little administrative involvement. This situation has since changed dramatically, with the 1988 inauguration of a school/business partnership, which is discussed below under the administrative domain. Technology is the major focus of this partnership and the principal has made this opportunity a central aspect of his administrative leadership in the school. Partnership funds have been utilized to acquire substantial amounts of hardware, as well as to provide training for the staff.

B. High School Z

School Z is housed in a 15-year old edifice that is on one floor and in generally good condition. Its 1990-91 enrollment was 1,175.

The principal characterized the student body as being "highly academic," with approximately 85 percent of its graduates continuing to college. The parents of the students are very supportive of academics in general and of the school in particular. The school reports a low level of discipline problems. The staff appears to be very stable and was described by the principal as being "outstanding." Staff professionalism is reflected in the belief that getting grants and taking part in pilot projects is just part of the job, a natural thing to do.

In comparison with School X, School Z's approach to technology is much more subdued. Z's administration supports departmental requests for new technology, but has not exercised leadership to move the use of technology into the curriculum in an integrated way. Z is, then, much more decentralized than X in its approach to technology integration.

C. Administrative Domain

This discussion of the administrative domain illustrates the range of processes that comprise decision-making about technology acquisition and use at both the district and school level, by focusing on three principal categories: **planning, leadership** and **communication.**

Planning. Planning about technology occurs at both the school and district levels in Howard County. The Howard County Public School System first adopted a formal technology plan in 1986, "Towards the Year 2000," which arose from the work of a "Technology Committee" comprised of both administrators (31) and community representatives (8). The report for this committee sets forth the district's philosophy and plans over the subsequent three years to include technology acquisition, support, and research and development in the budget. In November of 1989, a much more detailed proposal was adopted, which includes step-by-step plans for technology integration over a five-year period. This plan states as a goal affording all high school students the opportunity to have four hours per week with microcomputers. It calls for three microcomputer laboratories (two general, one vocational-technical) for each high school, as well as one microcomputer for each classroom and arrangements for external communications. Special education is to have hardware and software for classroom use and the means to enable teachers to develop individual educational plans electronically. Vocational education students are to have access to advanced CAD/CAM and computerized home management systems, as well as hardware and software being used by a variety of employers within the county. The county's plan also calls for an increased use of technology at the administrative level and for research on a variety of technologies. The implementation of this plan is the responsibility of the county's Microcomputer Supervisor, who works together with a technology committee toward this end.

The county's oversight of technology integration is largely limited to budgetary operations. At the building level, it is soon apparent that planning about technology use is characteristically more "decentralized" than "centralized," inasmuch as schools and, to a degree, departments within schools, proceed with a high level of independence in their planning about technology. Examples of such independence from central office guidance appear frequently. For example, all planning for equipment acquired from the school/business partnership at School X takes place at the "building" level. The Media

Center at School Z purchased and networked a computer with "book money" which school officials managed to divert for this purpose.

Howard County has been impacted by the current recession. One central office informant indicated that major cuts amounting to some $18 million in the county's school budget for FY 1992 had recently been announced and would profoundly limit technology acquisition in the years ahead.

Both School X and School Z have computer committees which are formally vested with responsibility for technology planning within their schools, albeit in quite different ways. School X's original computer committee has been replaced by a school/business partnership committee which meets on a monthly basis and decides on the use of partnership funds. School Z's technology committee meets three to seven times per year, controls only a very limited budget ($1200 during FY 1991) for software acquisition, and is advisory to the administration, the locus of actual decision making about computer resource acquisition and distribution.

The "partnership" agreement between School X and "Corporate Beta " [pseudonym], an agrichemical firm, was announced in September 1988, following nine months of deliberation between key individuals. Its goals are twofold: first, "to make dramatic changes in the planning, delivery, and management of teachers' instructional activities in a comprehensive high school"; and second, "to immerse students of ALL ability levels and disciplines into a technological learning environment that will increase their academic achievement." The partnership entails a five-year grant to School X totalling $200,000.

Specific projects and activities funded by the Corporate Beta/School X partnership include a Macintosh writing lab, introduction of laser disc technology to science classes, a mentor program in which corporate scientists guide student projects, a computer club to encourage student interest in computers, and teacher internships with the corporation during summer months to assist in research activities. Decision making about project activities is facilitated by an advisory committee of some 23 persons, including school administrators (2), a central office representative (1), teachers from various departments (11), the media center coordinator (1), parents (including one clergyperson) (2), students (2), and corporation representatives (3).

While this advisory committee formally decides on partnership activities, it is unclear how much responsibility actually devolves to it. The committee operates under the tutelage of a three-person executive committee consisting of the school principal, a corporation representative and the Central Office's Instructional Director of High Schools. In theory, specific proposals and ideas for pilot projects originate in the departments and are addressed by the committee. One committee member, however, remarked that members pick up how they are "supposed" to vote and do so accordingly. For example, in at least one instance Corporate Beta apparently preferred that money go to science and math, at the expense of English and other departments interested in acquiring additional Macintoshes for writing, "so that's what happened," remarks one committee member, who would have preferred that the school obtain the additional Macs.

In the specifics of the partnership's planning and implementation, evidence of central office influence is scarce. While central office personnel sit on the advisory and executive committees, no interviewee made reference to the central office serving as either a guide or constraint on partnership decisions.

At School Z the computer committee is presumably vested with responsibility for planning at the school level, although it is evident that many decisions are made without their in-put. Two individuals are key to the operation of the committee, the media specialist and a computer science teacher. They have alternated in the positions of "chair" and "co-chair" of the committee, depending on who is designated as "computer rep" to the central office for the year. Composition of the committee does not appear to be rigorously defined, but there are some three additional committee members, who are usually either math or science teachers. A special education teacher also in theory is a member, but she admits to seldom attending meetings. This teacher's low estimation of the committee's relevance to her department stems from her perception that this is yet another instance of special education's historic treatment by the district as a "step child." She points out that the county's Microcomputer Supervisor expects her to obtain grant money to meet even such basic technology needs as a printer ribbon. Meetings of the computer committee are not scheduled regularly and may occur anywhere from three to seven times throughout the year.

Apart from the acquisition of software, one member of School Z's computer committee describes the committee's leadership function as primary: to serve as "missionaries" within the school about the instructional potential of technology. Indeed, one member complains about the failure of school administrators to utilize the committee in making decisions about technology acquisition. This impression is supported by the assistant principal's description of the decision making process: departmental chairs submit requests to the principal who addresses each on a case by case basis to see whether funding is available. As an example of the ill effects of failing to utilize the computer committee, one informant provides the following example: a secretary and an art teacher both needed a computer. The art teacher needed color graphics for instructional purposes. Two computers were ordered: the secretary got a Color SI and the art teacher got a Mac Classic. The art teacher wants to know how she is supposed to make use of this without color graphics.

Leadership. At both School X and School Z leadership is crucial to the process of technology integration. By "leadership" we mean the ability to facilitate some aspect of technology integration by enabling others, especially teachers, to appreciate the instructional and administrative potential of microcomputer technology. Leadership is not necessarily coupled with formal responsibility for technology integration, but clearly it is beneficial when such a linkage exists.

School X, where the principal has exerted considerable leadership, is a case in point. At this school, where one of the most intensive efforts toward technology integration of any high school in the county has been underway since 1988, one would expect a high degree of openness to technological innovation. The principal of School X nevertheless faced considerable teacher and central office reluctance concerning his plans to introduce voice mail in the school as a means to facilitate school/home communications. Voice mail was, in fact, introduced during the spring of 1991. By phoning a "hot line" number and utilizing privacy codes, parents are able to learn about their children's classwork, tests, project dates and homework assignments, leave messages for teachers and check on attendance. The hot line also provides information about the lunch menu, school calendar and athletic schedules.

The principal of School X envisions voice mail as an opportunity to enhance parent/teacher communication at a minimal cost to teachers. The lack of such communication in the past had contributed to conflict with parents who were concerned about the school's suspension policy. The voice mail system offers the clear potential to inform interested parents on a regular basis about their children's educational activities, participation, and progress. Nevertheless, as the principal learned, many teachers were anxious about the introduction of this new technology, meaning that he had a selling job to do. Describing the genesis of this pilot project as "pretty much" his idea, something that he wanted to see happen, he found that ultimately, to make it happen, he had to "call in a lot of chits." He went individually to each department to explain that this was something that he wanted. "You have to look them in the eye," he says, to "get their commitment." Voice mail was still in its infancy at the close of data collection for the technology integration project, being only partially implemented, beginning with ninth grade only. At the close of field observations, the principal was not prepared to comment on its success, although he stated, with optimism, "you'll see the enthusiasm develop."

The commitment of School X's principal to technology integration does not arise from strong prior knowledge or belief about educational technology. He attributes this commitment largely to the opportunity that arose with the advent of the school/business partnership. Recalling that the partnership offer came at a particularly fortuitous moment, when morale and the school's image were poor, it has, in his view, helped to move the school forward substantially increasing school pride. He indicates that he would not necessarily choose technology as the focus for his efforts in another situation. While he has always been personally interested in technology, he does not consider himself an aggressive promoter of its use. He would not have picked technology as the focus for instructional improvement at School X, if the technology had not been there. When the partnership opportunity arose, however, he assessed the situation and "ran with it."

At School Z administrators manifest much less personal and professional investment in technology. Even where technology exists, some informants find that it will not be used without the interest of administrators. For example, one informant mentions the recent introduction of electronic mail in the school district, a system which enables instantaneous textual communication with the Central Office. Unless the principal "sees the E-mail system as useful," this informant remarks, "it will not be used."

As this informant's remarks about the process of technology planning in the school suggest, the administration's role is essentially reactive, mainly consisting of efforts to fund proposals for technology acquisition that originate from individual departments. Leadership that promotes technology integration at School Z resides, then, in individual educators who have either developed an interest in it or intentionally chosen it as a vehicle for change. The "missionary" activities of individuals on the computer committee are example of such leadership. One informant mentions a teacher within the school who wrote a DOS-based grade book manager software program. The same teacher is now rewriting it for Macs, which have become the school's administrative computers, and will make it available to all who are interested. "It is this kind of interest among the staff," remarks the informant, "that pushes the technology wheel around."

Another form leadership takes is in the technical support for computer use which is provided at both schools by a few committed individuals, often with little training in microcomputer technology themselves and usually without any formal designation to such tasks in their job descriptions. Technical support will be discussed further, under the human resources domain. The point to be noted here is that in these early years of the movement toward technology integration in education, many of the essential tasks that will almost certainly be institutionalized in newly created positions, as technology use expands, are presently carried out by "volunteers," that is, committed individuals, often having no particular expertise in educational technology, who make available their limited knowledge, skills and even personal resources to promote technology use.

Communication. Communication is an integral aspect of the administrative domain. The two high schools in Howard included in our study, Schools X and Z, differing so clearly in progress toward technology and administrative leadership, differ from each other in predictable ways on the level of communication about technology that takes place.

The previously mentioned story about the principal of School X's efforts to introduce voice mail illustrate the centrality of communication. In that instance, he went individually to each department to argue his case. Apart from this specific instance, there are several mechanisms in place at the school to keep staff informed and to foster dialogue. First, the principal publishes a weekly bulletin which includes technology news; he estimates that about sixty percent of the staff read it carefully. In addition, there are eleven teachers on the partnership advisory committee. The principal also meets regularly with a leadership team consisting of the department chairs. Finally, there are department meetings, which the principal attends periodically. With the exception of the Advisory Committee, none of these mechanisms is focused exclusively on technology integration, but the point is that when employed under the direction of an administrator who is strongly committed to technology, such mechanisms can be utilized to foster technology integration.

By contrast, at School Z, where the approach to technology is piecemeal, resulting essentially from the administrative disposition of specific departmental requests, there exists no single body where communication about educational technology takes place that is broadly representative of departments throughout the school. The one vehicle that does exist, the computer committee, does not include the participation of the humanities or social sciences, and meets only infrequently. It is marginal to the decision-making process.

Communication about technology at the district level is not highly structured. No formal surveys are used to determine technology needs. In the past the central technology office gathered information via computer representatives in each high school. This representative was also usually the computer committee chair or co-chair. At present, it does not appear that information is gathered in any systematic way to support computer-related decision-making at the district level. The central office of special education, which has committed the district to the goal of a computer system for each special education teacher's room, did, until 1991, monitor progress toward this goal by means of a hardware inventory, which was taken each year in the special education departments of the schools. As of 1991, due to budgetary restraints, this survey is no longer taken. In addition, there seems to be a variety of communications media which include information about technology such as a newsletter from the central office and from a special education supervisor. However, these are distributed to limited audiences, tend to be unsystematic in the coverage, and appear unregularly. In general, then, communication at the district level about technology needs is primarily informal.

D. Human Resources Domain

This discussion of the human resources domain focuses on the two categories that surfaced most prominently in the comments made by informants: **training** and **technical assistance**.

Training Programs. The district offers a variety of training. Some has been centrally organized and some is school-based. In recent years, there has been less school-based training and more emphasis at that level on the provision of informal technical assistance. Some formal training, however, has been provided as specific school needs arise. For example, at School X, when a writing lab was installed, special training was provided to English teachers. Partnership funds have enabled School X to provide more training opportunities than other locations.

The district's staff development Center offers technology-related courses on a variety of subjects: desktop publishing, the design of computer-based lessons, computer-generated slide shows, introduction to Macintosh, spreadsheets, word processing, data management, Logo Geometry, and the use of telecommunications with a stock market investment unit. All of the thirteen computer-related minicourses listed in the Spring 1990 catalogue meet for between one and six two-hour classes in a variety of locations in the county. Four courses, focusing on the Macintosh, meet at School X.

Scheduling has been a persistent problem in the area of training. Several informants remarked on the reluctance of teachers to attend after-school and Saturday training sessions. The alternative is to schedule sessions during the school day and provide substitutes, but, observes one principal, "parents and kids complain if you pull teachers out of class too much."

For some formal training offered in the district teachers can obtain State Department of Education or graduate credit. Apart from this, there are no special incentives. Time is generally not freed up for teachers to have the opportunity to pursue an interest in technology; they must do this on their own time.

Technical Assistance. Technical assistance is available from a variety of central sources including the Staff Development Center, the Microcomputer Supervisor's office, Media Services and the Department of Communications. The recently introduced E-mail system makes the turn-around time on technology-related queries from the Department of Communications very quick. Central assistance is also available for network installation. It seems that these central sources of support are generally accessed only by those teachers and other staff (e.g., media specialist, administrators) who have key responsibilities related to computers in the school. Most teachers go to staff within their school for technical assistance. Most often the sources of support are the media specialist, the computer science teacher, and other members of the computer committee. A scheduling difficulty arises here as well, however, because the schedules of teachers and of the providers of technical assistance, who themselves are teachers, in many cases, often conflict. Neither high school provides a formally designated, full- or part-time technical assistance person. Central media does have the goal of trying to establish such a position for each high school; however, it seems unlikely that this will occur in the near future, especially given the district's severe budgetary constraints. The lack of a truly timely source of technical assistance makes some teachers reluctant to make use of computer-based lesson plans.

The use that teachers make of available technical assistance is inconsistent. Those who are interested in using computers make the effort to get necessary technical assistance; however, access to technical assistance in the schools is highly dependent upon the personalities, interest, expertise, and schedules of those charged with providing the technical assistance. In some cases teachers simply give up trying to get help, often because of poor administrative planning or material resources deficiencies. One special education teacher, for example, has equipment that is unusable, because it needs cables and interface cards that she does not have money to buy.

E. Material Resources Domain

The discussion of this domain addresses the two focal points that emerged in informants' remarks: **availability** and **placement**.

Availability. Howard has the Apple II line, Macintosh, and MS/DOS compatibles. The first computers purchased in the district were Apple IIs. Many of those were originally in the high schools and later were moved to elementary schools; however, a number of Apple II computers remain in the high schools.

The pattern and mixture of computers for the schools included in our site visits is very similar. Most computers in both schools are in lab settings, but a number are distributed around the school in classrooms and offices. Interest is beginning to emerge in some newer, more sophisticated computer-based technologies (e.g., scanner with OCR software, laser discs, and telecommunications).

School X has more than 200 computers. Most of those employed instructionally are housed in lab settings. The writing lab consists of 15 networked Macintosh computers, two business labs with Apple IIes, and one MS/DOS lab for programming. There are plans to acquire soon a lab of IBM compatibles which will be shared by math and special education. In Math, each teacher currently has an IBM PS2 with projection device. There are also several class sets of TI-80 graphing calculators. Science classes utilize ten roving computers on carts for data entry and analysis. Some twenty of the older Apple IIes continue in use around the school: in special education classrooms, in the shop for CAD/CAM, and in social studies.

In addition, social studies and foreign languages are involved in a project which makes use of a satellite dish. This is not distance learning, but rather a way to enrich existing programs. For example, they pull in French and Spanish language TV shows to increase student awareness of the culture which surrounds the language they are studying and to increase their listening skills in the language. For social studies they bring in CNN daily news and the weekend review. In addition, supplementing this program, it is possible to obtain the text for lesson plans and other instructional materials using a modem.

The administrative computing environment at School X features the Macintosh. In addition, every major department has a Macintosh computer. Guidance and administration use Macintosh computers which are networked together for scheduling, grade reporting and electronic mail.

The available hardware at School Z includes 30 IBM PS2s in a networked business lab, 30 MS/DOS clones in a networked computer science lab, 15 Apples in a lab utilized by both Math and English, 15 Apple II+ and Apple IIes in special education, and several Apple II+ and IIe computers scattered in work areas and classrooms.

Placement. Many computers are assigned to specific locations for the long term and cannot be moved (e.g., refurbished computers provided by The National Cristina Foundation for use in special education programs; computer science lab computers). Others are under the control of the school's computer committee and can be assigned to a particular location only by the computer committee, usually working closely with the principal. The math/English lab at School Z was set up using this method. Consideration seems to be given to equity of access in terms of the numbers of computers available to students. However, in both schools special education and lower- achieving students tend to have access primarily to older Apple II line equipment (e.g., special education department computers in both schools; math/English skills lab at Centennial).

F. Instructional Applications Domain

While computers are used in all program areas, math, computer science and English are the areas where the most extensive instructional uses exist. Indirect applications, such as the use of an electronic gradebook or for test preparation, are quite widespread. As teachers become acquainted with computers through such managerial tasks, many expect the interest in instructional applications to follow. Even at School X, with the assistance of a business partnership, it is evident that expansion into new instructional applications is proceeding slowly. There is no evidence that new technology is being used simply for its own sake. Indeed, in-house studies at School X indicate that there is no appreciable gain in education from the use of technology per se; nevertheless, important self-esteem and motivational issues for students have been found.

Special education does have numerous applications for instructional technology, with drill and practice and tutorial applications being the most frequent. The advantage for special education is that teachers can program what individual students can do and monitor student achievements. Drill has been found especially useful in preparing students for functional tests -- math and citizenship -- that are required for graduation.

For the learning disabled, word processing and spelling check applications have been found especially helpful in motivating students to work on their writing. In the past, observes one special education supervisor, the learning disabled student would typically receive back a writing assignment with extensive markings and a notation at the top, "Do It Over." Word processing creates a much more acceptable environment for correcting and reworking text.

One special education teacher indicated an interest in interactive videodisc, which will enable the student to choose areas to work on, for example, in learning sign language, and repeat them as often as desired. Neither school has, as yet, invested in this technology and the media specialist at one expressed disappointment with the rudimentary level of much of the videodisc programming, which offers a range of choices, without being truly interactive.

II. Prince William County

Our research in Prince William County involved district level personnel in the special education office and the instructional media and technology office. It also included instructional, administrative, and support staff at two high schools. These high schools illustrate the varied level of computer use within this district. While the schools we studied in this district have a few very interesting programs involving instructional technology, the principles important to technology integration are illustrated more often by their lack than by their presence. Inasmuch as technology integration efforts are rare, this discussion will focus on general principles within each of the four domains, using examples from the districts and schools to illustrate the points.

As mentioned in the brief description of this district in Chapter I, Prince William County Schools are currently in a transition from centralized, district management, to site-based management. Primarily this means putting the majority of the school's budget, about 75 percent, in the hands of the principal. Principals report only to their area associate superintendents and the district superintendent. The associate superintendents in charge of curriculum, services, and management may only recommend changes, they cannot mandate changes at the school level. The district-wide transition to site-based management began in the 1990-91 school year. This change has had far ranging effects which are still becoming known. Its impact on technology integration in the high schools has been profound, if not dramatic.

A. Administrative Domain

Leadership

Because of the localization of budgeting and other decision-making matters, the role of leadership is changing within this district. While formerly the district administration has played a major role in determining the direction of technology use through the programs it funded and the technology it acquired for the schools, much of these responsibilities now rest within the schools. The switch has left some confusion about who has responsibility for what. Roles seem to be in a state of flux with school personnel unsure what to expect of district staff, and district staff unsure how to influence school staff.

Initiative

One of the crucial aspects of leadership we discuss in our model is initiative. In this district initiative about technology matters seem to be generated at the school level. This seems to be a result of the switch to site-based management, and the attitude of the current director of instructional technology. The district director of instructional technology feels that it is the schools' responsibility to lead out in technology, whereas she sees herself as a resource for the schools. Specifically, she feels the principal is the key factor in promoting technology use--if the principal doesn't promote technology use, nothing will happen. Because of the number of schools in the district, the technology director doesn't feel she has the time to spend with the schools that are not interested in technology. As they become more interested, she will work with them more.

Without the district taking responsibility for initiative, such leadership devolves to the schools. Under site-based management, this takes a number of different forms. The schools we studied offer two distinct views of leadership. In one school, change is definitely driven by the administration. The other seems to accept more direction from the teachers.

A teacher at School A obtained permission to join LABNET, a computer network of physics classes around the country. His use of this program is exciting, but has little impact outside his classroom, a point we realized because no one else talks about it. While impetus for new programs can begin in any arena of the schooling environment, and is often precipitated by an individual teacher's interests and actions, for such initiative and innovation to spread to the larger organization, some person with authority usually must disperse the idea.

At School B, the vice principals seem to have a more active role in creating initiative. With the principal they appear to provide the impetus for major programs in the schools. For example, they recently decided to take many of the computers scattered around the school and place them in a learning lab that is accessible to all classes. They also have recently begun a program that seeks to bring technology use into the school. They are particularly interested in better preparing those students who enter the workforce immediately following high school. As part of this effort they targeted the business program for acquiring a large purchase of computer equipment.

The structure of School A appears to allow teachers more freedom in their use of school resources. The structure of School B seems to be more carefully directed by the building administration.

Planning

Over the last six years the district has had a technology plan that guided its technology use. With the expiration of that plan and the advent of site-based management, administration had not intended on establishing a new plan at the district level. However, parental and school pressure led the superintendent to ask the district instructional technology director to prepare a new one. She has prepared the "vision" segment of this plan. However, she did not prepare a more detailed document because she has no budget to implement it. Its effect is uncertain because budgeting and program development has shifted to the schools.

The schools we studied have not developed any comprehensive plan to integrate technology. While administrators at School B seem to be considering technology in light of the curriculum and the changes they envision in teaching styles, they have not really focused on the myriad activities and systems that must exist to support such technology use. At School A, only one administrator seems to be concerned with technology. His interest is on administrative uses of technology and on its use as a research and information tool in the library. He also focuses more on the technology and its possibilities, not on the mechanisms required to support the system.

Administrators and teachers at the schools and district are engaged in some planning regarding technology use. However, we saw little to suggest that there was strong, systemic planning for technology use either at the school or the district level. Thus, while both schools and the district have plans for technology, they do not seem to be planning for technology integration.

Information Gathering

The only information gathering initiated by school personnel that we are aware of is the district instructional technology director's attempt to inventory computer equipment with the help of the schools' computer coordinators. The examples below offer some idea of the importance or possibility of information gathering in this district.

At School A, one of the school's computer aficionados, an administrator, has a definite vision of how technology can be useful to both the instructors and the administrators. He has convinced the principal to expend a large sum of money on a new computer network. However, when asked if the other administrators supported such technology use, he responded, "I don't know, I think so." His belief is that once people start to use them, they will be hooked. At this point it is unknown whether this particular technology is appropriate to the school's needs, or if it would be used.

At that same school Macro's use of a technology survey was rejected by a district office because:

> "The survey is not related to our needs. We can't justify the time required to give it for either the teachers or administration."

However, the school computer coordinator saw the survey as an excellent tool. While there is not much information gathering occurring at the school level, the district is trying to create an inventory of equipment in the district.

At School B the infrastructure for effective information gathering about technology is being established, though it is not currently seen in that light. "Quality circles" are being established to evaluate and provide feedback to teachers about teaching styles and curriculum. This may prove to be a mechanism for gathering information on how technology is being used and how teachers might want to use it. This school was more interested in the results of the technology survey.

In neither school do we see a systematic gathering of information about technology. No one person or even group of people is aware of everything that is occurring in the school pertaining to technology use. An example of this was mentioned previously: at School A, except for the teacher using the nation-wide physics network, no one mentioned this exciting use of technology. Such a dearth of information contributes to a poor ability to effectively coordinate and optimize the technological resources available in a school.

B. Human Resources

As schools implement technology, instructors and other staff have a need to understand how to use the technology and more importantly how to use it in enhancing their work. There is a great disparity in knowledge of technology use among the teachers in the Prince William County schools. Reasons for this can be seen in the following discussion about aspects of the human resource domain.

Competencies

Some steps have been taken to provide teachers with the knowledge they need to effectively use computers. This takes place at both the district and building level. There has been a district basic computer literacy requirement in the past, though teachers we talked to are not aware if that is still required. The district does not appear to have developed a set of computer competencies as part of that requirement.

Training

Training in Prince William occurs at both the district and school level. While the district instructional technology office offers eight courses, these do not seem to be familiar to the teachers we talked with. Those who did know of them were not impressed, because they felt the courses were much too basic for their needs. According to one teacher at School B, courses now being offered at the community college are quite good.

School A has a budget for teacher training, and has established technology training classes. Three courses were offered last year: word processing, databases, and spreadsheets. The district technology coordinator observed that the schools had already set up their training programs without giving her sufficient time to get out information about her own programs. The district class was taught by an English teacher about using computers in language arts instruction--the subject teachers in the school were interested in. The school's course was taught by a science teacher.

Inducement for taking courses, aside from the knowledge gained, is the accumulation of points which count towards recertification. College credit courses, such as those offered at the community college, offer a large number of points towards recertification.

This situation demonstrates the wide variety of opinions, needs, and activities that surround training in the district. It is difficult to determine exactly what the quality of the training in the district is. Communication about training may be good, though teachers think the training is poor, or the dissemination of information about current training is poor and teachers do not know the training's quality. In either case, teachers are not fully informed as to their options.

Technical Assistance

Technical assistance in Prince William is carried out by a number of people through both informal and formal channels. The formal avenues of assistance seemed to be the least used.

Formally we are aware of two district-level resources for technical assistance. The Instructional Media and Technology office (IMT) offers assistance generally, and the district data processing center offers assistance to the business programs. The IMT has one full-time and one half-time technician. However, the full-time person is leaving and the director says she will not be able to replace her, given how much she does, for the salary she will be able to offer. The director reports that both her technical assistance people are extremely busy. Teachers report that the district data processing center has no designated person to assist teachers with technical problems. They just help as they have time. This has proven quite ineffective for most business teachers.

Teachers in the business department described having to leave their classroom to call the data processing office--they had no phone in their room. A teacher would contact the district office, they would then answer the question if they could or call the appropriate company for assistance. The response would then be relayed to the teacher, she would go and try the suggestion, if it didn't work then she would have to leave her room, go back to a phone and start the process over again.

Teachers at both schools did not report using the help of the district technology people when they had problems. Indeed, most teachers did not seem aware of the IMT personnel. Instead teachers rely on the informal mechanisms to obtain solutions to their technical questions. Almost every teacher said that when they had problems they sought help from another teacher who was recognized as computer proficient, or they asked the help of family members (outside the schools) who had knowledge of computers. This was particularly common at School B.

C. Material Resources

Needs Assessment

At the district level, steps have been taken recently to obtain an accurate record of the technology employed in the schools. The instructional media and technology director has asked the school computer coordinators to compile an inventory of all computer equipment in the district. This activity is a first step in developing an effective needs assessment.

However, though the district is gathering information on computer equipment, needs assessment appears generally to occur at the school level. At both schools we studied such assessments seem to be informal instead of systematic. At School A it appears to be a departmental activity, with teachers from a given department meeting to discuss the next years needs. At School B, the vice principals seem to be considering the needs of the school as a whole. They keep a careful record of computer resources in the school, designating one vice principal to maintain an equipment inventory. They call him the "computer czar." As far as we could ascertain, though they inventory their equipment yearly, they conduct no formal needs assessment in their planning for computer use.

Placement

At School B, the vice principals seem to have much greater control on equipment within the areas under their auspices. Each year, they meet as a group to decide where equipment will be placed. However, they are constrained in moving equipment by the nature of the classes being taught and the effort some teachers went through to get computers. For example, the science department went to a great deal of effort to obtain computers through a local supermarket's promotion. One vice principal said that though theoretically the vice principals can move those, they would be crazy to do it. One step they recently did take was to move a number of the computers throughout the school to a central learning lab.

Acquisition

Under site-based management, principals determine where money will be allocated. Purchases were approved by the principal or vice principals based on the case that department heads presented. Administrators take the department chairs' concerns into consideration and then decide whether or not to go ahead with purchases.

The challenges associated with a shift to site-based management are evident in the acquisition system in this district. Though principals decide how money will be spent, district personnel are still tasked with purchasing the equipment. At School A this system has led to a long wait for the purchase of equipment for a local area network. The network has been approved by the primary user (the librarian) and the principal at her school, but it has not been acted upon yet by purchasing. The librarian was unsure what the reason for the delay was.

Another example, which occurred under the former system, also illustrates the need for links between classroom users and those who acquire technology. In the past the district data processing center has been in charge of acquiring technology for school business departments. They recently acquired new HP Vectras and a scanner for School A. However, neither the scanner nor the computers had the software required to perform the functions for which the equipment had been obtained.

Both these examples illustrate a misunderstanding of or about the processes involved in technology acquisition or a lack of communication between the school and district level. In the first situation there are delays that school personnel do not understand, and feel powerless to affect. In the second, those charged with acquiring technology are not well versed in the instructional purposes of the equipment and fail to acquire the appropriate software to enable the equipment's use.

Installation

Another situation that demonstrates the complexity of site-based management is in the maintenance operations. Generally teachers comment favorably on the time it takes district personnel to repair equipment. However, there comments are less positive about computer installation.

Traditionally, the district has had a policy that only district maintenance personnel could install equipment, because they were authorized to do so under the service contract. While some teachers overlooked that rule, most were unsure how to set up technology and abided by the policy. This policy often led to delays in setting up equipment. This was a frustration to teachers who had raised the expectations of students once the equipment arrived, and then had to wait while the equipment sat until the appropriate person could install the equipment. This policy may become less enforceable as teachers gain a greater understanding of technical equipment. Also, at least one teacher commented that it is no longer an issue under site-based management.

Given that the schools are choosing computer systems that no longer are on the district's purchasing list, there seems to be little point in having the maintenance people do the installation as a requirement of the service contract. For example, in the past, IBM has not been serviced by district personnel, so schools avoided acquiring such systems. Now, however, schools purchase what they think will best fit their needs.

Another example of the difficulties of installation and maintenance relates to the example given early about the acquisition of the new HP Vectras in School A. The personnel who installed the equipment did not leave disks of the software that was purchased. Thus, though the software is loaded onto the hard drives, if there is a problem with the software on a machine (not an unheard of occurrence, especially with high school students experimenting with it), the teacher cannot reload the software.

D. Instructional Domain

In both schools we studied, instructional technology use is quite high in specific courses. Business courses, especially, use computer technology extensively. Other areas that use computers include special education, science, and some of the vocational education classes, such as drafting. We documented various innovative uses of technology for instructional purposes in Prince William schools.

In a science class at School A, the teacher has gotten permission to be part of LABNET, a nationwide computer network. This required the acquisition of a modem and the cost of the telephone line, for which he received administration approval. His students take part in nation-wide experiments through the personal computer they have in their class. The first example demonstrates how small material acquisitions can have a large impact on the applicability of technology to the classroom.

At School B, students have been using CAD (Computer Aided Design) software on computers for a number of years. The drafting teacher was one of the first people to get a computer in the school, almost ten years ago. Since that time he has gradually acquired more powerful equipment. Now all his students must accomplish assignments on the computer. About four years ago the district started a program called "Challenge of Engineering" which he helped pilot at his school. Students performed experiments using the CAD equipment and had to track the results on spreadsheets. His next step is to obtain IBM compatible equipment so he can train his students on the most common CAD.

The second example demonstrates how the success of a classroom use of technology, in this case, CAD, can stimulate a larger program in the district. However, even given the success of such a program, it is valuable to note that the teacher was not able to employ the most common forms of CAD software (those most often used by businesses) because his district would not service the type of equipment required to run it.

One of the most innovative uses technology, which demonstrates how effective technology integration can be, occurred at School B. While that school is considered somewhat behind in technology use, the learning lab director has made good use of what is available. The director of the learning lab realized that one reason some students didn't do well in science classes is that they were unfamiliar and thus uncomfortable with the vocabulary. She asked the creative writing class to write stories using vocabulary from the science text. She then took the stories and asked the business teacher's students to edit them on the computer. From there the stories were given to the arts students to illustrate. Once all this was accomplished, the printing class used their equipment to print the stories with illustrations. Now students read these stories as they begin different units in their science classes.

This last example demonstrates a particularly exciting cross-departmental cooperation that makes effective use of the available technology resources for instructional purposes. This example has a deeper significance because of the teacher's comments about the experience. She was obviously excited about the project, but said she would not do anything similar any time soon because it was so demanding on her time.

This situation demonstrates how little time teachers have to develop such programs. The schools systems does not allow or necessarily enable such a use of time. The amount of technical effort involved in the project suggests that technology could be better used to accomplish such projects more effectively. The legwork involved in such a project is very demanding. The existence of a school-wide computer network, for example, could have greatly facilitated this process.

The issues this example raises demonstrates quite vividly the need for change in the structure and culture of the school organization if technology is to be effectively employed in furthering education.

Special Education

At neither of the schools we studied was technology employed as the special education teachers would have liked. At school A, the department chair uses technology with his students quite often. He never has a class of more than five or six students, and even though he has only a few computers, he can work with the students in small groups around the computer. He would like four to six computers to create a small lab just for special education. At school B, there are three computers for 112 special education students. The teachers there would like their own lab. Knowing that this is not an immediate possibility, they would be happy with a few computers that are compatible with the equipment used in the business and vocational areas so they can assist their students with the work in those classes.

III. Ridley School District

Ridley School District is a small school district near Philadelphia, Pennsylvania. The district has made an extensive effort to bring technology into the classroom. This process is still in its infancy, so it is hard to determine what the outcome will be, but large strides have already been made in technology use and understanding of instructional technology use.

Those district leaders who became interested in promoting technology use decided early that technology use required more than just making hardware and software available. They have seen technology use in light of technology integration. That is, they saw it as a systems challenge.

A. Administrative Domain

Leadership

In the Ridley School District, there has been strong leadership at various levels of the integration process. Support from the school board and the district administration, a visionary technology specialist, and school-level personnel who are dedicated to technology integration have provided a strong base for creating effective technology integration.

The recent push for an increased use of technology came from two district administrators. They believed that to promote effective, wide-spread technology use would require someone who could be involved with technology issues on a daily basis. Though both of these administrators were highly supportive of technology, neither had the time to devote to such a task. They convinced the school board of the need for a full-time position and asked a specific individual to apply for the job. Her background was in instructional technology support. The school board hired her as the district multi-media technology specialist.

At the high school level, the vice principal in charge of curriculum has served as a primary technology backer. With his support, the district technology specialist has created a number of mechanisms to pursue technology integration. In addition to administrative leadership, there are a number of teachers and other staff interested in technology who have played important roles in bringing greater technology use into the high school.

Initiative

Since her arrival, the district multimedia specialist has been the prime mover of technology integration in the high school. She has a vision of what she feels the district can do with technology. However, her focus is not on the technology as an end in itself. She sees technology as a tool for creating change in instructional techniques, change that will greatly enhance student learning.

Almost every informant singles her out as the reason that technology integration is occurring. Hers has been the primary role in creating change around technology understanding and use. However, the initiative of those administrators who saw the need for such a position was vitally important in creating the environment for change.

Some teachers have started to create their own uses for technology beyond what had been set forth in the district plan. Indeed, teachers are now approaching administrators with ideas and plans for technology use that were never envisioned. For example, the journalism teacher at the high school told the administrators to "put their money where their mouth was." He was provided with computers to use for desktop publishing.

Planning

Planning has been an essential part of the development of technology use in this district. Technology plans were created for both the district and the high school by the district multi-media specialist who has overall responsibility for planning. Curricular decisions are made at the building level by administrators, though the technology specialist has tried to work closely with them, because she sees technology as a tool which will improve the curriculum.

The technology plans were based in part on information gathered from school personnel through consultations and surveys. Currently, the technology specialist is working under a five-year technology plan. In creating the original district and high school technology plan, the technology specialist consulted with various teachers and administrators throughout the district. Several teachers report that they felt she was listening, but then did what she wanted to do anyway. The specialist herself felt that the process was rushed, but because of the pressure she was under to produce a plan quickly she had to make decisions rapidly. She also felt that at this stage, not many teachers had much understanding of what they were doing, and there was little time to educate them. Once it was developed, the plan was presented to teachers at an in-service meeting.

Generally the plan at the high school has three philosophical strands it is targeting.

- Computer Applications Training: Training all students in software applications that will apply across curriculum areas. These include word processing, databases. spreadsheets, and graphics.

- Instructional Technology Resources: Examining and implementing technology with the classroom in order to enrich and modernize the curriculum and facilitate the restructuring of the learning experience.

- Skill Training: Training students on technology that will provide them with marketable job skills. The Business Education and Industrial Arts departments are particularly involved in this program.

Cooperative Planning

Ridley School District expresses a desire to enable cooperative planning in technology related matters. The district technology specialist and high school administrators have established some mechanisms to allow teacher input into the planning process. Chief among these are technology committees. Prior to the arrival of the current district specialist, a small group of school leaders had met informally as a group in the central office to discuss further technology development. After the specialist's position was filled, committees were formally established or reformed after many years of inactivity.

At the high school, a committee composed of departmental representatives and other school staff had in fact been constituted for some time, led by vice principals. In the months prior to the district's new initiative on technology integration, this committee had met to discuss issues in technology development. Lacking sufficient information and knowledge of real possibilities within the district, these meetings were abandoned. Upon arriving, the technology specialist met with this group to present district ideas and plans for moving the schools up to current standards in technology use. Both she and committee members reported to us that the reaction of school staff was skeptical: they felt that the central staff had spoken this way before, nothing had happened, and they would believe it when they saw it.

As a result, the district specialist decided on a moratorium on meetings with the committee until some tangible signs of the new initiative were visible, for example, new computers. After her early efforts had become more visible, she returned to regular meetings. As implementation of the plan for the school progressed, equipment was introduced in stages, and training began, committee members became more receptive. During the second year of Macro's work with Ridley, the committee was observed to be highly active and involved in issues of planning, policy, and implementation.

The district specialist continued to play a role of setting direction and agenda, however. The pace of change, constraints of resource allocation, decisions by her superiors in the central office, and the clarity of her vision for integration, all seem to have combined to create the perception that the specialist's role is somewhat directive. This was seen especially during her first year. Teachers reported that although they felt she genuinely listened to their input, subsequent actions suggested to them that the decision had already been made. As the integration process has progressed, guided by school leaders in ways highly congruent with the principles found in the model of technology integration developed from Macro's research, such comments have evolved. Earlier concerns became supplanted with the assessment that the district specialist was in fact open to input and trying to do a good job, but hampered by the biases and agenda of higher level administrators.

By the end of the second year of Macro's observations, most informants were quire laudatory about the job that had been done. Comments were frequently made that without the leadership and initiative of the specialist, nothing would have happened. One originally recalcitrant teacher even observed that she was glad she had been forced into learning new ways of doing things. The technology specialist herself has frequently lamented the urgency with which early decisions had to be made and implemented, and expressed her concern that equipment and other changes were being made so rapidly that the proper goal of curriculum improvement and real integration might be lost or constrained in the future by current choices.

The Ridley case makes it clear, however, both that cooperative planning can take some effort and time to operationalize, and that it may not result in consensus on all matters. The selection of hardware for the district and high school early in the drive for technology development provides an example. For a variety of instructional, administrative, and technical reasons, including a need to quickly acquire platforms for training and to demonstrate the seriousness of the integration effort, district staff planned to standardize all schools on Macintosh computers. While many at the high school had no opinion or were acquiescent, some teachers were alarmed. Business education courses already were using DOS-based software, as were other instructors in mathematics, who used older Radio Shack computers as well. Serious exception was taken to the Macintosh development program.

This issue was one of the factors prompting concerns about the reality of cooperative planning, as the district announced its decisions to continue with its plans. The serious conflicts and potential for resistance was mitigated over time, however, through a variety of actions on the part of the district specialist and a vice principal at the high school. These steps included establishing a priority for development of a DOS computer laboratory for business education and other uses. A great deal of personal attention also was devoted to working with and providing assistance to key individuals who had been committed to DOS use. By the end of field research, successes in the technology integration program and the specific steps just mentioned appeared to have enabled continued cooperation. Disagreements in principle remained, but in operation staff were able to take advantage of the new resources and support within the established processes.

Information Gathering

The activities that demonstrate the district's emphasis on cooperative planning also illustrate mechanisms used for gathering information. One of the primary purposes of the district and school committees is to transmit information about technology uses to and from other staff. In addition to the existence of committees and close working ties with school teachers and administrators, the district technology specialist has conducted a number of surveys.

In preparing the district and high school technology plan, the technology specialist conducted a needs assessment, part of which was determined through a survey she created. That survey was administered throughout the district. In addition, Macro's technology survey was given in the high school. Evaluations and comments are formally solicited after training or technology awareness events.

The relationships, surveys, and committees provide a varied approach to gaining information on technology matters. The specialist also conducts or participates in technology training, another opportunity to learn from teachers.

B. Human Resources

The initial thinking of the district administrators who spearheaded the drive for technology development in the district was that training would have to play a key role in advancing the use of technology. While no formal set of required competencies have been established, they recognized that equipment alone would not lead to effective use of technology. For there to be wide-spread and worthwhile use of the equipment, the school would have to make an investment in planning and training, and they would need someone to lead in those activities.

Training

In bringing technology into the schools, training was to be a primary focus of the effort. District administrators decided to dedicate the majority of their in-service time for one school year to promoting technology awareness and use.

The first step at the high school was an in-service workshop in which the technology specialist introduced the technology plan to all staff. This was followed by training sessions for the teachers who would be using the new Macintosh labs which conducted by vendors. Over the summer, teachers who were to work in the writing lab received training from the district specialist. Also, teachers who would be using the other labs received additional training over the summer.

By the middle of the 1990-91 school year, the vice principal in charge of curriculum at the high school reported that about 50 percent of the teachers had taken introductory courses in computer use. This is an increase of abut 25 percent in less than a year.

While basic training is reaching a number of people at the high school, the technology specialist is trying to spread the message of technology use. In February of 1991, a full-day technology awareness day was held for the entire district. This was held on an in-service day and so was required attendance for all teachers. At this event, teachers had the option of attending various sessions taught by district teachers, outside teachers, and vendor representatives. Topics covered computer use at different school levels, levels of computer ability, and in curricular areas. Both instructional and administrative uses were addressed.

A few weeks after this event was held, two half-day in-services were held in which elementary schools and high school departments held technology-related events geared to the specific needs of that department or school. Currently, basic training continues for most teachers, while some are receiving additional training so that they can more effectively maintain the equipment in the computer labs.

As is evident, over the last year and a half, the district has invested heavily in promoting technology use among teachers. Training has taken various forms: general information, hands-on experience, and visits to other schools. This emphasis has resulted in an increase in computer knowledge throughout the district. As one administrator put it, "The technophobes are a dying breed." Though not all teachers seem to gravitate to technology use readily--many of the participants in the technology fair were obviously filling a square by attending--others seem captivated. The training has sparked an enthusiasm for technology use among many of the teachers. There are reports of various individuals seeking information on graduate work in instructional technology.

The increase in interest in technology can be attributed also to the greater availability of technological resources. However, training has played a key role in making this technology accessible and unthreatening to many of the staff.

The future of training is not certain. The technology specialist reports that while there will be continued budgetary support for acquiring technology, the focus of in-service time will shift in the coming year. She is unsure if money will be made available for teacher training. That is, teachers often have many activities and will need some incentive to attend after school training sessions. She is planning to distribute a questionnaire asking teachers to vote on various issues such as method of instruction, areas of interest, and desired incentives.

Technical Assistance

Technical assistance has been a challenge at Ridley High school. Staff are aware of the importance of technical assistance, though they are still struggling with the system that will best meet their needs. Such persons must be available as teachers need them, and have a grounding in at least the basic technical aspects of computer maintenance, both for software and hardware.

While there are computer coordinators at the elementary schools, the high school has not had a technical resource person until recently. Before then, most teachers simply contacted the district technology specialist if there were technical problems. She and technology users at the high school recognized that this was not a feasible relationship inasmuch as the technical matters interfered with her ability to direct technology integration throughout the district.

A new person was hired who had as part of his duties basic technical assistance in the high school. His responsibilities span a variety of areas, and he reports to a number of people. Over time it has become apparent that his responsibilities have made him relatively ineffective in assisting teachers. In addition, as his background was not originally in computers, he often has to call the district technology specialist, thereby generally negating the value of his serving as the primary technical assistance for the high school. In the future he does see himself working more with computers. After discussing the situation, members of the high school computer committee have decided to pick two teachers in each computer lab, to receive extra training and serve as the designated technical assistance persons for those labs. One will have primary responsibility for technical assistance, the other will be an alternate.

C. Material Resources

In the space of two years, Ridley High School has moved rapidly to acquire the hardware that facilitates technology use. The first stage of the district technology plan targets the high school for technology acquisitions. In the coming year this will shift to the elementary and middle schools. At the high school they have created a Macintosh lab for math and drafting courses, another Mac lab for keyboarding and word processing, and through a grant, they created a Macintosh lab for the English department. Each of these labs is new in the last year and contains 20 or more computers. This is an increase of three labs.

They have also expanded the IBM lab that the business department uses; it also has over 20 computers. They have taken their older Tandy machines and use them in basic math courses. There is also an Apple GS lab in the science department. In addition the social science and science departments use technology stations (a cart with a computer,large monitors, and interactive videodisc players) for class presentations. Also the front office and the counseling office have begun to use Macintoshes.

All of the above equipment was an original part of the technology plan. In addition, the journalism department has acquired computer technology for their classes and the music department is using a computer with a MIDI interface. Such projects were initiated by the teachers and demonstrate the effectiveness of the district plan to make teachers more aware of technology.

Defining the Purpose of Technology Use

An early component of the technology plan in this district was the needs assessment that the district technology specialist carried out. Much information was collected from teachers and administrators. The technology specialist also relied a great deal on her own experience, recognizing that teachers in the district had a limited knowledge of technology and its possible applications in instruction.

Choosing Installations

The general view of the technology specialist is that equipment choice should be based on the software required to meet instructional needs. This idea seems to be diffusing through the school. The vice principal in charge of curriculum told us that originally he thought the hardware question was the most important. Now he feels that you have to decide the purpose for the technology, choose software appropriate to your need and then choose your hardware.

Roles

The process of role definition occurs formally and informally. Both process are seen at Ridley. The district multi-media technology specialist is by far the most well defined of all the positions that relate to technology. Others that are in the process of being defined include the high school technical assistance person, the primary and alternate lab directors, and the software coordinator at the high school.

The multi-media technology specialist position has been defined by the school board. She has overall responsibility for all district technology efforts, including planning, training, and curriculum development. She also serves as the informal technical assistance person, a responsibility she has tried to move away from. Technical assistance bogs her down in details and keeps her from working on larger issues of integration.

The position charged with computer technical assistance was formally created by the district and has many responsibilities. This individual is at this point less involved in computers than in other technical concerns such as the school cable television studio. Because he has so many other responsibilities, the computer committee has decided to obtain more training for two teachers in each lab who will also provide assistance. Their roles are still developing.

A role the district technology specialist originally undertook by default was that of purchasing and distributing software. In the last year, this responsibility has been assigned to the high school librarian who keeps all the software and has set up a system for checking it out. She also helps teachers preview software so that they can determine if they want to purchase it.

Access

One of the characteristics of the high school is that it is very territorial. Recognizing this, planners placed computer labs in various parts of the building. Each lab has gained an identity--the math lab, the writing lab, the business lab--based on its primary use. However, the understanding is that labs will be open to all teachers and students when they are not otherwise scheduled. Whether teachers from different curricular areas will use these labs during free periods remains to be seen. The practice of locating them in parts of the building identified with certain subjects may discourage other teachers outside that area from using them. Students, however, appear to feel free to enter any lab to seek additional time on the computers. The committee is aware of this important issue of access. They are trying to promote access, while at the same time recognizing the cultural forces at play in the school.

It appears that lab time has quickly filled up with courses based around computer use. Currently, the labs are being used almost to capacity. As more and more teachers become aware of the contribution technology can make, they want to use it. Ironically, one of the district's specialist's fears was that they were acquiring technology too fast and not providing enough training. Now a bigger issue seems to be providing enough technology to keep up with demand.

Decisions about who will use the labs are discussed by the computer committee. It seems the vice principal in charge of curriculum plays a large role in determining who will use the labs because of his role in course scheduling and as a member on the committee.

Maintenance

A system has been established to provide for maintenance of computers. Most maintenance is handled under contract with the vendor. At each school in the district one person has been designated the computer maintenance contact. Whenever a computer needs repair, individuals contact that person. The contact person then delivers the machines to the vendor. At the high school the contact person is the technical assistance specialist. He takes computers to the vendor if they need to be fixed. In addition, the vendor comes to the school once a week to collect any computers that need fixing. Teachers are aware they need to get the computer to him before that day.

Implementation

Ridley has used a number of avenues to obtain computer equipment. The primary source has been the district itself. They have budgeted $100,000 a year for computer equipment. In the last year, this money has been targeted for the high school. In the coming year this is earmarked for the elementary and middle schools. Each school also has $10,000 they can used to acquire equipment, as well as a few more thousand they use for supplies. Any part of these funds can be use for technology acquisition.

In addition to district and school sources, Ridley has sought equipment from outside sources. The computers for the writing lab were obtained under a grant which the technology specialist prepared. Ten or eleven DOS machines were acquired from a supermarket promotion. This effectively doubled the size of the Business Department's IBM lab.

The Macintosh labs that the school has obtained with district funds were leased. This arrangement will allow the school to get the newest equipment in three years.

Installation

The district technology specialist reports that she is still learning about installing computers in a school district. She had assumed that by getting everyone's agreement and scheduling the installation it would be done. She has discovered that she has to do more than that. If not supervised carefully, things don't get done quite as she would like. In the first lab installed, when they turned the computers on, there was a brown out. The wiring for the surge suppressors had not been done properly. She says that she is learning how to deal with such things.

D. Instructional Domain

Technology efforts at Ridley have been focused on instructional ends. The technology specialist told us the reason she is so pro-technology is because it can change the way teachers teach for the better. Her concern is teaching and learning, not the technology. There has been an emphasis on how to use computers in the classroom.

Currently, the curriculum is being reviewed for ways that technology can support and alter it. For example, the high school is planning on phasing out typing. They have opened up the keyboarding courses to anyone and may require everyone to take it within the next few years. Also the Special Education program is under review, and technology's part in it is being considered. Due to the interest shown by special education staff, plans to develop this area of technology integration were given higher priority than originally proposed in the district technology plan.

Special education lags behind in computer use in this school. Currently the equipment is not available specifically for special education courses. Special education students use the computers in other classes, but the resource rooms do not have equipment. Both special education teachers at the high school are very interested in computer use. They have attended training sessions and visited other school where computers are used. The department head will be taking one home for the summer this year to become better acquainted with it. She is quite excited about this. The school allows teachers to take computers home for the summer which appears to be a strong incentive to learning more about them, and about how to use them in instruction.

Some faculty would like to see the math course move into using the computers in algebra and geometry courses instead of for programming, and have made steps in that direction. Already the Macintosh lab is being used as a writing lab.

The introduction of new technology into the schools has not been without incident. One business teacher who was originally opposed to the introduction of the Macintoshes, is quite enthusiastic about them now. However, she has said that for awhile she was barely ahead of her students in understanding what was going on. She was doing planning on a day-to-day basis because there was so much to learn. This example suggests that even given the time made available to these teachers, they could still use more time in preparing courses.

There is no formal software application evaluation procedure. The district media specialist seems heavily involved in reviewing software application. Also curricular specialists at the district level also seem to quite involved in this activity.

IV. Chittenden South Supervisory District

Chittenden South Supervisory District is a rural-suburban unit serving approximately 3300 students. As is the case with many New England school systems, the district is actually the union of several smaller and semi-autonomous schools, each of which has a governing board and its own community base. In such situations, the resources for action by the union school district commonly are complex, rather than simple allocations of authority, and effective direction requires the negotiation of support from all the participating schools, as well as acknowledgement of each school's goals.

Chittenden South is no exception. Working with a board that includes representatives from each school, the central office seems to have been successful in coordinating and supporting the union activities, especially in the area of technology integration. At the single high school, which accepts the students from all of the district schools, a combination of school and central district efforts appear to have created favorable conditions for the integration of technology. This balance of centralized support and leadership with decentralized decision making and direction for technology development has occurred in the context of similar approaches and changes in the areas of curricular reform and school reorganization generally.

Champlain Valley Union Senior High School serves approximately 800 students in four grades (9-12). Under the direction of the school principal and supporting central office staff, the school is further subdivided into three "houses." Students are randomly assigned to a house. Counselors' student case loads coincide with house membership. The faculty organization into departments exists as a parallel structure to the houses, but each department assigns its faculty to specific houses, creating an ongoing interdisciplinary team for each of them. The assignments of students and faculty are independent processes. A house director supervises the students and faculty within the unit.

The high school, and many other schools in the district as well, began to investigate computer technology as an "alternative instructional delivery system" in the early 1980's. With leadership from an assistant superintendent (supported by the district superintendent) and from the high school principal, equipment and software acquisition began. A district Educational Technology Committee was established in 1984. It incorporated representatives from each school; representatives from the high school were among the more active members. A building level committee also functioned for a couple of years to guide acquisition and budget allocations. Its functions were supplanted, however, when departments were given most of the authority over budgets decisions, including technology. In the meantime, district resources were devoted to training and staff development activities, while the high school created positions for technical support of faculty. By the close of fieldwork in 1991, many staff at Champlain Valley Union (CVU) had come to take technology use for granted. New concerns are now focused on "restructuring" for more effective schooling, with the use of instructional technology assumed as an integral part of that process.

A. Administrative Domain

Structures and positions have been developed in the Chittenden South district and at CVU High School to facilitate many of the functions and activities required in the Administrative Domain to support technology integration. As identified in the model of technology integration developed by this project, important steps were enabled in the areas of **vision and philosophy,** and **leadership**. Aspects of **planning** and **communication** are also addressed by activities in this domain in the district and the high school. Cooperative planning and projects are one result of the approaches taken. The district's **technology committee** appears to play an important role in many of these areas.

Vision. Chittenden South's philosophy and goals for technology integration have not been formally expressed in a technology plan or similar document. Instead, the district vision and the high school's conception of the role of technology use have been expressed in the personal statements of key leaders such as the assistant superintendent and the principal, in the consistent plans for technical and staff development undertaken by administrators and groups such as the Educational Technology Committee (ETC), and in the operating policies and procedures established by the ETC and for computer use in the high school.

Explicit and visionary statements of a philosophy that promotes technology integration have not been lacking, however. Increasingly in the last three to five years, technology has been highlighted as a part of a larger program, one that clarifies and directs the schooling goals toward a restructured and specific set of instructional objectives. For example, in the fall of 1989, district staff conducted what they sometimes referred to as a "town meeting" about education. Held in the high school, parents and interested individuals from across the district were invited to hear the superintendent articulate the "purposes" for education that are being developed. They participated in sessions to discuss various issues and these purposes.

"Sharing the vision" entailed focus on "essential behaviors for learners" that are seen both as characteristics of learners in an effective school as well as outcomes of a successful education. Emphasis is placed on thinking skills, self-confidence, the use of all and any appropriate tools for learning and the application of knowledge, independent capability within the context of cooperative learning, active learner involvement in the process, and the ability to express ideas, thoughts, and feelings. As interpreted by staff in the schools to whom we spoke, a central tenet of this vision is individualized instructional delivery, made appropriate for each child in each school, using whatever delivery system is needed for effectiveness.

Computer, television, and video technologies are clearly indicated as valuable components of the effort to pursue these instructional goals and purposes for schooling. The high school principal and house leaders appear to have been supportive of both the general direction and the role of technology in this particular vision. One of our key informants, a house leader and special educator at the high school, often strongly expressed his commitment to restructuring, and to the individual learning approach. Within this approach, the use of technology is a central element in addressing individual needs and development.

Acting further on the ideas embedded in the vision statements of the district, this informant worked with the Principal, the Assistant Superintendent for Alternative Delivery Systems, and other staff to prepare a proposal for funding the use of computerized personal instructional management software throughout the high school faculty. In their philosophies of use, the district and high school clearly support a view of technology as a tool for pursuing newly reformulated purposes and as one vehicle in an effort to reform education.

Leadership. Informants in Chittenden South and at the high school agree that instructional technology is increasingly used, and most would say it provides important benefits. While the perceptions of integration may differ in some ways among the district staff, the house leader, the high school computer coordinator, and specific classroom teachers, it does seem that the use of instructional computer and other technologies is becoming a norm at the school. The efforts of some key individuals appear to have been central in this development.

At the highest level, the statements of the district superintendent provide a congenial context for pursuing technology integration. The progressive direction set for the district incorporates a vision of the contributions technology can make, while authorizing school participants to consider its use and even develop some innovative applications in their lessons. This kind of thinking is backed up by the district mini-grant program, providing direct support to such innovations and explorations.

The superintendent does not usually, however, involve himself directly in the processes and activities that are involved in technology integration. An assistant superintendent (now for Alternative Delivery Systems) does play an energetic operational and coordinating role. This individual has a highly visible position of leadership in promoting and enabling technology integration among all the schools. In practice, he assumes this role by focusing on and highlighting the 'facilitating' aspects of leadership. For example, in his role on the technology committee, he ensures that issues of importance to his position or the district leadership are raised, but he is careful to give the initiative in discussing them, and much of the decisional authority, to the representatives from the schools.

The assistant superintendent seems to play a crucial brokering role for technology information, vendor relationships, and other resources, among schools in the district. He provides detailed assistance in identifying appropriate technology, in the development of specifications, contracts, and during negotiations, when schools are prepared to take steps in technology development and integration. He is very active in his participation in regional and national settings, promoting the accomplishments of his district and gaining various resources for it, such as CNN Newsroom and local cable television collaborations. The assistant superintendent has found the Manual useful, providing it to principals and leaders not only in Chittenden South but other districts who are interested in technology integration.

At the high school, the past and current principals both appear to have been key factors in the integration of technology within existing and restructuring programs. The principal's role is not as dramatically focused as that of the assistant superintendent but informants agree that the interest, encouragement, and finally, resources provided by the principal are largely responsible for much of the technology development and successful integration seen to this point.

Technology Committee. The district's Educational Technology Committee appears to play a key role in many of the functions and activities of the Administrative Domain. Originally charged to coordinate computer usage and teacher training throughout the district, the group recently seems to be taking on a broader mission. This increase in scope is occurring not only in the range of technology considered, but also in more complex issues of policy in the areas of human and material resource development. Substantial interest in several schools and at the district level in video production and cable television transmissions is an example of the first scope. As an example of the second, the committee last year began to grapple with the issues involved in defining the district's expectations of new and existing staff regarding competence, philosophy, and knowledge of educational technologies.

The committee meets monthly during the school year, with meetings usually slated for no more than one half day. In the summer, members meet for several days to address longer range planning needs, as well as to review activities and outcomes of the previous year. A major responsibility of the committee throughout its life has been to arrange for ongoing training to the entire district staff. It also periodically publishes a newsletter that goes to all schools. Committee members act as reviewers to coordinate a mini-grant program that encourages teachers to incorporate innovative uses of technology to "enhance the role of the teacher as the manager of the educational process." Between 1985 and 1990, this program delivered nearly $100,000 in grants. The Assistant Superintendent for Alternative Instructional Delivery Systems serves as administrative staff for that program, and also as the central district representative to the ETC. At the close of fieldwork, the committee was composed of three classroom teachers, a special educator, one librarian/media specialist, one computer coordinator, two computer technicians and the assistant superintendent. Members describe themselves as "proactive."

Planning. While there is not a comprehensive long term technology plan for either the district or the high school, a great deal of "strategic" as well as operational planning about technology does occur. For the district, much of the planning is incorporated in the activities and concerns of the ETC. In addition, technology use appears now to be integrated within planning for new schools and for curriculum review. At the high school, technology is a large and key component of planning for reform activities. Departments also identify needs and interests for instructional technology, often in consultation with the building computer coordinator or the district's assistant superintendent, and make purchase and budget requests that are then reviewed and acted on by the principal and her staff.

The technology committee increasingly deals with issues that have long term effects and fundamental implications for the district's schools. The development of "position papers" in the last two years provide an example. One not only specified the importance of word processing technology for the teaching of writing in the schools, but called for steps to act on this recognition: word processing will be taught at every developmental level; all students will learn keyboarding as they learn to write; teachers must also be able to use word processing in order to be effective teachers of writing and skills that entail writing; and software and equipment will be available and accessible to all teachers and students.

A second draft position starts to specify that all prospective, and eventually existing, faculty will have minimum knowledge and competencies in technology use. This paper includes a specification that faculty will be conscious of potential technological benefits and be able to discuss applications to their instructional program within a philosophy consistent with the Essential Learning Behaviors approach. Given imminent retirements of many staff, such positions, if adopted as policy, can have powerful impacts indeed.

At a recent summer meeting, committee members addressed topics such as a review of the previous year's activities, new certification procedures and course offerings, reports on new and interesting applications or technologies, recommendations to be presented to the district administrative council, the future of the mini-grant program, position papers to be developed, results of the latest technology survey, and a free-wheeling discussion with Robert Pearlman from AFT on technology initiatives across the nation. While the summer "retreat" structure provides one setting for long term planning, questions of strategic importance also appear to arise at regular monthly meetings as well, including status of position papers, discussions of the committee's relationship to the school board and its subcommittees, and similar topics.

Communication. Information gathering about technology use and needs has received great attention at Chittenden South and at CVU High School, although structures for that process differ between these two levels. The ETC and the assistant superintendent have made substantial use of technology surveys to identify progress and needs to the governing board. Over the last five years, those surveys have coincided with Macro's instruments. During Phase II of the project, administrations of the revised survey were reported to be helpful, while the basic format is being investigated as a template for new questions and foci for the survey. At the high school, departments use a variety of means, including meetings, to solicit technology needs and reports on status of use. The computer coordinator is often consulted for information and discussion. That individual also plays a key role in information gathering by devoting time to informal but apparently effective communication with many teachers regarding technology use, needs, plans, and assistance.

Because the members of the technology committee are also members of the faculty or staff of their respective schools, they can represent, to some extent, the interests of their constituency. Teachers at the high schools do apparently communicate some concerns to the computer coordinator relevant to the scope of the committee's work, and to a lesser extent to the media specialist, who also is a long time member of the committee. Much of this communication regards topics for training courses, which is by far the most visible aspect of the committee's work to teachers and principals. Representatives from the high school have been observed in committee meetings to bring up issues or items that appear important to staff generally or even to specific individuals, although they may not have been directed to do so by particular teachers or principals.

The committee representatives distribute their periodic newsletter to staff at the school. Feedback to the committee and our observations suggest that these are not a major source of technology information for teachers. Indeed, when seeking information about course topics or publicizing a class, a brief survey or special flyer is often employed, in addition to announcements in the newsletter.

Formal mechanisms to facilitate ongoing communication and collaboration among teachers about technology are few but do exist. There is a house newsletter periodically published. Each house has a team meeting. General faculty meetings also are regularly held. Our informants report that while technology issues sometimes arise in those gatherings, they are not a major focus at this time. Departmental meetings are optional and appear not to be very regular. Departments must deal with technology issues periodically, however, particularly in the context of budget preparation and equipment or software acquisition requests.

Teachers report some exchange among each other, particularly regarding the selection and review of software. At the same time, direct collaboration initiated by teachers seems relatively rare. One math instructor detailed the importance of interactions with other teachers in selecting software. She pointed out that time for that and more elaborate exchanges is very limited. Collaborations and initiatives stimulated by the principal, house leaders, and facilitated by the assistance of the computer coordinator do appear to occur, however. With the support of the principal and apparently some initiative from the house director, the math instructor just mentioned as well as other faculty from that department worked with the director to propose new distributions and use for computers in mathematics instruction. As a result, a Mathematics Resource Room was created.

In this case, special education and mathematics are working together. Special education also has been active in efforts to integrate technology. The coordinator reports special educators as among the strongest users of computers in the school. A technology Resource Room for special education has been established for several years. Special educators meet as a department at CVU to plan for curriculum progress and the role of technology within it. Recently, this group has directed attention to the use of software to help them address what they see as a significant need for social skills development, particularly as related to the transition to work. The house leader and special educator who served as our primary distribution point for the Manual in the high school reports that the Model of Technology Integration was reviewed and provided useful "concepts" to the group in their deliberations.

B. Human Resources Domain

From the very beginning of interest, Chittenden South and CVU High School as well have focused on the development of human potential as central to technology integration. **Positions** and **training** have been established to promote staff development in terms of knowledge, skills, comfort in use, and positive beliefs about instructional technology. Even now, as described in the previous section, the attention of the technology committee is on training, and also has evolved to consider the **competencies and philosophies** to be expected of faculty, seen in the development of position papers on technology in the writing process and on expectations of new faculty regarding technology.

Positions. A crucially important step in the district appears to have been the assignment of technology issues and alternative instructional delivery systems to an assistant superintendent. These foci take much of this position's time and attention. The individual who fills this role also is a highly active and creative person who is very interested in technology as an educational resource. Beyond that, establishment of active supervision at such a level of authority legitimates the pursuit of technology integration, provides explicit leadership and endorsement, and also facilitates the provision of support, seen for example, in the district's maintenance of a mini-grant program, MECC software holdings, and similar resources.

By Phase II of the technology integration project, the assistant superintendent was working with a subset of the district's governing board, focused on Alternative Delivery Systems. The establishment of this group also signifies visible endorsement and high degrees of interest in the use of technology to achieve the schools' mission. The activities of the district's Educational Technology Committee have been described earlier.

At the high school, the media specialist and librarian was an early and active member of the technology committee; in fact, she chaired this group for many years. Information about software (including some inventory records) such as catalogs or reviews are maintained in the school library. The media specialist reports relatively little technical knowledge, but has managed various technology related programs, particularly in the areas of video and cable television. She does not appear to be an important source of technical assistance, however.

Computer coordinator and laboratory supervisor positions have evolved at the high school. The coordinator seems to be a key figure in many aspects of technology integration. In the summer, some of his time is allocated to administrative computing and data management, but most of his time during the school year and some of the summer time as well are devoted to his coordinator functions. These include lab supervision, working with instructors who use the labs (less now than previously), equipment acquisition and placement, maintenance, and technical assistance to faculty, house directors, and the principal. He also teaches training courses. He is one of the school's two representatives to the ETC. There is now a part time assistant who monitors and manages one computer lab, thereby freeing the coordinator for other activities.

Training. Early courses, delivered through the mid to late 1980's, aimed to increase knowledge and familiarity with computer technology. Topics included such foci as basic introductions to equipment, to types of software, and to particular instructional applications. Courses also addressed the use of technology in particular areas of the curriculum, and distance learning. Current offerings have evolved in light of the growing knowledge base of the district's staff. They now include offerings on video technologies and their use, as well as more sophisticated applications courses in addition to basic classes. As with other aspects of schooling in the district at this time, the classes reflect the concern to tie all activities to the goals of restructuring.

Teachers have always had the opportunity, for most courses, to receive recertification or continuing education credits for class participation. A substitute is sometimes arranged for a given teacher to receive training or more information about a particular program or instructional application of software or equipment. Teachers interviewed by project staff pointed out that it may be a difficult trade-off to use a substitute or release time, however, because the class will fall behind schedule.

Members of the technology committee, led and supported by the assistant superintendent, also have taken pains to maintain their knowledge of technological possibilities and to explore new areas of potential benefit for instruction in the schools. For example, at one meeting observed by project staff, a committee member provided an extensive report on time he spent investigating the programs of the Saturn School in Minnesota. At several occasions in the past few years, the committee as a whole has taken the opportunity to attend workshops and classes at Lesley College, which provides significant resources and focus on technology integration. Members drive to this event in Massachusetts from Vermont and use the time for strategic planning and free discussion of technology futures for the district. Visits to other districts and schools have been arranged, and some members have joined the assistant superintendent in presentations at national meetings and conferences.

Competencies and Philosophies. The Educational Technology Committee is addressing several issues that constitute an emergent specification of expectations from new and old faculty regarding their philosophies of technology use and their knowledge and skills in that area. No formal list had been approved as district policy at the close of fieldwork. However, drafts of position papers being developed by the committee have highlighted points that include the following: word processing knowledge and skills, the ability to teach at least the keyboarding aspects of word processing, competence to use core equipment and peripherals, experience with software to manage student records, and coursework in computer instructional technology. The committee has discussed eventually submitting these papers to the process of review by the governing board that would lead to their adoption as policy.

At the school as well, there appears to be an emergent, though not formalized, set of expectations about the degree to which prospective staff are conscious of the potential uses of computer and other technologies. Technology competencies as such are not formally or informally required of prospective teachers. There is an overriding concern about the commitment of new faculty to restructuring and the objectives of the Essential Learning Behaviors, however. Within that context, candidates are interviewed about their knowledge and plans for delivery systems, including computer and other technologies.

C. Material Resources Domain

CVU High School has approximately 200 microcomputers, a few interactive videodisc stations, CD-ROM players in the library, various other peripherals, and a mini-computer for administration. That latter system will be replaced with a network of computers on which will be used special software for school administration and instructional management. The school's computer coordinator oversees the equipment. When consulted by department faculty or the principal, he advocates a consistent upgrade path for new equipment. He reports that at the close of fieldwork, there were approximately 40 Apples, 60 Macintoshes, and 100 DOS machines.

Computers at CVU are located in department or house offices, on a few carts, in some classrooms, and in computer labs. Labs include a writing lab, an open use lab, the special education Resource Room, the Mathematics Resource Room (new), and other departmental labs such as business or science. The coordinator has developed his own three year plan to place a computer on every teacher's desk.

As reported earlier, computer equipment and software is now acquired through department budgets. The coordinator indicates that most faculty discuss selections with him prior to their final decisions. He also reports that the principal will seek his opinion regarding various items as she determines final budget approval. In all cases, he emphasizes that he conceives his role as one of support for the teacher's purpose: simply to clarify or suggest equipment (primarily) solutions to the teacher's expressed instructional needs.

The coordinator is also the primary source for maintenance and logistical support of equipment and general applications software such as word processing. As software and equipment acquisitions have accumulated over the years, the coordinator with the support of school leadership has defined policies to specify supported and unsupported materials at the school. For example, he will support the current version of the word processing software standardized for use by the administrative network. He usually does not directly support specific instructional applications such as those used primarily by one department such foreign languages. He will assist to the extent possible with problems, however, and suggest other sources of information such as knowledgeable teachers, or the vendor.

D. Classroom Instructional Applications Domain

It is reflective of the findings incorporated into the Model of Technology Integration that at CVU and in the district generally the activities in other domains define the parameters and character, for the most part, of the Classroom Instructional Applications Domain. Many of the central items of this domain have already been outlined in the discussion of the other three domains. These include software selection, classroom organization (e.g., laboratory use), and instructional goals, including social and developmental objectives. A key element here is the long term emphasis on staff development, which has enabled many teachers to identify potentially useful applications and not fear to try them, as well as to exploit the resources and support processes available to them from other domain activities.

Practical Constraints. Sometimes, of course, the existence of supporting structures does not determine the actual experience of instructors and students. For example, the restricted number of interactive video disc stations required one math teacher to send students out of the classroom to use software she wished to apply, an undesirable outcome from her instructional point of view. The mathematics resource room was conceived and designed to pull together classes and individual users in a way that avoided current groupings of students requiring additional time or work. Because enough machines have not yet been acquired or reallocated, and because further scheduling will be required in math classes, this goal has not yet been reached. The room is primarily used by students for extra time or remediation efforts.

A wide range of software and approaches to its use appears to be found at CVU. This situation reflects both the prior training and attitude of staff as well as the control of budgets and instructional application by department faculty. Interactive video discs are used instructionally, as described above; the library makes use of CD-ROM, online services, and other applications for information retrieval and support of student writing and research.

The special education Resource Room traditionally has been heavily used and contains a variety of software for writing, drill and practice, and other uses. Although the staff in recent months have been concerned to conceive new and progressive directions for the room to keep it relevant, interesting, and stigma-free, there seems to be no doubt that many individual students have put it to good use.

Software Selection. The office of the assistant superintendent at the district has housed the central collection of software from MECC. These titles were an important core to the instructional applications collection for many years, but are now being phased out along with the few Apple II machines still remaining at the high school, and for that matter, in the district as a whole. This district office also downloads video transmissions such as CNN's Newsroom for use by classes in various schools.

The computer coordinator understands and supports the restructuring effort, and sees his challenge to be the successful translation of computer technology, which is originally designed for business use, to the high school mission. Many selection decisions are software decisions, however, and he explicitly takes a supportive but secondary role to the teacher in this area.

The media specialist maintains catalogs and information on software, as well as inventory of software available in the school. The latter appears infrequently used, and may no longer be up to date. Information about software is also available from some departmental offices. Faculty say they do use that source and the library collection for information.

Teachers interviewed for this project, however, indicate that these are not their most important sources, or the sources that have the most impact. Instead, these teachers seem most comfortable trying an application if another teacher has examined it or applied it. Another valued source is vendor or other displays and presentations at conferences or meetings. During Phase II, these sources were identified as very important, although the opportunities to attend such gatherings seem to be limited for staff.

Teachers report that they do talk to the computer coordinator about software choices, but usually not about its suitability for a particular instructional use. The coordinator corroborates this, explaining that while he tries to interpret instructional concerns into technical solutions, he is not a trained educator and cannot address the curriculum objectives. As a result, both teachers and the coordinator tend to focus on equipment needs or conditions required to successfully use a specific application.

Chapter IV

The Technology Survey

I. Pretest of Technology Assessment Survey

During the first year's study, a prototype technology assessment procedure was pretested. The survey format utilized a version of discrepancy evaluation method (DEM) analysis, as advocated by Malcolm Provos. Analyses of the pretest indicated that the method had heuristic value. The technology assessment survey approach was anticipated to become a component of the planned model development efforts.

The first year result from the pretest of the survey, although limited in scope and sample, indicated that word processing was rated as both important and highly used by special education teachers, both for their own use and as a teaching tool with students. Major discrepancies between relatively higher rankings of importance and lower rankings of use were bound for CAI applications. Interesting differences in perceptions of importance versus use were noted: between high and low level computer users, and between teachers in the two school districts.

In one instance, an interesting discrepancy in the results between the two school districts was followed up during the summer of 1987. Information was obtained that explained the difference and, thereby, reflected the utility of the technology survey approach, as a means to obtain decentralized information that would be useful to administrators and innovation planners.

II. Technology Assessment Surveys

Macro's conceptual model identified a need for administrators and teachers to develop better channels of communication regarding technological innovations in instruction:

Overly centralized (top-heavy, by administrators) decisionmaking can lead to resource allocation that does not reflect the interests of teachers. New media (e.g., computers) will be underutilized.

Over decentralized (bottom-up, by teachers) decisionmaking can lead to incompatibility of systems, and to applications that are not shared, inadequately supported, and vulnerable to staff turnover.

One solution to the communication gap is to develop mechanisms that provide opportunities for administrators to get a better understanding of staff experiences and interests related to new instructional technologies.

During the first year, a technology assessment survey (Version 1) was pretested with special education teachers. During the second year, 1987-88, these tests were extended to two larger formative evaluations of the survey (Versions 2 and 3), including all teachers in the high schools. At each step, the survey instrument was revised, based on findings from the prior study.

A fairly lengthy treatment of the results from the surveys, as presented to the two participating school districts, was presented in the Second Annual Research Report. Subsequently, additional analyses were also conducted in the fall of 1988 and the findings were presented at the Council for Exceptional Children's Conference on Special Education Technology.

A. Rationale for the Technology Surveys

During the past decade, as microcomputers have become more common in schools, teachers have discovered that there are a variety of applications that can be made. Word processing, drill and practice, telecommunications, and programming are examples. Many of these applications have potential usefulness in both special and regular education. Similarly, many appeal to teachers and administrators for their own personal or professional use, as well as for use by their students.

The evidence for patterns of preference and use is unclear and sometimes contradictory. For example, some researchers have found that special education classes used computers more often for drill and practice and educational games than for other types of applications (Hanley, et al., 1983; Rieth, Bahr, Polsgrove, Okolo, & Eckert, 1987; Cosden & Semmel, 1987). Alternatively, Lee (1987) found that teachers of learning disabled students preferred using tutorials to drill and practice programs. Thormann, Gersten, Moore, & Morvant (1986) also found that special education classes were making more use of tutorial software and programming applications.

Other investigators have looked at the broader picture of computer use across schools and districts. In a series of reports, Becker (1983-84; 1986-87) presented evidence of wide variability in applications between elementary and secondary schools and between different educational programs, as well as various shifts over time during this initial period of microcomputer implementation in schools.

One question that may be raised, therefore, is how school and district planning--regarding equipment, training, and policies--should attempt to incorporate the different perspectives present among educators. In line with Macro's conceptual framework, a paper-and-pencil survey format was designed to assess educators' perspectives and experience with computer applications in the schools. The survey was envisioned as one element in a model of practices to improve the integration of technology with the curriculum for mildly handicapped mainstreamed high school students. Local results from the surveys were shared with administrators, special education supervisors, and computer coordinators in the schools. Methods were examined for using the information to improve teacher training and computer management systems. Formative evaluations continued during Phase II of the project (1989-1991), to refine this and other communication mechanisms that are part of the model for technology implementation.

The preliminary results from initial tests of the surveys may have some heuristic value, inasmuch as they document current practices in two school districts with a history of commitment to the instructional application of new technologies. Further, evaluations were conducted in these initial surveys to determine whether the differences of opinion among educators were meaningful and reliable, particularly at the local level. Do some groups of teachers (e.g., special education) truly differ from others in their perceptions of which technologies appear most promising to them and, perhaps more importantly, in terms of current usage?

III. Method

A. Subjects

Following the pilot test of the survey with special education teachers in year 1 of the project, a revised version was administered during the second year, in two separate surveys:

- To all teachers in the Chittenden South, Vermont, school district (five elementary or middle schools and one high school)
- To all secondary teachers in the Howard County school district (eight general high schools and one vocational-technical high school)

The first administration of the revised survey (February 1988) was conducted by the district and school-based educational technology committees in Chittenden South. The survey forms were distributed, completed, and collected at special school faculty meetings, convened expressly for completion of the surveys. Under those conditions, almost all (99 percent) of the teachers in the schools completed the survey (n=193).

The second administration of the revised survey (May 1988) included a substudy to examine the response rates of alternate survey administration methods, including techniques that were less formal. Across the varied conditions, 74 percent of high school teachers in the Howard County, Maryland, school district completed the surveys (n=378). In both districts, other staff (e.g., principals, library and media specialists, counselors, and others) also completed surveys; but their results are not summarized here. Analysis of results from these other groups suggested that the instrumentation and procedure required modification to make the survey more valid for those groups.

B. Materials

A questionnaire, entitled "Technology Needs Assessment Survey," was developed in each school district, with the cooperation of the local staff. In particular, local staff identified the categories of computer use that they felt would be most helpful to them (in interpretation of the results), and also specified additional questions that were included on the survey forms (not analyzed here). One intent in model development is to provide flexibility in the survey mechanism, so that it can be tailored to particular--even idiosyncratic--concerns of local educators.

The researchers standardized the collection of information in two areas on the 1988 surveys: (a) ratings of "eventual importance," and (b) reports of current levels-of-use; each on 12 generic categories. The categories were agreed upon through discussions between the research team and local school staff:

- Drill and practice
- Behavior management and rewards
- Tutorial
- Student records
- Simulation
- Word processing
- Problem solving
- Database
- Programming
- Spreadsheet
- Educational games
- Telecommunications

The school staff felt that this list was meaningful to them.

The survey form consisted of a double-sided page. It was presumed that keeping the survey short would contribute to higher response rates. On the front page, staff were requested to rate "how important these computer applications might eventually be for you." The directions noted that importance could refer to either their own professional use or to their use with students. On the back page, staff were asked to indicate how often they currently used each of the applications.

The ratings of importance were on a 5-point scale: 1 indicating "Little" and 5, "Very." "No opinion" could also be entered. The reports of level-of-use were also formatted to a 5-point scale, but each point was nominally coded, to foster concurrent validity across responses:

- 1 -- Never
- 2 -- Once in a while
- 3 -- Once or twice a month
- 4 -- Once or twice a week
- 5 -- Almost every day

It was assumed that putting the ratings of importance and level-of-use on separate sides of the survey form would partially discourage efforts to "match" responses across the two sets of variables. Similarly, the ordering of the application categories was counterbalanced (scrambled) between the front and back pages and between the two surveys.

C. Procedure

As previously noted, tight control over distribution and completion of the surveys in Chittenden South school district resulted in very high response rates (99 percent of teachers). Because this survey is part of the model development effort, a substudy was conducted during the administration in the second setting (Howard County) to evaluate the possible impact of various, less controlled techniques for completing the surveys. These results were obtained:

Method of Distribution	Schools	Average Response
(1) Distribution at faculty meeting	4	83%
(2) Distribution by department heads	4	74%
(3) Distribution by mail boxes	2	65%

As anticipated, the rates of response were correlated with the level of control and associated visibility of administrative support for the survey.

IV. Results

A. Psychometric Substudies

Prior to the content-related analyses, survey data were examined in terms of various assessment properties. Analyses of Variance (ANOVAs) on specific items, and Multivariate Analyses of Variance (MANOVAs) treating all items, disclosed the following:

Across the 12 categories of computer applications, and in both the ratings of importance and levels-of-use, there were significant differences in ratings associated with:

- Teacher Role: Responses differed between special education teachers, math and science teachers, humanities (English, social studies, languages) teachers, and other (physical education, art, vocational education, business, etc.) teachers.

- Sex of Teacher: Responses differed between male and female teachers, in analyses which controlled for variance associated with teacher role.

Minor differences in the ratings between schools and districts could not be attributed to schools and districts as factors. (The few significant interactions between school or district and particular survey items occurred at a rate that could be attributable to chance.) Further, the MANOVA extracted role and sex as significant discriminant variables, but not school.

Another series of analyses were performed to examine the effects of nonresponse, specifically in Howard County where the proportion of teachers who responded ranged from a low of 58 percent to a high of 97 percent across the nine high schools. Some of the analyses that were performed are reported briefly here:

Comparison of weighted and unweighted estimators--A total of 336 comparisons (24 ratings variables [12 on importance, 12 on level-of-use] across 14 aggregated or stratified analyses [4 teacher roles, 9 school summaries, total]) were tested. The number of comparisons that yielded differences, between weighted (by stratified population totals) and unweighted estimators did not exceed the number that could have resulted by chance.

Many of the reports that would be returned to the schools incorporated ranks (rather than scalar metrics), to facilitate staff interpretations of the data. Consequently, analyses were also conducted of the possible differences between the ranks that would be generated from weighted versus unweighted score averages. Across 28 Spearman correlations (14 subgroups by ratings of importance, and by ratings of level-of-use), there were 14 perfect correlations; the remaining 10 correlations were all above 0.99.

These results demonstrated that, within certain limits, reductions of response rate did not appear to bias results. In the future, it would not be necessary, for example, to expect or require a 99-100 percent completion to satisfy validity or reliability of results. Similarly, it would not be necessary to weight data during analyses. (It was presumed that weighted analyses, although always preferable in surveys, would present problems to local school districts in their attempts to conduct such surveys.)

Direct test of sampling bias associated with reduced response rates--Another test of the effect of different response rates within schools was based on an alternate hypothesis that, where teachers had some choice as to whether or not they would complete the survey (demonstrated by comparably lower proportions of respondents within a school), the group that completed the survey would be biased in favor of teachers who were more favorably disposed to technological innovations (the subject of the survey). A compelling rival hypothesis could also be that higher responses rates indicated higher levels of interest within the school. The null hypothesis, in either case, was that response rates and actual ratings on the variables were not related.

These suppositions were tested through examination of the correlations between school response rates, which varied from 58 to 97 percent, and the average ratings, within schools and within the four specific teacher groups within school, on each of the 24 variables. Visual inspection of the correlations (and their signs) suggested a lack of bias associated with sampling rates. The set of correlations were also submitted to Kolmogorov-Smirnov goodness-of-fit test (Norusis, 1986) which showed that the distribution was normal and free from bias. These analyses provided additional support for the conviction that, within certain limits (e.g., the 58-97 percent ranges of response) average ratings and ranks were reliable estimators of teacher responses.

Other analyses were conducted to examine the potential bias from missing responses on particular survey items. Manual edits of the data disclosed, for example, that some respondents failed to circle any of the five importance, or five level-of-use, choices on items that, based on analyses of completed responses, generally rated as lowest in importance or infrequently used. Eliminating the nonresponses from analyses could potentially bias results if, in fact, nonresponse meant the same as "Little" or "Never," respectively on importance and level-of-use. Correlational analyses of groups who completed ratings on both types of items, and groups who completed one but not the other, clearly indicated that this was true. Consequently, in final analyses of data, values of "1" (Little, or Never) were imputed for missing responses on the importance and level-of-use items in cases where respondents had completed a majority of the other items.

B. Ratings of Importance

Multiple choice items on the survey forms permitted post- stratification of results for separate groups of teachers in the schools:

- Special education teachers
- Humanities teachers (English, social studies, languages)
- Math and science teachers
- General education teachers (only in the first survey, which included all schools in that district; these teachers were primarily grade-level instructional staff in elementary and middle schools)

- Other teachers (art, music, business, physical education, vocational education, ROTC, etc.)

In this summary of the results, Survey 1 refers to the survey of teachers in all schools in Chittenden South; Survey 2 refers to the survey of all high school teachers in Howard County. Availability of results from survey replications with these two very different school districts in the second year permitted some examination of the generalizability of findings.

In each of the surveys, there were significant differences between the ratings of importance across the teacher groups. Differences between teacher groups were significant ($p<.05$) on 6 of the application categories in Survey 1 and on 11 of the application categories in Survey 2.

In those application categories where significant differences in group variances were obtained, planned contrasts were examined. The planned contrasts tested the differences (two-tailed, at $p<.01$ level per test) between each specific teacher group, and all other teacher groups. This contrast approach had two advantages:

Limiting the contrast examination to one test between each group and all other groups reduced the number of possible contrasts and, therefore, reduced the potential for Type I errors.

The contrast was meaningful. Essentially, what was examined was whether any group stood out from others; for example, whether the ratings of importance for specific groups of teachers (e.g., special education teachers) were different from the ratings by teachers in general.

To further control for the relatively large number of contrasts that were examined, the alpha level for each contrast was set at .01. Consequently, for all teacher contrasts on each rating variable (5 teacher groups in Survey 1; 4 teacher groups in Survey 2), the aggregate alpha represented a 95 percent level of confidence ($p<.05$) per variable.

In Survey 1, three of the five groups of teachers differed from other teachers (significant contrast) on at least one of the importance ratings. In Survey 2, all four groups of high school teachers differed from other teachers on at least two of the importance ratings. The number of significant contrasts obtained for each group are shown below:

Significant Contrasts on 12 Variables of the
Importance of Computer Applications

Teachers	Survey 1	Survey 2
Special Education	3	2
Humanities	0	7
Math and Science	0	6
Grade level	2	-
Other Teachers	4	4

Exhibit IV-1 summarizes the contrasts in ratings of importance, between special education and other teachers.

In both surveys, two categories of application were viewed as more important by special education teachers: educational games and behavior management and rewards. A third category, tutorial applications, was rated more highly by special education teachers in both districts, but the difference was significant only in Survey 1. This degree of congruence in the areas that most distinguished special education teachers from others in the two school districts was particularly interesting, in light of the fact that Survey 1 was administered primarily in elementary and middle schools (only 1 of the 6 schools surveyed was a high school), and Survey 2 was administered exclusively in high schools.

Overall, there was a fairly high (.75) and significant ($p<.05$) degree of correlation on ratings of importance by special education teachers between Survey 1 and Survey 2. In both school districts they rated word processing, tutorial, and student records as highly important (above 4.0 on the 5-point scale). However, they differed in their relative ratings for some other areas, most notably on telecommunications.

C. Levels-of-Use

Reports of levels-of-use also differed significantly across groups of teachers in both surveys. Groups differed on 10 of the levels-of-use variables in Survey 1, and on 11 (of the 12) in Survey 2.

Exhibit IV-1

Average Responses for Teachers, and Comparisons to Responses of Special Education Teachers

Ratings of Importance				
	Survey 1		Survey 2	
	All Teachers	Special Education	All Teachers	Special Education
Drill and Practice	3.3	3.8	3.5	4.0
Tutorial	3.5	4.2*	3.4	4.0
Simulation	3.3	3.8	2.8	3.1
Problem Solving	3.7	3.9	3.0	3.5
Programming	2.6	2.5	2.5	2.5
Educational Games	3.5	4.1*	2.9	3.8*
Beh. Mgmt. & Rewards	2.6	3.4*	2.5	3.3*
Student Records	3.8	4.3	3.9	4.0
Word Processing	4.2	4.8	4.1	4.4
Database	3.3	3.7	3.0	2.8
Spread Sheet	3.0	3.0	2.6	2.2
Telecommunications	3.2	3.9	2.6	2.2
Reports of Levels-Of-Use				
	Survey 1		Survey 2	
	All Teachers	Special Education	All Teachers	Special Education
Drill and Practice	2.1	3.1*	1.9	3.0*
Tutorial	1.9	2.9*	1.8	3.0*
Simulation	1.5	1.6	1.5	1.4
Problem Solving	2.0	2.3	1.7	2.2
Programming	1.3	1.5	1.5	1.4
Educational Games	2.4	3.6*	1.8	3.0*
Beh. Mgmt. & Rewards	1.4	2.2*	1.4	2.2*
Student Records	1.7	2.5*	2.1	2.5
Word Processing	2.8	4.4*	2.8	3.0
Database	1.6	1.9	1.7	1.8
Spread Sheet	1.4	1.4	1.6	1.3
Telecommunications	1.3	1.5	1.3	1.1

* $p < .01$ (Variable-wise level of confidence on all contrasts: $p < .05$)

Planned contrasts (conducted the same as with ratings of importance) demonstrated specific differences for all groups except one, humanities teachers in Survey 1:

Significant Contrasts on 12 Variables of the
Level-of-Use of Computer Applications

Teachers	Survey 1	Survey 2
Special Education	6	4
Humanities	0	8
Math and Science	2	5
Grade level	3	-
Other Teachers	2	2

Exhibit IV-1 shows the contrasts between the self-reported levels-of-use from special education teachers and those of all teachers in each of the surveys.

In both surveys, special education teachers reported significantly higher levels-of-use for four generic categories of computer applications: drill and practice, tutorial, educational games, and behavior management and rewards (the last two of these had also been rated as more important by special education teachers). In two other categories, student records and word processing, higher levels-of-use were measured in both surveys, but were significantly different from other teachers' reports only in Survey 1.

As with the ratings of importance, levels-of-use reported by special education teachers in both districts were strongly correlated ($r=.84$, $p<.05$). Word processing, drill and practice, educational games, and tutorial applications were the most commonly reported applications by special education teachers.

V. Discussion

Two broad purposes of the project were served in the surveys conducted to this point:

- To model and evaluate psychometric properties of a survey designed to obtain teachers' impressions of the value of various computer applications, and their reports of current usage.

- To ascertain that teachers in different program areas, and special education teachers in particular, do actually differ in their orientation to the instructional application of computers.

Both of these objectives were met. With the support of the local school staff, high levels of response contributed to the reliability of survey data and permitted examination of the more content-related factors. The results also demonstrated quite adequately that, in at least the two participating school districts, there were measurable differences between teacher attitudes toward, and experience with computer-based instructional applications.

These results should not, however, be interpreted to suggest that the patterns expressed by teachers in these two surveys can be generalized to other districts. In fact, the findings that there were differences between the two school districts, and variability in the results across schools, emphasize a general variability that supports the intent of the survey as a component of Macro's model. (If all teachers, everywhere, had the same perspectives on technology, there would be no need to conduct local surveys.)

Further, it should be noted that, although the results confirmed differences between special education and other teachers, they also disclosed some similarities as well. For example, most teacher groups, in each of the surveys, rated word processing as most important and most commonly used. In Survey 2, which included data from high school teachers only, all four categories of teachers agreed on three out of four of the applications they rated most important: word processing, student records, and tutorial.

Alternatively, the two application categories where special education teachers' ratings of importance differed consistently from those of other teachers were educational games and using the computer for behavior management and rewards. In a recent survey of elementary school teachers in California, Cosden (1988) obtained a similar result and concluded that, "More special education teachers reported motivational and social goals for microcomputer instruction than did regular educators" (p. 251). If further research establishes that such patterns do have national generalizability, then it may call for more general efforts to alert policymakers to the significance of such a conclusion.

A. Implication for the Model

Results from the technology surveys in the second year became part of the considerations related to using the survey assessment approach as part of a model to address local efforts at technological innovation. In that regard, the critical objective, addressed in formative evaluations in the third year and planned for further evaluation during the replication stage (Phase II), can be represented by two questions:

- How can information about the differences in teachers' orientation toward computers be shared in the schools?

- How can this information be used in a strategic way to improve the planning and implementation of instructional technology systems, especially in high schools (primary focus of the study)?

While it was interesting, in the scientific sense, to demonstrate empirically that educators differ in their perspectives on technology use, it was neither surprising nor, in itself, particularly useful. The value of such knowledge will be derived from its transfer and application to strategic planning and implementation.

B. Phase II Use

With this concern in mind, the technology survey is incorporated as a resource for needs assessment in the model of technology integration resulting from Phase I project activities. Further, the survey was used as an information gathering instrument in Phase II monitoring of the replicability and significance of the model, incorporated within the Manual for Technology Integration. That purpose required a general identification of technology use and integration indicators, applicable across a range of schools where the survey would be unfamiliar to staff. At the conclusion of Phase I research and work with the instrument, a version had been prepared in which categories were not specified as specific applications (e.g., "word processing") but rather as functions or activities (e.g., "print materials"). This development occurred in response to input from participating schools, and in the context of our recognition that technical needs assessment must proceed from an assumption of little technical knowledge on the part of current or potential users. The overall task of assessment is to identify the technical applications that address the functional concerns or needs of school staff. Either the application-based or the activity-based versions of the survey have an important role in needs analysis, depending on the current conditions in a given district or school. For our Phase II purpose, the latter seemed most appropriate.

A copy of the activity-based technology survey questionnaire is included in this report, along with survey results for all teachers from three schools where it was administered twice: once early in the evaluation phase, and at the end of the Phase II field research. The data obtained from these instruments offer a rich set of insights into the change process at specific schools, in addition to their utility as practical tools for technology integration planners. Future analysis of these data will complement the presentation of qualitative analyses from the field sites in subsequent publications, including a comprehensive monograph on the technology integration project and its outcomes.

SCHOOL MICROCOMPUTER TECHNOLOGY SURVEY

Please take a few minutes to complete this survey on computer uses. The survey lists activities related to both your professional and instructional uses of the computer. The first two pages that follow focus on how much you use computers **now**, and the last two pages focus on how much you'd like to use computers in the **future**.

What is your primary role in the high school? (Check one)

____ 1. Special education staff (teacher or therapist)

____ 2. Teacher in humanities/language arts (English, history or social studies, foreign language, reading, etc.)

____ 3. Teacher in math/science areas (math, computers, biology, physics, chemistry, etc.)

____ 4. Teacher in arts and applications (business, art, industrial arts, music, drama, physical education, health, home economics, driver training, etc.)

____ 5. Teacher in other area; SPECIFY: ______________________________

____ 6. Teacher's Aide, Substitute Teacher, or Tutor

____ 7. Library or media specialist

____ 8. Administrator

____ 9. Counselor or psychologist

____ 10. Health professional

____ 11. Other; SPECIFY: ______________________________

____

This information is confidential; you do not need to sign your name. However, sometimes it is helpful to get followup information. If you would be willing to comment further, please sign your name.

____

First, think about how you are using computers right now.

How often are you currently using computers for these activities?
(Please circle one number for each item.)

	Never	Once in a while	Once or twice a month	Once or twice a week	Almost every day
To prepare print-based instructional materials	1	2	3	4	5
To prepare correspondence and reports	1	2	3	4	5
To prepare staff newsletters and publications	1	2	3	4	5
To manage student records or grades	1	2	3	4	5
To manage school records and course schedules	1	2	3	4	5
To manage curriculum and course content materials	1	2	3	4	5
To develop educational plans (for students or classes)	1	2	3	4	5
To inventory or monitor supplies, materials, equipment, or services	1	2	3	4	5
To develop or modify computer programs	1	2	3	4	5
To access information sources	1	2	3	4	5
To communicate electronically with colleagues	1	2	3	4	5

	Never	Once in a while	Once or twice a month	Once or twice a week	Almost every day
To present new course material	1	2	3	4	5
To measure student abilities or performance levels	1	2	3	4	5
To reinforce previously presented course material	1	2	3	4	5
To develop and improve students' writing and composition skills	1	2	3	4	5
To simulate situations or present problems linked to course material	1	2	3	4	5
To develop students' skills in using the computer as a tool to accomplish tasks	1	2	3	4	5
To develop students' awareness of what computers are and how they can be used	1	2	3	4	5
To allow students to communicate electronically with other students and schools	1	2	3	4	5
To develop students' skills in creating or modifying computer programs	1	2	3	4	5
To allow students to access information sources	1	2	3	4	5
To reward students for good behavior and performance	1	2	3	4	5

Now, think about how <u>you would like</u> to use computers in the <u>future</u>.

If training and material resources were available, how often would you like to use computers in each of these activities?
(Please circle one number for each item.)

	Never	Once in a while	Once or twice a month	Once or twice a week	Almost every day
To measure student abilities or performance levels	1	2	3	4	5
To reinforce previously presented course material	1	2	3	4	5
To present new course material	1	2	3	4	5
To simulate situations or present problems linked to course material	1	2	3	4	5
To develop and improve students' writing & composition skills	1	2	3	4	5
To reward students for good behavior and performance	1	2	3	4	5
To develop students' awareness of what computers are and how they can be used	1	2	3	4	5
To develop students' skills in using the computer as a tool to accomplish tasks	1	2	3	4	5
To develop students' skills in creating or modifying computer programs	1	2	3	4	5
To allow students to communicate electronically with other students and schools	1	2	3	4	5
To allow students to access information sources	1	2	3	4	5

	Never	Once in a while	Once or twice a month	Once or twice a week	Almost every day
To manage school records and course schedules	1	2	3	4	5
To manage student records or grades	1	2	3	4	5
To manage curriculum and course content materials	1	2	3	4	5
To inventory or monitor supplies, materials, equipment, or services	1	2	3	4	5
To develop educational plans (for students or classes)	1	2	3	4	5
To access information sources	1	2	3	4	5
To develop or modify computer programs	1	2	3	4	5
To communicate electronically with colleagues	1	2	3	4	5
To prepare correspondence and reports	1	2	3	4	5
To prepare print-based instructional materials	1	2	3	4	5
To prepare staff newsletters and publications	1	2	3	4	5

COMPARISON OF AVERAGE RATINGS ON
SCHOOL MICROCOMPUTER TECHNOLOGY SURVEY

Pennsylvania High School
All Teachers

Compared Ratings of Current Levels of Use

Use of Computer Technology	Survey 1 Average	Survey 2 Average	Percent Difference
Print Materials	2.51	2.78	10.76%
Letters and Reports	2.26	2.27	0.44%
Staff Publications	1.36	1.32	-2.94%
Student Records	1.77	1.83	3.39%
School Records	1.24	1.26	1.61%
Course Mat. Mgmt.	1.84	2.03	10.33%
Develop Ed. Plans	1.98	2.06	4.04%
Maintain Inventory	1.41	1.27	-9.93%
Program (Teachers)	1.31	1.26	-3.82%
Info. Srcs. (Tchrs.)	1.36	1.42	4.41%
Elec. Comm. (Tchr.)	1.13	1.1	-2.65%
Measure Performance	1.61	1.64	1.86%
Reinforce Material	1.63	1.82	11.66%
Present New Material	1.74	1.97	13.22%
Simulate Situations	1.6	1.64	2.50%
Writing Skills	1.33	1.58	18.80%
Reward Behavior	1.21	1.19	-1.65%
Computer Awareness	1.58	1.73	9.49%
Computer as Tool	1.56	1.64	5.13%
Program (Students)	1.16	1.19	2.59%
Elec. Comm. (Stdt.)	1.06	1.01	-4.72%
Info. Srcs. (Stdts)	1.16	1.23	6.03%
All Categories	1.54	1.6	3.90%

COMPARISON OF AVERAGE RATINGS ON
SCHOOL MICROCOMPUTER TECHNOLOGY SURVEY

Pennsylvania High School
All Teachers

Compared Ratings of Desired Levels of Future Use

Use of Computer Technology	Survey 1 Average	Survey 2 Average	Percent Difference
Print Materials	3.4	3.37	-0.88%
Letters and Reports	2.9	2.71	-6.55%
Staff Publications	1.85	1.79	-3.24%
Student Records	3.49	3.37	-3.44%
School Records	2.44	2.62	7.38%
Course Mat. Mgmt.	2.85	2.9	1.75%
Develop Ed. Plans	3.1	2.95	-4.84%
Maintain Inventory	2.21	2.04	-7.69%
Program (Teachers)	1.8	1.96	8.89%
Info. Srcs. (Tchrs.)	2.71	2.72	0.37%
Elec. Comm. (Tchr.)	1.99	1.86	-6.53%
Measure Performance	2.66	2.55	-4.14%
Reinforce Material	2.89	2.9	0.35%
Present New Material	2.94	2.9	-1.36%
Simulate Situations	2.86	2.85	-0.35%
Writing Skills	2.56	2.67	4.30%
Reward Behavior	2.09	2.22	6.22%
Computer Awareness	2.8	2.68	-4.29%
Computer as Tool	2.89	2.87	-0.69%
Program (Students)	1.91	1.91	0.00%
Elec. Comm. (Stdt.)	1.85	1.85	0.00%
Info. Srcs. (Stdts)	2.35	2.38	1.28%
All Categories	2.57	2.55	-0.78%

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COMPARISON OF AVERAGE RATINGS ON
SCHOOL MICROCOMPUTER TECHNOLOGY SURVEY

Vermont High School
All Teachers

Compared Ratings of Current Levels of Use

Use of Computer Technology	Survey 1 Average	Survey 2 Average	Percent Difference
Print Materials	2.78	3.07	10.43%
Letters and Reports	3.02	3.5	15.89%
Staff Publications	1.64	1.81	10.37%
Student Records	2.02	2.43	20.30%
School Records	1.51	1.76	16.56%
Course Mat. Mgmt.	2	2.36	18.00%
Develop Ed. Plans	2.22	2.38	7.21%
Maintain Inventory	1.41	1.52	7.80%
Program (Teachers)	1.27	1.31	3.15%
Info. Srcs. (Tchrs.)	2.22	2.4	8.11%
Elec. Comm. (Tchr.)	1.29	1.36	5.43%
Measure Performance	1.46	1.67	14.38%
Reinforce Material	1.81	2.14	18.23%
Present New Material	1.97	1.95	-1.02%
Simulate Situations	1.75	1.93	10.29%
Writing Skills	2.2	2.24	1.82%
Reward Behavior	1.24	1.5	20.97%
Computer Awareness	2.08	2.55	22.60%
Computer as Tool	2.31	2.5	8.23%
Program (Students)	1.14	1.14	0.00%
Elec. Comm. (Stdt.)	1.15	1.31	13.91%
Info. Srcs. (Stdts.)	1.71	1.93	12.87%
All Categories	1.83	2.03	10.93%

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COMPARISON OF AVERAGE RATINGS ON
SCHOOL MICROCOMPUTER TECHNOLOGY SURVEY

Vermont High School
All Teachers

Compared Ratings of Desired Levels of Future Use

Use of Computer Technology	Survey 1 Average	Survey 2 Average	Percent Difference
Print Materials	3.39	3.57	5.31%
Letters and Reports	3.59	3.62	0.84%
Staff Publications	2.42	2.5	3.31%
Student Records	3.47	3.64	4.90%
School Records	2.97	3.07	3.37%
Course Mat. Mgmt.	2.9	2.95	1.72%
Develop Ed. Plans	3.03	3.1	2.31%
Maintain Inventory	2.42	2.52	4.13%
Program (Teachers)	2	2.07	3.50%
Info. Srcs. (Tchrs.)	3.24	3.79	16.98%
Elec. Comm. (Tchr.)	2.44	2.69	10.25%
Measure Performance	2.19	2.98	36.07%
Reinforce Material	2.56	2.81	9.77%
Present New Material	2.39	2.74	14.64%
Simulate Situations	2.9	2.9	0.00%
Writing Skills	3.08	3.17	2.92%
Reward Behavior	1.78	2.02	13.48%
Computer Awareness	2.92	3.1	6.16%
Computer as Tool	3.15	3.48	10.48%
Program (Students)	1.92	1.79	-6.77%
Elec. Comm. (Stdt.)	2.32	2.52	8.62%
Info. Srcs. (Stdts.)	2.95	3.29	11.53%
All Categories	2.73	2.92	6.96%

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COMPARISON OF AVERAGE RATINGS ON
SCHOOL MICROCOMPUTER TECHNOLOGY SURVEY

School X
All Teachers

Compared Ratings of Current Levels of Use

Use of Computer Technology	Survey 1 Average	Survey 2 Average	Percent Difference
Print Materials	3.20	3.20	0.00%
Letters and Reports	2.77	3.08	11.19%
Staff Publications	1.70	1.92	12.94%
Student Records	1.93	2.65	37.31%
School Records	1.33	1.45	9.02%
Course Mat. Mgmt.	2.20	2.38	8.18%
Develop Ed. Plans	2.77	2.72	-1.81%
Maintain Inventory	1.90	1.75	-7.89%
Program (Teachers)	1.70	1.65	-2.94%
Info. Srcs. (Tchrs.)	1.60	1.80	12.50%
Elec. Comm. (Tchr.)	1.07	1.20	12.15%
Measure Performance	1.93	1.92	-0.52%
Reinforce Material	2.60	2.17	-16.54%
Present New Material	2.37	2.30	-2.95%
Simulate Situations	2.03	1.88	-7.39%
Writing Skills	1.67	1.83	9.58%
Reward Behavior	1.43	1.55	8.39%
Computer Awareness	2.23	2.20	-1.35%
Computer as Tool	2.20	2.10	-4.55%
Program (Students)	1.07	1.38	28.97%
Elec. Comm. (Stdt.)	1.03	1.23	19.42%
Info. Srcs. (Stdts)	1.50	1.55	3.33%
All Categories	1.92	2.00	4.17%

COMPARISON OF AVERAGE RATINGS ON
SCHOOL MICROCOMPUTER TECHNOLOGY SURVEY

School X
All Teachers

Compared Ratings of Desired Levels of Future Use

Use of Computer Technology	Survey 1 Average	Survey 2 Average	Percent Difference
Print Materials	3.73	3.22	-13.67%
Letters and Reports	3.33	2.97	-10.81%
Staff Publications	2.03	2.15	5.91%
Student Records	3.77	3.30	-12.47%
School Records	2.27	2.30	1.32%
Course Mat. Mgmt.	3.13	2.92	-6.71%
Develop Ed. Plans	3.53	2.95	-16.43%
Maintain Inventory	2.40	2.55	6.25%
Program (Teachers)	2.07	1.98	-4.35%
Info. Srcs. (Tchrs.)	3.23	2.95	-8.67%
Elec. Comm. (Tchr.)	2.60	2.55	-1.92%
Measure Performance	2.47	2.45	-0.81%
Reinforce Material	3.07	2.67	-13.03%
Present New Material	3.03	2.85	-5.94%
Simulate Situations	2.97	2.63	-11.45%
Writing Skills	2.17	2.45	12.90%
Reward Behavior	2.10	2.10	0.00%
Computer Awareness	2.70	2.50	-7.41%
Computer as Tool	3.03	2.58	-14.85%
Program (Students)	1.63	1.75	7.36%
Elec. Comm. (Stdt.)	1.80	2.08	15.56%
Info. Srcs. (Stdts)	2.67	2.45	-8.24%
All Categories	2.72	2.56	-5.88%

Abbreviations Used in Exhibits

Abbreviation	Description
Print Materials	To prepare print-based instructional materials
Letters and Reports	To prepare correspondence and reports
Staff Publications	To prepare staff newsletters and publications
Student Records	To manage student records or grades
School Records	To manage school records and course schedules
Course Mat. Mgmt.	To manage curriculum and course content materials
Develop Ed. Plans	To develop educational plans (for students or classes)
Maintain Inventory	To inventory or monitor supplies, materials, equipment, or services
Program (Teachers)	To develop or modify computer programs
Info. Srcs. (Tchrs.)	To access information sources
Elec. Comm. (Tchr.)	To communicate electronically with colleagues
Measure Performance	To measure student abilities or performance levels
Reinforce Material	To reinforce previously presented course material
Present New Material	To present new course material
Simulate Situations	To simulate situations or present problems linked to course material
Writing Skills	To develop and improve students' writing and composition skills
Reward Behavior	To reward students for good behavior and performance
Computer Awareness	To develop students' awareness of what computers are and how they can be used
Computer as Tool	To develop students' skills in using the computer as a tool to accomplish tasks
Program (Students)	To develop students' skills in creating or modifying computer programs
Elec. Comm. (Stdt.)	To allow students to communicate electronically with other students and schools
Info. Srcs. (Stdts.)	To allow students to access information sources

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Chapter V

Substudies

I. Computer Industries Substudy

Industry representatives participated in Phase I of the project on our Vendors Team: representatives were invited from two hardware vendors (IBM and Apple) and from two software companies (DLM Teaching Resources and Mindscape). The Vendors Team participated in our Principal Partners meeting during the fall of 1986, with representatives from the school districts, and assisted in planning the first year's qualitative research. During the spring of 1987, the Vendors Team also assisted in the design and completion of an industry substudy, targeting issues related to vendor/educator interactions and special education use of computer technologies. The following comments represent highlights from that substudy.

A. Product Selection and Development

Vendors reported that processes for identifying and developing new product lines in the educational computing sphere were largely internal to the organization of the companies. Very rarely does an outside individual, such as a special education teacher, come up with a "great idea" or prototype product that is then adopted by the commercial concern.

More and more, the larger companies rely on local sales representatives to obtain information on school needs and interests. This information is then reported back to development groups within the companies who have responsibility for new products, or updating older products. Company representatives also participate in educational and professional conferences to: (a) get information on trends, and (b) increase their visibility in the educational marketplace.

A primary factor always considered in new product offerings is profitability. Other factors include contribution and integration with existing product lines, and reflection of the company's public image. Vendors attributed some of the mistakes of the past to faulty executive-level decisionmaking, overly complicated technologies, awkward execution of good ideas, and high pricing.

B. Marketing and Advertising

Although vendors reported that their companies made use of all traditional marketing and advertising venues, they agreed that personal approaches were the most successful. In this regard, many firms in recent years have hired educators to become sales and marketing representatives, working directly with local school staff to provide and support hardware and software. Such representatives are also more capable to pick up and interpret information and trends on computer use, and pass that information back to the parent companies.

While general mass marketing efforts were characterized as limited in impact, targeted mailings have been useful. Mailing lists are now part of electronic databases that allow the vendors to carefully and multidimensionally select specific target audiences for particular promotions.

In general, vendors did not perceive the special education market, or special educators, as much different from other educational markets. It was noted, however, that some special educators are "too desperate" for materials and, therefore, make unwise choices. Also, special education programs do not have as much clout in terms of larger purchases, still mostly controlled by district level and general education groups in the schools. Vendors also suggested that unused funds were available for hardware and software purchases--some from private foundations--but educators were not well enough aware of such resources or of how to use them.

C. Partnership with Local School Districts

Three of our four vendor companies established some partnership relationships with the school districts: two with Chittenden South and one with Howard County. One of these relationships was initiated prior to the onset (fall, 1986) of this study. None of the relationships was directly related to instructional uses of computers for handicapped students at the high school level.

Vendors reported that typical partnership relationships between their companies and schools were small in scope and conducted primarily as vehicles to promote sales of company material, by making local educators more knowledgeable about the products and familiar with procedures for using them effectively. Relationships also provide a mechanism for picking up information on trends in educational use of computers and, in the case of larger and more structured projects, evaluating and refining prototype products and their supporting materials.

D. Future Directions

Vendors were enthusiastic about evolving technologies, such as high storage media, networks, and speech synthesis. Nevertheless, they characterized the current climate as uncertain: recent changes in hardware and operation systems (e.g., IBM's OS/2 and Apple's IIgs) made it unclear where the market would head in the next decade. Many developers and vendors were adopting a "wait-see" attitude before committing to any major new innovations or developments.

On the software side, vendors saw some shift toward products that were more integrated: into instructional management systems and in the context of established curricula and materials, including texts. They also foresaw less emphasis on narrow-market products, such as only for special education, and more concentration on broadening a product's appeal to wider audiences, without necessarily sacrificing the features that make the product useful to the narrow markets.

II. Curricular Studies in the Second Year

The curriculum for mildly cognitively impaired high school students in the two school districts was examined through surveys of student IEPs and class schedules. In conjunction with these surveys, a comprehensive, organized list (Curriculum Taxonomy) was developed of the content areas that could be targeted in high school instruction: in resource rooms and in the mainstream. The list could also be used to analyze and link software and other media to instructional goals (a possible long term objective of the model development activities).

To incorporate materials from within the two lead school districts, and from a broader, national base, a series of reviews were conducted of various curricular guidelines. A primary purpose for these reviews was to develop a paradigm--in the form of an organized taxonomy of possible curricular content areas--that could be used to guide the actual curricular investigations.

The purpose was to develop a fairly comprehensive general outline of the major content areas, and a detailed list of Math and Language Art areas, that would be reflected in the curriculum of mainstreamed, mildly cognitively handicapped high school students. Much of the further work of the project could then be carried out with this taxonomy as a reference point, rather than tying the work to the curriculum goals of any individual school district. An intention at that point was to have this taxonomy serve as an interface through which school-system-specific objectives for individual students, information from student course schedules, and the content of available CAI software could eventually be linked.

It was assumed that this group, mildly cognitively handicapped mainstreamed students, would primarily be following the scope and sequence of the general education program in their district. However, in general, their progress would be somewhat slower than that of their nonhandicapped peers. Therefore, the sources for the content categories that were developed included both regular and special education documents. In general, there was little difference between the two, and this reinforced a belief that it would be appropriate to look at both and, in fact, give their objectives equal consideration for inclusion in the taxonomy.

In addition to curriculum materials obtained from the two participating school districts, State materials from Maryland, Vermont, California, New York, Florida, and Texas were used. In a way, the original curriculum taxonomy represented a set of hypotheses about what content might be identified in the planned studies on student curricula:

Content expressed in IEP objectives--Subject matter contained in the courses in which students were enrolled (primarily mainstream courses)

Computer applications and software in use--Modifications to the taxonomy would be made to include additional content areas, as they came up in the actual investigations during year 2.

It was anticipated that most of the students in the sample would be progressing through the scope and sequence of regular education at a slower rate than nonhandicapped students. Therefore, greater detail was provided to content areas up through the level that would be the minimum required for high school graduation. Consequently, only broader objectives were identified, for example, in the mathematics section above the pre-algebra level. Similarly, the detailed content objectives in language arts were restricted to information derived primarily from three sources: State minimum competency requirements, school-system-prepared IEP objectives, and the English objectives of regular education up to the minimum level required for high school graduation.

The initial curriculum taxonomy included:

- Mathematics content areas - 476 categories

- Language arts content areas - 586 categories

Additional curriculum areas:

- Personal development - 9 categories
- Vocational/adult education - 8 categories
- Social studies - 10 categories
- Science - 17 categories
- Fine arts - 13 categories
- Foreign languages - 7 categories

Total initial curricular areas - 1,126 categories

As these counts disclose, only the content areas in mathematics and language arts were covered in detail. Descriptors in other areas were much more generic. For example, in Science one category was "Chemistry." Alternatively, under Mathematics there was a separate category for "Traditional multiplication algorithm: Multidigit multiplier, multidigit multiplicand, with regrouping."

As anticipated, the data collection and subsequent analyses during the spring did result in the addition of other categories to the Curriculum Taxonomy. The final taxonomy included 1,355 categories. This taxonomy is presented in the Appendices (Volume 2) of the Second Annual Research Report.

A. Sample Design

The subject population was Mildly Cognitively Handicapped High School Students in two school districts. With consultation between Macro staff and the COTR, Dr. Charlotte Royeen (OSEP), this finite population was operationally defined to include all special education students in the regular high schools with local classifications associated with the Federal definitions of Mental Retardation, Speech or Language Impaired, and Specific Learning Disability. The final sample from Howard County included 95 students: 6 (MR), 39 (SI/LI), and 50 (SLD). Along with the 42 students in the one high school in Vermont, data collection was conducted on a total sample of 137 students in the two school districts.

B. Data Collection Procedure

The type of information to be collected included both quantitative and qualitative data. Although the primary units of analysis were the students, data were not collected directly from them. In a sense, as in the case studies during year 1, the field site representative was the "respondent" for the survey data. Through unstructured interviews, observation, and review of school documents, information was obtained to complete items, on five separate research instruments, covering student background information, course schedules, IEP objectives, and participation in computer-assisted instruction.

C. Coding and Editing of Data

In addition to providing answers to direct items, many of the variables in the survey included content analysis of original information, prior to subsequent coding. The principal coding guides, provided to each field representative were: (1) the Curriculum Taxonomy (previously described), and (2) a specially prepared Software List, containing 1909 separate titles. All staff participated in inter-rater reliability substudies, special training for data collection, and actual data collection, coding, editing, and key entry of the data.

D. Analysis of the Student Survey Data

Due to the unusual design of the survey--finite population and multiple stratification--special computer programs were developed to generate the survey results. Standard errors (SEs) were adjusted for finite population correction (fpc) and represented the expected range of error, at the 95 percent level of confidence, in generalizing the results to the finite populations (Howard County and Chittenden South mildly cognitively impaired high school students).

E. Results of Curricular Studies

1) Analysis of Students' IEP Objectives

The average number of IEP objectives per student was 33. This average did not vary much across the three handicapping conditions:

Handicapping Condition	Average Number of IEP Objectives
Mentally Retarded	39
Speech or Language Impaired	36
Learning Disabled	31

However, the average number of IEP objectives did vary a good deal from school to school; from a low of 10 in one high school to a high of 60 in another. Because there were only a few special education teachers in each high school, the variance across schools might also be attributed (although this was not analyzed) to teacher patterns. During the coding of the data, it was noticed that student IEPs were often highly similar for students who shared the same teacher (IEP author).

A major purpose for these analyses was to examine the concentration of objectives across particular curricular areas. The results disclosed a very wide distribution of objectives, not only in math and language arts, but also in areas related to physical and personal development, vocational and adult preparation skills, and general school performance (e.g., behaviors). There were also marked differences in the distributions of objectives between handicapping categories and between schools.

A notable difference, which became apparent during the coding and prior to the actual analysis of the data, occurred between the two school districts. In general, IEP objectives in Howard County varied in their specifics a great deal, but were largely targeted to academic content areas, such as math and language arts. In contrast, the objectives on the IEPs from Chittenden were more focused on personal development and generic academic achievement (e.g., study skills) goals.

	Howard County		Chittenden South	
	Average	Percent	Average	Percent
In Math areas	4.7	14%	0.0	0%
In Language areas	6.9	52%	9.6	35%
In Other areas	10.6	32%	17.9	65%
In All areas	32.7		27.6	

One explanation for these differences was obtained from the qualitative notes. It seems that during the 1987-88 school year, the Chittenden District switched to a new IEP guideline system, different from that used previously. The new IEP system was computer-based and emphasized "process" and behavioral objectives. Interestingly, over the summer Macro learned that teachers were generally dissatisfied with that system and, in the coming year, they will be returning to IEP guidelines that contain more content-related objectives.

In terms of the model development goals, this finding documented the idiosyncrasies of IEP development procedures in the schools and the great variability present in curriculum, to the degree it is operationalized in IEPs. Inasmuch as IEP objectives are interpreted to represent teachers' goals related to students, integration of technology with curriculum requires an understanding that appropriate technological solutions (software, etc.) can vary greatly from school to school, district to district, teacher to teacher, student to student.

Another difference in the IEP results was the generally higher concentration on language arts, as compared to mathematics, objectives for all students. For all students in the two districts, the analyses estimated that:

- Only 24 percent had IEP objectives in mathematics
- Almost 77 percent had IEP objectives in language arts

Another interesting contrast was the unexpectedly high percentage of special education students in Howard County who had IEP objectives related to social studies: 28 percent (the figure was 0 percent in Chittenden). Again, understanding of the particular district context provided an explanation: students in Maryland are required to pass a Citizenship Test in order to graduate.

Summary. The analyses of IEP objectives validated an a priori assumption of wide variability in the definitions of curricula (as represented by IEP objectives) across settings and students. The analyses also suggested various organizing principals that can be used in the upcoming model development efforts, to assist teachers and administrators in targeting general categories of curricula for technological (and other media) concentration.

2) Analysis of Student Course Schedules

Another component of the operational definition of curriculum was the course schedule for mainstream students. Because most mildly cognitively impaired high school students spend a good deal of their time in regular education courses, it seemed important to examine the types of courses in which they were enrolled.

As anticipated, most mildly cognitively impaired students in the two districts were enrolled in courses in mathematics (83 percent) and language arts (99 percent). The majority of such courses were "general," however, a notably large percentage of students (22 percent) were taking Algebra.

In other course areas, students were heavily enrolled in physical education and health (43 percent), vocational education and industrial arts (40 percent), social studies courses (88 percent), science courses (67 percent), and arts and music courses (33 percent). As the results in Exhibits V-5 and V-6 show, some special education students were also enrolled in various "college prep" courses, such as Geometry, Trigonometry, Calculus, English Literature, Psychology, Biology, Chemistry, and Latin.

In terms of course periods per week, the students' course content looked not unlike the average schedule for their nonhandicapped peers:

Course areas with largest number of periods	Average
General language arts courses	5.2
Any social science course	4.8
Any mathematics course	4.4
Vocational education or industrial arts	3.9
Any science course	3.4
Physical education or health	2.3
Any arts course	1.9
Study skills	1.4
Release time or study hall	1.4

These results reflect the fairly broad array of content and skills that are part of the curriculum (as indicated by courses) for mainstreamed students. To some degree, technological innovations in instruction may target this range of content,as well as the specific instruction that occurs only in resource rooms, or only as spelled out in IEPs.

3) Analysis of Computer Applications in Course Areas

A related substudy examined the actual use of computers for instruction in the different courses attended by students. The data for these analyses was collected through interviews, observations, and document reviews (e.g., computer lab sign-up sheets). One analysis estimated the average number of class periods, over the 1987-88 school year, in which computer applications were used in courses attended by the students.

The highest exposure to computer-based instruction, based on overall number of periods per year, occurred in language arts courses (68 periods per year). Of these, 38 occurred in general language arts courses, 20 in study skills courses, and 8 in typing. The next highest exposure occurred in vocational education and industrial arts courses: 33 periods. Mathematics courses offered students an average exposure to computers in 27 periods per year, with 20 of those falling in general mathematics courses. The average across all social studies courses was 10 periods/year; across all science courses, only 2 periods per year; in home economics, also 2. The average computer-use periods in other areas was lower.

To get some sense of the meaning of these figures, the following list expresses the sum of the periods as a percentage of the average number of academic periods in the school year (1080).

Any language arts course	68
Vocational education or industrial arts	33
Mathematics	27
Social studies	10
Science	2
Home economics	2
All other areas (combined)	3
Total estimated periods of computer-use	145
Percent of total (1080)	13 percent

In other words, for the average student in the target population, computers were available and used for some instructional application in approximately one out of eight school periods during the year. As the results disclose, however, these periods of exposure were concentrated in a few principal areas. Additional analyses can provide more detail on the specific types of applications that occurred during these class meetings.

4) Software Titles in Use

The last general analysis which was completed on data from the student survey pertained to the software that teachers were using. The results of these analyses, reported in the Second Annual Research Report (pp. 52-54, plus Tables 6 and 7), were designed to provide some support for model development components related to software issues. The use of 170 different software programs in instructional applications was documented. Word processing/ desktop publishing, games and rewards, and computer-assisted instruction (CAI) were the most common types of applications with the largest numbers of software programs in use, for both special and regular education teachers.

5) Secondary Analyses: National Curricular Norms in Math and Language Arts

With data provided by the Psychological Corporation, a secondary analysis was conducted to link achievement grade levels of test items in their database, with mathematics and language arts areas in the Curriculum Taxonomy. This analysis suggested scope-and-sequence structure for the content areas, and also served to identify particular content areas that are the subject of at least one national testing system. This knowledge could also be used to highlight curricular objectives that would contribute to improving student performance on achievement tests. Information from the Psychological Corporation data analyses also contributed to refinement of the Curriculum Taxonomy in mathematics and language arts areas.

III. Exploratory Analysis of Second Year Curriculum/Computer Data

During the third year, additional analyses were conducted on the student and staff data from the second year--to more closely examine the relationship between curriculum and computer use. One series of analyses integrated information that was collected across different survey instruments:

- Instrument 1--Student-specific IEP and background information
- Sorting forms--Linking students with their courses
- Instrument 2--Basic data on courses and teacher use of computers
- Instrument 3--More detailed information on courses in which computers were used

Prior analyses (in the 2nd year) had indicated that mildly cognitively impaired high school students were exposed to computer-based instruction in approximately 13 percent of their classes (Second Annual Research Report, Vol. 1, p. 52). However, the on-site researchers' first-hand experience in classrooms suggested that this exposure was not evenly distributed. Computer use seemed higher in special education classes, and the extent of use varied greatly from class to class.

A. Computer Use Special Analysis #1

The first of these analyses examined the distributions of computer use across the sample of courses in which students were enrolled in the 1987-1988 school year. The following results were obtained:

Classes Conducted by Special Education Teachers			
Content Areas	Number	Used Computers	Proportion
All Areas	72	55	0.764
Mathematics	10	9	0.900
Language Arts	47	37	0.787
Voc. Ed. & Ind. Arts	0	0	0.000
Home Economics	1	1	1.000
Social Studies	9	6	0.667
Science	4	2	0.500
Other Areas	1	0	0.000

Classes Conducted by Other High School Teachers			
Content Areas	Number	Used Computers	Proportion
All Areas	445	119	0.267
Mathematics	77	26	0.338
Language Arts	72	22	0.306
Voc. Ed. & Ind. Arts	43	12	0.279
Home Economics	10	6	0.600
Social Studies	71	27	0.380
Science	59	18	0.305
Other Areas	113	8	0.071

There were 517 different classes attended by the samples of students in Howard County and Chittenden South. Of these, 72 (14 percent) were conducted by special education teachers and 445 were conducted by other high school staff. There was a significant difference (Chi-Square 68.4; $p<.001$) in the proportion of classes that used computers: 76 percent of the special education classes compared to 27 percent of the classes taught by other high school teachers. This comparison was consistently higher for special education classes across the major academic areas.

B. Computer Use Special Analysis #2

The first analysis (above) measured whether any use of computers occurred in the courses. A more detailed examination was then conducted of the amount of computer use that occurred in those classes, special education and regular, where any computer use had been recorded. During the interviews and observations with computer-using teachers, staff recorded estimates of the frequency of computer use in each class. Preliminary examination of the data disclosed that there was great variability across classes in the number of class periods in which computers were used. For example, in the 174 classes--55 special education, 119 regular education--which used computers, 51 classes used computers for instruction on 10 or fewer days throughout the entire school year. Exhibit V-2 lists the number of classes, in each subgrouping, which used computers during more than 20 percent of their meetings (greater, on average, than only once a week):

Content Areas	Made Any Use of Computers	Used Computers More Than Once a Week	Proportion
Special Education:			
All Areas	55	33	0.600
Mathematics	9	4	0.444
Language Arts	37	26	0.703
Home Economics	1	0	0.000
Social Studies	6	3	0.500
Science	2	0	0.000
Regular Education:			
All Areas	119	43	0.361
Mathematics	26	11	0.423
Language Arts	22	14	0.636
Voc. Ed. & Ind. Arts	12	9	0.750
Home Economics	6	3	0.500
Social Studies	27	1	0.037
Science	18	2	0.111
Other Areas	8	3	0.375

In general, special education classes which used computers surpassed the frequency of usage in other classes that used computers. On average, in classes that made any use of computers, special education settings utilized computer-based instruction more than once-a-week in 60 percent of the classes; regular education computer-using classes used computers more than once-a-week in only 36 percent of the classes (Chi-Square of the difference, 8.7; $p<.01$).

It should be pointed out, however, that the lower overall level of use in regular education computer-using courses may have been an artifact of specialized use in some areas. For example, in Howard County high schools, students were required to pass a State Citizenship Test. A CAI program had been locally developed to assist students who were having difficulty with the annually-administered test. This software was only used infrequently in regular social studies classes, explaining the low proportion of such classes that used computers on a more frequent basis. Out of 27 regular education social studies courses that used computers, only one used them, on average, more frequently than once a week. In contrast, half (3 out of 6) of the special education social studies courses that used computers used them more frequently.

In contrast, the rate of computer use in Mathematics and Language Arts classes was similar, for regular and special education classes:

Percent of Class Meetings In
Which Computers Were Used
(In Computer-Using Classes)

	Mathematics	Language Arts
Special Education	56%	30%
Regular Education	58%	36%

This outcome suggested that, at least in the primary instructional areas of high school mathematics and language arts, there may be some consistency in patterns of use that develop among computer-using teachers.

C. Computer Use Special Analysis #3

Having demonstrated some variability in the extent of computer use across various high school disciplines, a series of parametric analyses was conducted to link the information about computer use in high school classes with the data obtained on the class schedules of students in the 1987-88 student samples.

These analyses utilized the special weighting and analytical procedures that were previously developed to reflect the complex sampling design and provide aggregated and stratified results for the groups.

1) The Curriculum of Mildly Cognitively Impaired High School Students

The first new analysis of the student data was a more detailed examination of the distribution of courses for secondary students in the sample. It was necessary to perform these more detailed analyses of the curriculum, to lay the foundation for the analyses of computer use in the context of the curriculum.

In the Second Annual Research Report it was noted that the average course schedule for handicapped students, in terms of academic areas covered, "looked not unlike the average schedule for their nonhandicapped peers." Those analyses, however, did not discriminate between courses conducted by special education and regular education teachers. Although other information indicated that all of the students were mainstreamed, it was not clear to what extent instruction was provided in special education or in mainstream settings.

Exhibit V-2, "Percent of Mildly Cognitively Impaired Students Enrolled in Special and Regular Classes," shows the estimated percentages of students who received instruction in either setting. Stratified estimates are provided for:

- MR - Mentally retarded
- SI - Speech impaired
- LD - Learning disabled
- HC - Students in Howard County (8 regular high schools and 1 vocational-technical high school)
- CS - Students in Chittenden South (1 regular high school)
- ALL - A statistical estimate for the complete finite population (both school districts)

As previously reported, all sampled students (100 percent repeated across the top row of the table) received some instruction in regular classes or settings (e.g., work release programs). Interestingly, only 69 percent of the students received any instruction in special education settings. By handicapping condition, this proportion was highest for mentally retarded students (100 percent) and lowest for speech impaired students (60 percent); 71 percent of learning disabled students received instruction from special education teachers.

In Howard County high schools, 72 percent of the mildly handicapped students received instruction from special education teachers. The remaining 28 percent had IEPs prepared and, in some cases, the special education teachers conferred with their regular education colleagues about students' progress.

Exhibit V-2

Percent of Mildly Cognitively Impaired Students Enrolled in Special and Regular Classes

Content Areas	Mildly Cognitively Impaired H.S. Students* MR	SI	LD	HC	CS	ALL
Regular Education Classes (All)	100	100	100	100	100	100
Special Education Classes (All)	100	60	71	72	36	69
Regular Mathematics Classes	0	72	63	61	91	64
Special Mathematics Classes	100	14	19	21	0	20
Any Mathematics Classes	100	82	82	82	91	83
Regular Language Arts Classes	22	57	65	60	98	63
Special Language Arts Classes	100	56	64	66	36	63
Any Language Arts Classes	100	96	100	99	98	99
Voc. Educ. & Industrial Arts (Regular Education Only)	0	34	45	42	43	42
Regular Social Studies Classes	0	66	76	71	86	73
Special Social Studies Classes	72	19	14	17	0	16
Any Social Studies Classes	72	85	89	88	86	88
Regular Science Classes	0	57	68	61	95	64
Special Science Classes	64	9	0	3	0	3
Any Science Classes	64	66	68	65	95	67
Other Regular Classes	100	86	77	77	100	79
Other Special Classes	22	10	0	3	0	3
Any Other Classes	100	86	77	77	100	79

* MR, mentally retarded; SI, speech impaired; LD, learning disabled; HC, Howard County; CS, Chittenden South; ALL, finite population estimate.

The very low figure of 36 percent in Chittenden South requires some explanation. Only one special education "course," in language arts, was conducted at the high school, and only about one-third of the handicapped students were assigned to it. Instead, the special education teachers and a remedial skills teacher jointly operated an Enrichment Center. Typically, special education students were assigned to regular education classes throughout the day. However, if a student was having any problems in regular classwork, he could voluntarily go to the enrichment center for tutorial work with the special education staff.

Some students also attended the Enrichment Center during their study hall periods. Periodically, some students were assigned to the Enrichment Center for blocks of time (e.g., weeks) when they were having special difficulty with the regular classwork. Given the nature of the data collection (i.e., its reliance on course schedule information), instructional activities and time spent in Chittenden's Enrichment Center are not reflected in these analyses. (In weighted statistical estimators, Chittenden students only accounted for about 8 percent of the finite population; separate estimators [HC and CS] in the tables permit examination of such differences where applicable.)

The most common course area for the targeted students was language arts; overall 99 percent were scheduled for some course in language arts. Assignment to language arts classes was fairly evenly split between course conducted by special and regular education teachers. The average figure of 63 percent of students assigned to each type of course indicated that about 13 percent of the students were "doubled" in that academic area, taking both special and regular education courses in language arts.

A majority of handicapped students were also scheduled to three other major academic course areas for instruction:

Academic Course Area	Regular Education	Special Education
Mathematics	64	20
Social Studies	73	16
Sciences	64	3

In these disciplines, the primary instructors were regular education staff. Similarly, all vocational and industrial arts education was provided by regular education staff; 42 percent of students were assigned to those programs. And 79 percent of the mildly handicapped students also participated in a wide variety of "Other" classes and scheduled activities, primarily conducted by regular education. The "Other" classes included:

Other Content Areas	Percent of Studies
Physical Education or Health	43
Arts (e.g., art, music, drama)	33
Release Time or Study Hall	17
Home Economics and Cooking	11*
Languages (foreign and *sign*	10
ROTC	4
Drivers Training	2
Social Skills Training	<1

*There was a surprising amount of computer-based instructional activity in home economics courses. Details on computer activities in home economics courses are included in some of the tables (exhibits) in the Appendix, but they are subsumed in the "Other" category in this discussion, because home economics represented a relatively small part of the curriculum.

Another perspective on the curriculum for mildly handicapped students, also based on the course and class data, is presented in Exhibit V-3, "Percent of Class Time in Different Content Areas." Where Exhibit V-2 showed the percent of students scheduled for courses in different areas, this exhibit shows the average percentages of students' time which was actually spent in each course area. (This analysis also controls for the irregular distribution of class hours to some course areas, e.g., vocational education and release time.)

Once again, this exhibit makes it clear that mildly cognitively impaired high school students in the two districts were mainstreamed in the broadest sense: only 19 percent of the time they spent in high school, during the 1987-88 school year, took place in special education classrooms and resource rooms. The only group which spent most of their time in special education settings were mentally retarded students.

With only one exception, instruction in the primary academic areas occurred mostly in regular education classrooms. That exception was in language arts. In that area, instructional time was about evenly distributed between regular and special education settings, particularly in Howard County. Given that the population of students studied consisted primarily of speech impaired and learning disabled students, this concentration of special education services in the language arts area was not surprising. Based on scheduled classtime, about two-thirds (12 percent compared to 19 percent total) of special education services concentrated on language arts instruction. This finding could imply that integration of computers with the curriculum in special education should reflect the emphasis on language arts.

Exhibit V-3

Percent of Class Time in Different Content Areas

Content Areas	Mildly Cognitively Impaired H.S. Students* MR	SI	LD	HC	CS	ALL
Regular Education Classes (All)	34	81	82	80	95	81
Special Education Classes (All)	66	19	18	20	5	19
Regular Mathematics Classes	0	15	10	11	13	11
Special Mathematics Classes	17	2	3	4	0	3
Any Mathematics Classes	17	17	14	15	13	14
Regular Language Arts Classes	4	11	11	11	14	11
Special Language Arts Classes	19	10	12	13	5	12
Any Language Arts Classes	21	20	24	24	19	23
Voc. Educ. & Industrial Arts	0	10	14	14	8	13
Regular Social Studies Classes	0	11	14	13	11	13
Special Social Studies Classes	16	4	2	3	0	3
Any Social Studies Classes	16	15	16	16	11	16
Regular Science Classes	0	10	11	11	12	11
Special Science Classes	11	2	0	<1	0	<1
Any Science Classes	11	11	11	11	12	11
Other Regular Classes	31	24	22	21	37	22
Other Special Classes	4	2	0	<1	0	<1
Any Other Classes	34	26	22	21	37	23

* MR, mentally retarded; SI, speech impaired; LD, learning disabled; HC, Howard County; CS, Chittenden South; ALL, finite population estimate.

2) Computers in the Curriculum of Mildly Cognitively Impaired High School Students

With this backdrop--a snap-shot image of the academic curriculum for mainstreamed high school students in the two participating school districts--the next series of analyses examined how computers were used for instruction during the 1987-88 school year. The information from special studies ## 1 and 2, on computer use in high school courses, was linked with the distributional findings on course schedules of the specific students in the sample.

Appropriate weighting and analytical procedures were used to develop finite population estimates from the sample data. These findings can be generalized to the population of mildly cognitively impaired high school students in the two participating school districts. Because Howard County and Chittenden South were purposely selected on the basis of their commitment to the use of new technologies for instruction, these results--particularly any point estimates of the extent of computer use--should not be extrapolated or over-generalized to any other population of school districts.

On the other hand, as results from the first year studies demonstrated, decisions on adoption and actual use of computers for instruction were highly decentralized. This factor, along with the wide variability in results between schools and classrooms, suggest that the findings might represent a fair description of the implementation of technology when usage is left largely to the interests and discretion of particular teachers.

As Macro's model stipulates, availability of material resources and training can have an important impact on what applications will be implemented. However, in the case of both of these school districts, a relatively large base of hardware was available in all the high schools and teachers had access to it, depending upon the proclivity of each teacher to actively pursue and acquire the resources. Those who wanted to use computers were, by and large, able to procure them.

Software may have represented a larger problem. With the exception of software that was made available by school districts for computer education courses, teachers were largely on their own to purchase or acquire software for their own use. Various sources of support were available for software acquisition (e.g., "dollar diskettes" of MECC software in one school district) but, overall, software resources--especially when it came to purchase of large or expensive courseware programs--were limited.

In spite of these qualifications to the interpretation of the findings, the results were generally consistent and intuitively logical, in the context of Macro's model and the background derived from the prior qualitative studies. Exhibit V-4 displays the percent of handicapped students who were exposed to computer instruction during the 1987-88 school year. Overall, 87 percent of the population had some exposure to computers, in one or more of their classes. Regular education classes provided computer contact for 65 percent of the students; special education classes, for 57 percent (there was some overlap). Given the four-to-one ratio of regular to special education classtime, this differential reflects the relatively larger use of computers in special education classes.

In terms of general academic areas, computer exposure varied:

Percent of Students Exposed to Computers			
Academic Area	In Regular Classrooms	In Special Education	In Either Program
Language Arts	21	51	62
Mathematics	23	18	41
Social Studies	25	9	34
Science	15	1	16
Other Areas	8	1	9

As this list discloses, the most common exposure to computers occurred in language arts classes and, of these, primarily in special education. About one-half of the targeted students made some use of computers for instruction in special education language arts classes.

Another perspective on computer use is shown in Exhibit V-5 which lists the average number of classroom periods that the students: (1st column) spent in classes in each major academic area; and (2nd column) used computers in each academic area. (The computer use included teachers' use in some periods; so this does not imply that each student personally used the computers, but that they were exposed to computers.) Overall, the average computer-time amounted to 144 classroom periods during the year: about 83 in regular classes and 61 in special education classes. This represented an average of 13 percent of classtime for the students (Second Annual Research Report, p. 52).

Exhibit V-4

Percent of Mildly Cognitively Impaired Students Exposed to Computers for Instruction In Their Classes

Content Areas	Mildly Cognitively Impaired H.S. Students*					
	MR	SI	LD	HC	CS	ALL
Regular Education Classes (All)	22	69	65	64	79	65
Special Education Classes (All)	100	42	60	59	36	57
In Any High School Classes	100	85	87	87	81	87
Regular Mathematics Classes	0	37	20	25	7	23
Special Mathematics Classes	100	12	18	20	0	18
Any Mathematics Classes	100	49	38	44	7	41
Regular Language Arts Classes	22	23	21	23	7	21
Special Language Arts Classes	100	35	54	52	36	51
Any Language Arts Classes	100	55	63	64	38	62
Voc. Educ. & Industrial Arts (Regular Education Only)	0	15	12	13	0	12
Regular Social Studies Classes	0	20	27	21	64	25
Special Social Studies Classes	72	7	9	10	0	9
Any Social Studies Classes	72	27	35	31	64	34
Regular Science Classes	0	12	16	15	21	15
Special Science Classes	0	3	0	1	0	1
Any Science Classes	0	16	16	15	21	16
Other Regular Classes	0	13	6	7	17	8
Other Special Classes	22	3	0	1	0	1
Any Other Classes	22	16	6	8	17	9

* MR, mentally retarded; SI, speech impaired; LD, learning disabled; HC, Howard County; CS, Chittenden South; ALL, finite population estimate.

Exhibit V-5

Probability of Exposure to Computers in Different Classes

	Average Number of Classroom Periods/Year	Periods Using Computers	Proportion Using	Ratio (Spec./Reg.)
Regular Education Classes (All)	901.3	82.6	.092	
Special Education Classes (All)	208.9	61.4	.294	3.2*
Regular Mathematics Classes	124.4	18.8	.151	
Special Mathematics Classes	35.3	8.3	.235	1.6
Regular Language Arts Classes	122.9	19.1	.155	
Special Language Arts Classes	133.1	48.9	.368	2.4
Voc. Educ. & Industrial Arts (Regular Education Only)	155.6	32.5	.209	---
Regular Social Studies Classes	143.8	6.1	.042	
Special Social Studies Classes	30.3	4.1	.135	3.2
Regular Science Classes	118.0	1.9	.016	
Special Science Classes	5.5	0.1	.018	1.1
Other Regular Classes	247.7	4.2	.017	
Other Special Classes	4.7	0.1	.021	1.2

* An extremely conservative procedure was used to test the significance of the ratio of proportions of class computer use between special and regular education programs. Using the 95 percent confidence intervals around estimates of hours, the minimum proportion of computer use in special education classes was compared to the maximum proportion in regular classes. By this procedure, only the overall ratio of proportions -- between all special education and all regular education classes -- was significant.

There was a significant difference in the proportion of classroom time devoted to computer use between regular and special education settings ($p<.05$, derived from ratio estimators). Overall, 29 percent of classroom time in special education courses utilized computers, compared to only 9 percent in regular education settings, a three-fold difference. The largest proportion of class time devoted to computer applications occurred in special education language arts courses, where approximately 37 percent of the periods included exposure to computers.

Another view of this computer use may be obtained by estimating the amount of computer time only for that segment of the students, in selected course areas, who were exposed to computers:

Academic Area	A. Periods Using Computers (Overall Average)	B. Proportion of Students Exposed to Computers in That Area	C. Average Periods For Those Students (Using)
Language Arts:			
Special Education	48.9	.505	96.8
Regular Education	19.1	.233	81.9
Mathematics:			
Special Education	8.3	.179	46.4
Regular Education	18.8	.213	88.3

The figures in the final column indicate that, when computers were a component of instruction, their use represented a sizeable investment of classtime. Extrapolating from a similarly derived (calculations not shown) average of classtime in Language Arts and Mathematics areas, only for students enrolled in such courses, these estimates were obtained:

Academic Area	Average Number of Class Periods (for those enrolled)	Average Periods of Computer Use (for those in classes using computers)	Percent of Class Time With Computers
Language Arts:			
Special Education	210.9	96.8	45.8
Regular Education	196.0	81.9	41.8
Mathematics:			
Special Education	180.1	46.4	25.8
Regular Education	195.0	88.3	45.3

3) Summary of Results from Special Study #3

Computer use for handicapped students in the surveyed high schools was distributed across the curriculum, in both special and regular education classes. On the whole, special education teachers made relatively more use of computers for instruction than did their regular education peers. In the classes attended by mainstreamed students, the principal source of student exposure to the technology occurred in special education language arts classes. The average student in the target population experienced about 49 periods of language art instruction supplemented, in some fashion, by computers during the 1987-88 school year.

Exploratory analyses suggested that, in the classes which used computers, as much as 45 percent of the class periods included computer activity, i.e., in special education language arts and regular education mathematics courses attended by mainstreamed students. (Note: these regular education mathematics classes are not necessarily representative of general mathematics courses. The sampling procedure and analyses dealt with the very special population of courses attended by mainstreamed mildly cognitively impaired students. In many high schools, the general math classes which these students attended were characterized as "math labs," and emphasized the use of math CAI.)

Alternatively, these results on the extent of computer use in some classes should be viewed against a background of the more general finding of little computer use in the majority of classes, particularly regular education classes. Further, these results only attest to the use of computers; no claims are made for the effectiveness or even appropriateness of the applications conducted. Nevertheless, the findings attest to the general and, in some cases, fairly intensive adoption of computers for instructional purposes by special and regular education teachers who served handicapped students.

IV. Supplemental Study: The Association Between School District Size and Teacher Decision-making

Macro's model to improve technology integration for instruction of handicapped students at the high school level is based on assumptions, supported by research, of the need for greater communication within school districts. In particular, the model components represent an attempt to increase the exchanges of information:

- Vertically--Between administrators and teachers; and
- Laterally--Between special and regular educators.

Along with the current research, a series of prior qualitative studies of microcomputer implementation in special education programs (Hanley, 1987) have documented the diversity of organizational patterns in schools and their impact on technological innovation. An important construct in these studies has been the issue of centralization/decentralization--the degree to which administrators (centralized) or teachers (decentralized) participate in planning and decisionmaking on instructional applications of computers.

In recent years, reexamination of the earlier case studies, along with the new research conducted in this project plus the review of literature and reports from other studies, has prompted a more refined hypothesis related to these patterns. It appears that distance between centralized and decentralized elements in a school district (or in a school) has an influence on communication and participatory decisionmaking.

The review of the case studies suggested that the clearest examples of both overly centralized and overly decentralized patterns were more common in larger units of analyses: larger school districts and, for school-based systems, larger schools. Other factors were also important, e.g., leadership qualities of administrators and the general tone (staff enthusiasm, adequate resources, etc.) within the school or district. However, as a general (and easily measurable factor), size of program (district or school) seemed to have some predictive power in determining the probability that administrators and teachers would communicate regularly and share decisionmaking. Interestingly, the qualitative data also provided some evidence, although not quite as clear, that size was also associated with lateral communication patterns: the degree to which special and regular educators exchanged information or, extrapolating, the nature and extent of communication across the various program groups within a school or school district.

A clear example of such patterns can be taken from the Phase I studies in this project. Both school districts had established district level "educational technology committees." In the smaller school district, membership in the committee consisted primarily of representative teachers, from each of the (consolidated) district schools. In contrast, the committee in the larger school district consisted entirely of district level (centralized) program administrators; there was no direct teacher input.

A further example of this separation of administrators and teachers in the large school district was the reaction of the district committee to the results of the teacher-based technology survey in 1988. The committee expressed reservations about the findings of the survey because, "They were not in compliance with the [district's] technology plan."

A. Empirical Validation of the Size Hypothesis

The Carnegie Foundation has conducted a mail questionnaire survey of teachers, covering the issue of teacher involvement in decisionmaking. A preliminary report (Boyer, 1988) included statistical tables of the percent of teachers, by State, who reported they were involved in ten decisionmaking areas:

1. Choosing textbooks and instructional materials
2. Shaping the curriculum
3. Setting standards for student behavior
4. Deciding whether students are tracked into special classes
5. Designing staff development and in-service programs
6. Setting promotion and retention policies
7. Deciding school budgets
8. Evaluating teacher performance
9. Selecting new teachers
10. Selecting new administrators

The findings are summarized in Exhibit V-6. The listing of the items (above) reflects the rank ordering of items from highest national (weighted) rating of participation (79 percent - Choosing textbooks and instructional materials) to lowest (7 percent - Selecting new administrators).

Two of the items in the Carnegie survey were directly related to curriculum issues:

- Choosing textbooks and instructional materials; and
- Shaping the curriculum

Consequently, it was envisioned that the Carnegie findings would provide an opportunity to test the presumed relationship between teacher participation in media/curriculum decisions and the factor of school district size.

Exhibit V-6(1)

Percent of Teachers Involved in Areas of School Decisionmaking

	Survey Item*									
State	1	2	3	4	5	6	7	8	9	10
Alabama	71	51	47	47	45	38	19	8	4	3
Alaska	79	68	59	55	53	45	24	13	8	7
Arizona	78	61	60	47	40	43	18	17	12	9
Arkansas	88	51	47	44	41	39	9	12	4	3
California	74	62	64	40	51	41	35	8	17	11
Colorado	83	70	59	55	43	38	36	14	20	11
Connecticut	73	68	47	47	61	33	22	13	7	10
Delaware	84	71	39	40	40	30	21	8	5	12
Florida	64	42	37	39	43	21	20	6	5	3
Georgia	74	54	41	52	37	35	19	20	3	4
Hawaii	91	69	54	53	32	37	57	14	9	2
Idaho	83	67	53	48	46	34	17	7	13	8
Illinois	86	62	46	45	45	39	12	11	4	5
Indiana	90	71	38	45	38	35	13	7	5	5
Iowa	90	75	45	48	41	37	15	7	6	10
Kansas	90	76	51	46	54	37	13	10	5	4
Kentucky	85	64	46	53	52	45	16	13	3	6
Louisiana	89	40	45	36	36	27	10	8	1	6
Maine	89	82	63	60	62	47	29	14	16	14
Maryland	61	44	51	44	40	24	18	8	4	4
Massachusetts	76	71	40	46	39	29	29	11	8	13
Michigan	87	66	51	42	55	41	15	7	7	8
Minnesota	88	79	57	63	48	45	20	14	17	12
Mississippi	81	59	56	50	54	36	11	17	4	5
Missouri	85	69	47	42	33	35	18	8	5	5
Montana	90	78	51	55	46	44	17	7	7	5
Nebraska	87	75	48	54	43	32	19	9	5	6
Nevada	73	46	44	38	31	25	27	6	5	1
New Hampshire	79	76	52	56	61	42	32	11	20	19
New Jersey	73	66	37	40	34	33	11	6	2	5
New Mexico	88	67	43	43	34	34	15	8	4	4
New York	78	62	43	44	38	36	18	7	9	11
North Carolina	76	53	49	43	42	36	28	17	4	4
North Dakota	92	71	48	48	37	43	8	7	4	4
Ohio	84	70	40	40	46	29	14	11	5	5
Oklahoma	92	62	40	46	82	37	10	8	3	3
Oregon	87	72	68	56	38	41	29	10	20	13
Pennsylvania	84	74	39	38	34	33	14	7	5	9
Rhode Island	68	70	37	40	30	31	17	6	5	7
South Carolina	87	61	51	46	49	30	23	16	4	3
South Dakota	90	76	50	55	53	49	10	9	8	8
Tennessee	71	55	47	45	51	38	16	13	3	4
Texas	78	62	43	42	33	24	20	8	4	3
Utah	76	63	59	46	37	26	23	20	10	4
Vermont	93	85	60	56	50	50	39	16	17	20
Virginia	82	61	41	41	84	30	16	14	4	3
Washington	78	68	64	53	48	36	25	7	18	12
West Virginia	67	43	52	39	38	27	12	11	4	2
Wisconsin	87	77	48	51	57	34	29	9	7	8
Wyoming	89	81	63	57	36	39	34	8	16	14
Weighted National Average	79	63	47	45	43	34	20	10	7	7
Minimum	61	40	37	36	30	21	8	6	1	1
Maximum	93	85	68	63	82	50	39	20	20	20

Exhibit V-6(2)

- Survey Items:

1. Choosing textbooks and instructional materials
2. Shaping the curriculum
3. Setting standards for student behavior
4. Deciding whether students are tracked into special classes
5. Designing staff development and in-service programs
6. Setting promotion and retention policies
7. Deciding school budgets
8. Evaluating teacher performance
9. Selecting new teachers
10. Selecting new administrators

Weighted average state percentiles derived from Boyer, E. (September, 1988), School control: Striking the balance, in Teacher involvement in decisionmaking: A state-by-state profile. Princeton, NJ: Carnegie Foundation for the Advancement of Teaching.

B. Method

The 1987-88 Common Core of Data (CCD) tape of Public Elementary and Secondary Education Agencies in the United States was obtained from the National Center for Education Statistics (NCES). Student enrollment data for the 15,704 education agencies in the 50 States and the District of Columbia were analyzed. The principal results are shown in Exhibit V-7.

Average school district enrollment sizes were computed for each State, based on State enrollments in regular school districts including supervisory union components (a merge of agency categories 1 and 2 in the CCD agency files). These average (mean) size results were incorporated in a computer datafile that included the State-by-State average ratings on the Carnegie items. Correlation analyses were then developed, between the State teaching ratings and the State average enrollment size data.

C. Results

For general information purposes, correlations between district size and all ten survey items are presented in Exhibit V-8, although the specific analyses of interest were only those related to the curriculum survey items (nos. 1 and 2). The District of Columbia and the State of Hawaii were excluded from the analyses because they do not operate local school districts in a sense comparable to other States; there is only one education agency in DC and in Hawaii.

Pearson product moment correlation coefficients were significant ($p<.01$, df 48) for a number of the items. The highest correlations (Pearson r) were, however, on the two items of specific interest:

Exhibit I-6(1)
Exhibit I-6(2)
Exhibit I-7

(1)	Choosing textbooks and instructional materials	-.6273*
(2)	Shaping the curriculum	-.6951*

* $p<.001$

These are extremely high correlations, indeed, to be obtained in educational research.

Exhibit V-7

Distributions of Students in Education Agencies Across States

	Total Agencies			Regular School Districts Including Supervisory Union Components			Regional Education Service Agencies and Supervisory Union Administrative Centers			State-operated, Federally-operated and Other Agencies		
States	Students	Agen-cies	Mean Size	Students	Agen-cies	Mean Size	Students	Agen-cies	Mean Size	Students	Agen-cies	Mean Size
Alabama	728234	129	5645	728234	129	5645	0	0	0	0	0	0
Alaska	106043	56	1894	105873	55	1925	0	0	0	170	1	170
Arizona	585756	218	2637	585731	216	2712	25	2	13	0	0	0
Arkansas	437155	330	1325	437042	329	1328	0	0	0	113	1	113
California	4488398	1079	4160	4488398	1079	4160	0	0	0	0	0	0
Colorado	560236	177	3165	560196	176	3183	40	1	40	0	0	0
Connecticut	465279	176	2644	450033	166	2711	1511	6	252	13735	4	3434
Delaware	100002	22	4546	97655	19	5140	0	0	0	2347	3	782
D.C.	86435	1	86435	86435	1	86435	0	0	0	0	0	0
Florida	1664774	67	24847	1664774	67	24847	0	0	0	0	0	0
Georgia	1110947	186	5973	1110947	186	5973	0	0	0	0	0	0
Hawaii	166160	1	166160	166160	1	166160	0	0	0	0	0	0
Idaho	212444	115	1847	212444	115	1847	0	0	0	0	0	0
Illinois	1827680	1060	1724	1795608	977	1838	5849	46	127	26223	37	709
Indiana	964129	317	3041	959652	301	3188	1839	12	153	2638	4	660
Iowa	481275	446	1079	480846	436	1103	0	0	0	429	10	43
Kansas	421112	304	1385	421112	304	1385	0	0	0	0	0	0
Kentucky	642696	178	3611	642696	178	3611	0	0	0	0	0	0
Louisiana	789187	74	10665	785887	66	11907	0	0	0	3300	8	413
Maine	207110	230	900	106510	144	740	100600	86	1170	0	0	0
Maryland	683797	24	28492	683797	24	28492	0	0	0	0	0	0
Massachusetts	825357	365	2261	798548	334	2391	26809	31	865	0	0	0
Michigan	1606573	619	2595	1595794	562	2839	10779	57	189	0	0	0
Minnesota	721455	434	1662	721455	434	1662	0	0	0	0	0	0
Mississippi	494002	156	3167	492270	152	3239	1732	4	433	0	0	0
Missouri	802060	545	1472	802014	544	1474	46	1	46	0	0	0
Montana	152207	547	278	152057	545	279	0	0	0	150	2	75
Nebraska	268100	866	310	267601	860	311	0	0	0	499	6	83
Nevada	168353	17	9903	168353	17	9903	0	0	0	0	0	0
New Hampshire	164118	162	1013	164118	162	1013	0	0	0	0	0	0
New Jersey	1097639	582	1886	1094848	573	1911	2791	9	310	0	0	0
New Mexico	284800	88	3236	284800	88	3236	0	0	0	0	0	0
New York	2594070	760	3413	2568536	719	3572	25534	41	623	0	0	0
North Carolina	1085966	140	7757	1085966	140	7757	0	0	0	0	0	0
North Dakota	120835	290	417	119072	279	427	0	0	0	1763	11	160
Ohio	1833406	664	2761	1796944	615	2922	36462	49	744	0	0	0
Oklahoma	586053	611	959	586053	611	959	0	0	0	0	0	0
Oregon	454281	309	1470	453649	302	1502	89	3	30	543	4	136
Pennsylvania	1659703	537	3091	1623018	499	3253	36337	37	982	348	1	348
Rhode Island	134064	40	3352	134064	40	3352	0	0	0	0	0	0
South Carolina	614922	95	6473	613737	91	6744	0	0	0	1185	4	296
South Dakota	134014	210	638	127270	184	692	2049	7	293	4695	19	247
Tennessee	823783	139	5926	823783	139	5926	0	0	0	0	0	0
Texas	3236867	1074	3014	3226158	1063	3035	0	0	0	10709	11	974
Utah	419814	46	9126	415896	40	10397	3918	6	653	0	0	0
Vermont	90401	255	355	90079	247	365	322	8	40	0	0	0
Virginia	874935	133	6578	874935	133	6578	0	0	0	0	0	0
Washington	775826	296	2621	775826	296	2621	0	0	0	0	0	0
West Virginia	344236	55	6259	344236	55	6259	0	0	0	0	0	0
Wisconsin	772363	430	1796	772363	430	1796	0	0	0	0	0	0
Wyoming	98572	49	2012	98572	49	2012	0	0	0	0	0	0
All States	39967624	15704	2545	39642045	15172	2613	256732	406	632	68847	126	546

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Exhibit V-8

Correlations* Between Teacher Decisionmaking Items and Average (Mean) School District Size

Item	Pearson Product Moment r	Spearman Rank Order Coefficient rho	Quadratic (sq. root) of Size r	Log(e) Transform of Size r
1. Choosing textbooks and instructional materials	-.6273	-.6529	-.6810	-.6800
2. Shaping the curriculum	-.6951	-.7310	-.7739	-.7612
3. Setting standards for student behavior	-.1740	-.2557	-.2105	-.2255
4. Deciding whether students are tracked into special classes	-.4021	-.5953	-.5110	-.5731
5. Designing staff development and in-service programs	-.2292	-.3508	-.2975	-.3220
6. Setting promotion and retention policies	-.6175	-.6027	-.6834	-.6778
7. Deciding school budgets	-.0199	.0659	-.0156	-.0143
8. Evaluating teacher performance	-.0365	.0623	.0404	.0979
9. Selecting new teachers	-.2616	-.3548	-.3041	-.2941
10. Selecting new administrators	-.3508	-.4029	-.4040	-.3939

* Correlations were obtained between point estimates -- percent of teachers indicating involvement on items and average (mean) school district size -- from the data for 49 states: DC and Hawaii were excluded from analyses because they each operate only one "school district"; the State and local education agency are synonymous in those two cases. Information on DC was also missing from the Carnegie Foundation survey results.

The size of the correlation suggested further examination of the data, particularly to rule out statistical artifacts. For example, neither of the scales was truly ratio-interval or normally distributed. The survey items were constrained by being presented as percentages, with limits of 0 and 100 percent; percentiles tend to be asymptotically distributed. The average school district sizes included a few States with relatively much larger sizes, a non-normal distribution of the scores on that variable. These factors, especially the possibility of correlation inflation due to outliers, warranted a series of alternate approaches.

The first of these was to conduct an examination of the Spearman Rank Order Correlation Coefficients (rho). Spearman's rho is particularly useful when the traditional metric assumptions underlying correlational analyses may be violated. Spearman's rho ignores the metric and distribution characteristics of the data and, instead, measures the correlation between the ranks of scores in variable sets.

The Spearman rho correlations are presented in the second column of Exhibit V-8. Both correlations were significant ($p<.001$) and, in fact, higher than the Pearson coefficients. This finding indicated that the interpretation of strong (negative) association between size and teacher participation was not simply an artifact of the distributional characteristics of the datasets.

Therefore, two additional correlational and regression procedures were conducted--to attempt to model the association:

Quadratic transformation (square root) of the independent variable (size); and

Log(e) transformation of the independent variable.

The results of these analyses are shown in the third and fourth columns of Exhibit V-8. In both cases, the correlations were again significant ($p<.001$) and greater than the Pearson or Spearman correlations.

Taken together, these results demonstrate a strong negative association between school district size and teacher involvement in decisionmaking in two areas that relate to instructional innovation: (1) selecting instructional materials, and (2) shaping the curriculum. In brief, the larger the school district, the less likely a teacher will participate in decisionmaking in these areas. This is an empirical confirmation, on a national scale, of the finding previously drawn from qualitative studies.

Taking the curvilinear regression equations (quadratic and log transforms) as the best fit to the data, the results imply that a high level of the variance, from State-to-State, in teachers' participation in such decisions is predicted by school district size:

Carnegie Item	Variance Accounted For (r-squared)	
Teacher Involvement:	Quadratic	Log(e)
(1) Choosing textbooks and instructional materials	.464	.462
(2) Shaping the curriculum	.600	.579

About 46 percent of the variance in item 1, and between 58 and 60 percent of the variance in item 2, can be regressed on school district size.

Does School District Size Determine Teacher Participation?

It would be illogical to assume that enrollment size was, in some way, directly involved in restricting or promoting teacher participation is decisions related to materials and curriculum. Further, the variance in the results--between 40 and 55 percent of the variance that was not accounted for--suggests the more direct role of other intervening variables.

Macro's model emphasizes that people, administrators, coordinators, teachers, and students, are the players who interact to determine the path of computer implementation for instructional purposes. As case studies have shown, patterns of overcentralization and overdecentralization can occur during implementation processes. These are associated with vertical discontinuity in chains of communications. Lateral discontinuity, i.e., between groups of educators at the same level, administrators or teachers, can also occur and interfere with the exchange of information.

In both of these phenomena--vertical or lateral discontinuity--there is a tendency for what might be called "encapsulation" in larger school districts. Given that, in effect, larger school districts have more players within groups, individuals can more easily establish power bases, within their group orientation. This is clearly the case in large school districts at the central district level, where district administration can become an almost autonomous unit. School buildings themselves can also exercise autonomous authority and, within larger schools, there is tendency for teaching specializations to become encapsulated. For example, in large high schools it is common to observe "departments": mathematics, foreign language, special education, English, etc. In smaller high schools, there is a greater likelihood for all staff to convene as one group when information is being shared.

In essence, the intervening variable may be the specific organizational pattern operating in each unit of analysis, i.e., school district or school. Macro's model would propose that the organizational pattern largely determines the chains of communication and decisionmaking which, in turn, affect the implementation of educational innovations. One step back, in the form of a causal or structural model, the size of the unit of analysis influences the nature of the organizational patterns which emerge. Larger school districts will reveal more encapsulation: vertically, between administrators and teachers; and laterally, between groups of educators.

So, size may predict organizational structure, and organizational structure predicts communication patterns, including the level of teachers' participation in decisionmaking. Future research studies can examine this hypothesis in more detail. The current findings do, however, imply that model development and replication should consider and be prepared to interact with different patterns of organization and communication. Further, planning should anticipate some relationship between school district size and the patterns that will be discovered in replication sites.

V. Field Evaluation of Critical Issues with Implications for the Model

In the spring of 1989, field staff visited the research sites to solicit impressions about many of the issues that had been identified in previous work as potentially important for the development of the model of technology integration. Project staff collected comments and assessed a rating for each critical issue, from (3) very important (or effective) to (1) not at all important (or effective).

The results of this activity were in line with the expectations developed by previous review of the literature and research during the previous three years. A summary is presented in Exhibit V-9. As can be seen, in most cases the mean rating confirms the importance of the identified issue. (Note, however, that due to the nature of this data collection and the number of respondents for a given question, this information should not be considered statistically significant. Rather, its purpose is simply to provide an opportunity for informants to present their impressions of accuracy and importance.)

Across the four domains, some issues stand out as especially important. Leadership, resource commitment, key change agents, and the role of administrators are reported as very important issues in the administrative domain. In the material resource domain, issues in the selection and acquisition of both software and hardware are seen as significant. Having time for training and having in-service programs, as well as maintaining enthusiasm, are highly rated issues. The selection of computers as an instructional medium and linking software to instructional needs appear to be the most important issues in the area of classroom instructional applications.

Field staff also gathered responses from a limited number of educators (3) about the effectiveness of instruments (such as the Technology Assessment Survey) used during this project. Significantly, two of the three had not seen the survey. The media specialist who had seen the survey suggested that such efforts might be even more effective if they were specifically targeted to already motivated or interested persons.

Exhibit V-9(1)

Ratings of Importance or Effectiveness of Issues in Technology Integration

Question	Mean	n (number of responses)
Administrative Domain		
1. Importance of leadership in any innovation process	3	9
2. Importance of the commitment of resources in any innovation process	3	15
3. Membership, workscope, responsibilities and support of an LEA technology task force	2.3	3
4. Roles of central general education, central special education and building administrators	2.7	9
5. Identification of other key change agents at district and school levels	2.78	7
6. Obtaining input from general special education teachers and other staff about needs in the area of computer technology	2.5	17
Material Resources Domain		
1. Selection and acquisition of hardware	2.86	11
2. Implementing a stand-alone vs. a networked system	2.4	6
3. Decisions about hardware to be supported	2.38	13
4. Equity in the provision of material resources	2.4	12
5. Hardware placement options	2.65	19
6. Maintenance, depreciation, and replacement of equipment	2.4	5
7. Equipment loans and special purchase arrangements	2.57	8
8. Selection and acquisition of software	2.79	25
9. Storage and distribution of software	2.1	5
10. Staff responsibilities for the management of material resources	2.3	8
11. Dissemination of information about material resources currently available and acquisition of those not available	2.58	12
Human Resources Domain		
1. Maintaining enthusiasm for the use of computers in education	2.73	17
2. Membership, workscope, responsibilities and support of a school level technology committee	2.6	4
3. Identification of competencies need by teachers to carry our established LEA computer goals	2.3	5
4. Assessment of current computer competencies of teachers and other staff	1.5	1
5. Determining content of inservice training programs based on system goals	2.56	15
6. Conducting and coordinating inservice training programs, including by whom and how	2.7	20

Exhibit V-9(2)

Question	Mean	n (number of responses)
7. Use of outside resources for training including videotape and other technologies	2	3
8. Availability of time for training	2.9	15
9. Incentives for participation in training	2.6	15
10. Ensuring the availability of new staff experienced in and knowledgeable about microcomputer technology	2.5	1
Classroom Instructional Applications Domain		
1. Computer use as media selection	2.75	10
2. Linking software with instructional needs in both special and regular education classes	2.72	22
3. Linking computer use with individual student needs in special education classes	3	3
4. Managing classrooms in which computers are present	2.75	4
5. Use of computers for whole class hands on, whole class demo, and small group or individual work	2.6	10
Effectiveness of School (System) Efforts for Technology Integration		
1. Building level computer technology committees	2.1	8
2. Efforts to ensure that teachers receive adequate training in the use of computer technology	1.6	16
3. Effort to communicate to staff about what is available and how to access available equipment and materials	1.6	10

Factsheets containing information about computer applications for various education functions, provided as an example of a possible resource for future technology integration efforts, seemed to be very well received.

In contrast to the relatively high scores assigned to the critical issues when queried about perceived importance, respondents were much less positive about the effectiveness of current efforts to promote technology integration. Committee activities, programs to ensure adequate training, and efforts to communicate about available and accessible materials, all were seen as only somewhat or not at all effective. Several respondents indicated that they had just learned of such efforts during the interview process, a clear indication to them that the programs were not being effective.

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Chapter VI

Conclusions and Implications

Chapter VI. Conclusions and Implications

The Evaluation of the Integration of Technology for Instructing Handicapped Children (High School Level), conducted by Macro International, Inc., for the United States Department of Education, Office of Special Education Programs (Contract Number 300-86-0126), yielded important findings and products found to be of use to school practitioners. In this concluding chapter, we summarize the results of research activities and of our evaluation of the model of technology integration during the second phase of the project. Discussions of the implications of the research and the model for use, further investigation, and dissemination are also provided.

I. Summary of Phase I

During Phase I of the project to evaluate the integration of technology for instructing mildly handicapped students at the high school level, Macro investigated the experience of integration efforts in schools, as well as examined the activities of software producers and the findings of other researchers. This investigation led to development of a model of technology integration for schools and districts.

During the first three years of the five year project, research activities included a comprehensive review of the literature and consultations with educators, administrators, and industry leaders. Observations and interviews were conducted and documents collected in nine high schools in two school districts. Data also were incorporated from the administration of a needs analysis instrument, and from several substudies involving focused surveys in schools and the technology industry, as well as from secondary analysis of relevant data sets.

Findings were incorporated within a Manual to guide technology implementation and management. Those findings included the following understandings and recognitions.

Technology integration takes place over time, involving many different practices. It is as much a management issue for administrators as it is a task for classroom instructors. Integration is enhanced by coordination across the district and school. Infrastructure must be established to support and lead the classroom instructor. Four domains of activities have significant effects on technology integration: administrative, human resource management (e.g., staff development), material resource management (including technical assistance), and classroom applications.

Several key elements seem important. The school system should follow a clear philosophy or set of principles for the use of educational technologies. Leadership must exist to guide instructors and support providers to and through the innovation process. A crucial factor is the need for planners and administrators to incorporate information from teachers, by explicitly assessing needs, creating permanent routes of communication from the classroom, and by incorporating teachers into the decision-making process, via committees, for example. In addition, institutionalization of technology use is fostered when collaboration among teachers, and with resource managers, is encouraged. These are activities that can be accomplished by administrators.

Responsibility and resources for staff development should be allocated. Steps to manage human resources for technology integration might include incentives to participate in training, or provision of substitute teachers or other time allocations to enable learning. Staff development should become a structured and ongoing part of the integration process.

Effective management of material resources is required to provide necessary equipment, to assist in the selection and use of appropriate software, and to make regular technical assistance to instructors an integral part of the use of the technology. Responsibility for material resources and support should be explicit, structured, and assigned to specific positions.

Classroom instructional applications of technology achieve integration as they are coordinated with instructional objectives and supported by administrative policies and the appropriate management of human and material resources. In addition, student grouping, time allocations, and other aspects of classroom organization, including the use of computer laboratories, can be tailored to take advantage of the characteristics of computer-based technologies. The curriculum for many students with disabilities coincides with that of regular students, and to a high degree takes place in regular classrooms. Integration processes for special education thus must also spread across regular education, and are fostered by greater communication between regular and special educators than is often seen.

II. Summary of Phase II

During Phase II, Macro presented the Manual and supporting materials to six schools located in four school districts. Evaluation of the model was conducted by several case studies, in which its impact was assessed both for formative and summative purposes. Implementation of technology integration either using the model or following similar principles was identified and observed. Additional signs of technology integration outcomes and progress were sought to describe the goals and approaches taken within the participating school systems.

Macro identified various indicators that reflect the components of technology integration for each school district. Changes in the presence or form of these indicators within a given site were determined. Informants' perceptions and opinions regarding the model and technology integration were collected. Because technology integration is process as well as a structural condition, we examined the history and character of technology-related activities. Our evaluation focused on the four domains of organizational activity involved in technology integration: administrative, human resource, material resource, and classroom instructional application domains.

Macro employed five major types of data collection in Phase II: interviews, observations, documents, a brief technology survey, and telephone monitoring with liaisons at the district level and in one or two high schools in the system. The technology survey was administered to faculty and staff in participating high schools early in Phase II and again at the end, although not all schools complied with requests to conduct two administrations of the questionnaire.

Evaluation of the model of technology integration indicated that it was indeed a relevant, apparently accurate, and useful conceptual tool for schools undertaking or involved in the technology integration process. Its greatest utility appears to be for administrators and technology coordinators (or equivalent staff) who have responsibilities for guiding the pursuit of integration objectives.

The model provides a framework for decision making and policy formulation, as well as specifying the range of steps and issues, involving all school actors, that must be addressed in the technology integration process. It also appeared to be consulted to identify useful operational guidelines, particularly by those charged with establishing procedures and structures to promote and support technology use.

The model was of interest to classroom instructors as well. Its primary impact there, however, seems to have been to provide a overall view of the many components involved in supporting effective technology use, and giving teachers some idea of what they should expect to see from the school and district in order to encourage their use of the innovation. Phase II work confirms the applicability of the model of technology integration to a wide range of schools and districts.

The manual as such also proved to be an important resource. Evaluation made it clear, however, that its role as a conceptual toolbox and resource guide needed to be clarified, and that it needed to be clearly targeted to a focal audience. Because it was to a very great extent used only by coordinators, planners, and administrators, the manual was revised to target those individuals who are in a position to lead and create changes in the organizational systems that affect technology integration. These often are district officials, district or school technology coordinators, and principals, as well as members of technology committees.

The manual was reorganized so that the presentation allowed quick recognition of the purpose and the level of resource provided, while retaining sections containing sufficient depth to promote development of the concepts and structures necessary to pursue technology integration. The revision concentrated on providing practical concepts useful to those planning and implementing technology use in the schools. Detailed descriptions of technical issues were deleted, reflecting the findings that the manual could not successfully address all audiences, that operational technology managers already had much of this knowledge in hand, and that local conditions among schools and faculties differed so widely that very particular solutions were seldom appropriate for replication.

III. Limitations of the Research

Use of the research conducted by Macro International, Inc., to evaluate the integration of technology for instruction of students with disabilities at the high school is limited by some operational and design characteristics of the project. These are discussed below, beginning with a consideration of operational factors.

A. Level of Field Observations

As is the case with any study of process, culture, and change, the depth and significance of the findings are enhanced in proportion to the amount of qualitative investigation actually done at the field sites. While Macro's project incorporated an adequate, and relatively high, degree of contact with the participating schools, there is always more that can be accomplished.

This was particularly true during the evaluation of replicability and utility of the model during Phase II. More intensive observations on-site would have allowed greater direction of the dissemination of the Manual within the schools, more direct investigation of implementation and innovation events, and thus a more comprehensive as well as more detailed understanding of the impact of the model. In general, however, the findings of Phase II work provide ample indication of the applicability of the model to many schools and districts, and can be used with confidence.

B. School Participation

The initial participation of Charles County schools, followed by their abrupt withdrawal, disrupted the schedule of Phase II activities, resulting in some minor impacts on project outcomes. These impacts were compounded by the increasing resistance, for many reasons, of other schools to participate in research projects such as the technology integration evaluation. This resistance appears primarily to stem from increasing burdens of work at schools in a context of budget cutbacks and mandated changes in instruction and organization, on the one hand, and an emerging sense of being "beleaguered" that seems to a growing part of teachers' culture, on the other.

Conversely, the Charles County experience provided some important insights into what is needed for effective dissemination of resources such as the model and Manual. Schools do not want materials that appear to repeat efforts and materials they already have produced. Further, districts and schools at some stages of technology integration appear to tackle problems and decisions in a sequential way. The county's initial interest in participation stemmed from their immediate need to develop information and policy related to technology planning. As that need was addressed and became supplanted by other concerns, such as a fiscal crisis, their interest flagged.

C. Cooperation and Data Collection

The most important of the impacts on the project from Charles County's withdrawal was simply that we obtained only one year's worth of field research from the alternative site, Prince William County schools. As a result, one high school reported only one administration of the technology survey. The second participating high school in that district decided against use of the survey at all, reasoning that it was an additional burden on staff time not warranted by its immediate local benefit. There also appeared to be some concern about the implications of using general surveys on any type in the school, for example, in the area of privacy, or use of data by outside agencies.

One high school in Howard County also failed to complete two administrations of the technology survey. This appeared to be the result of schedule and operational conflicts, perhaps due to the lower priority of project participation compared to other challenges facing the school administrators. The two surveys each obtained from three other high schools, however, are sufficient to compare results from early and late in Phase II investigation.

D. Qualitative Research Design

The evaluation of technology integration at the high school level was fundamentally a qualitative study. It entailed ethnographic field research, case studies, and multisite comparisons, using the model of technology integration to provide analytical constructs that enabled discussion of local conditions and findings within a synthetic and general framework. This approach proved to be highly appropriate for the topic of evaluation. At the same time, the qualitative design and its distinctive analytical methods define some limits on its use.

The benefits of the approach are rooted in the greater depth, detail, and understanding of local conditions and beliefs, and of processes, that result. Great confidence in the accuracy, if not the scope, of resulting models is one outcome, while many factors of change and process that are difficult to describe and analyze otherwise are taken into consideration. In this sense, the research and the model derived from it can have substantial logical, cultural, and "practical" validity. Further, findings are general to the extent that they can be expressed in a coherent framework or model, and prove to be accessible, relevant, and accurate to other groups in the same category of population who review that model. In this respect, the Phase II work among participating schools addressed the issue of validity and generality.

Statistical generalizability, however, is not provided by this research. While some data and findings were considered and analyzed in quantitative form, this was done primarily for utility and ease of understanding in the presentation of the analysis. The limited number of field sites, the possibility of intervening factors such as regional or state effects, and the importance of local conditions, limit the degree to which findings can be extended as specific hypotheses and conclusions. Our formulation of reports and the model itself attempt to make this clear by their presentation as conceptual schemes or frameworks that contain only principles and guidelines, illustrated by the experience of particular schools.

One significant outcome of using a qualitative research approach in the evaluation of technology integration was the clear demonstration that local conditions vary greatly. The process of technology integration thus will be determined by, and has to be guided in light of, those unique conditions and concerns. This recognition imposed a limitation on the products of the project in that they had take the form of principles and guidelines that can be flexibly applied, rather than a rigid and specific outline of interventions and innovation steps to be taken.

IV. Dissemination of Research and Materials

Macro will work with other groups and organizations to seek the best possible way of disseminating the information and materials resulting from the technology integration project. A revised manual describing the model for technology integration and containing detailed guidelines for its implementation will be made widely available. As described in the first chapter of this report, it contains numerous guides and resource lists to help users find further information and assistance.

It is Macro's intention to provide this manual at corporate cost to International Business Machines or another appropriate organization for distribution. We will collaborate with appropriate organizations or sources of funding if it appears that further development of the manual will enhance its utility to administrators or other staff who play key roles in the integration of technology for regular or special education. While Macro is not in a position to undertake major development itself, it is committed to assisting in such efforts to the extent possible.

In addition, Macro is preparing a comprehensive monograph discussing the five year project, its methods, findings, and implications for technology integration in schools and districts. Macro will seek a suitable publisher for this monograph who will ensure widespread availability to those interested in educational technology. The document will be based on the structure and content of this Final Report. The presentation, however, will be revised to address the concerns of researchers and practitioners generally, while some sections that are of particular interest to OSEP but not other audiences will be condensed.

Individual staff, with Macro's endorsement, plan to develop further articles for journals and presentations for delivery at appropriate professional meetings. There are many components and aspects of the investigation of technology integration that provide good candidates for more analysis.

The observations and interviews conducted at school sites, for example, will yield detailed focal cases that can give important insight into the practical experience of technology use, the changing roles and stresses that accompany integration, or the impact of very specific procedural changes. The information gathered using the needs assessment instrument in Phase I and the technology survey in Phase II also is a rich source of further work, especially when analyzed longitudinally and focused on target groups in the schools. The substudies described in Chapter V, documentation of leadership activities, and development of the research taxonomy are other potential sources of future production and dissemination.

The investigation of technology integration conducted by Macro cuts across a wide range of analytical topics and substantive concerns. These include organizational analysis, educational administration and leadership, innovation research and evaluation, teacher education, curriculum development, multisite qualitative evaluation and methodology, educational technology generally, instructional technology, and technology transfer and support. As a result, there are a variety of journals and communication channels that are potential arenas for future dissemination from the project's activities. We will identify the potential for publications and presentations in each of these areas.

V. Implications for Future Research

The Model of Technology Integration and the analysis that underlies it address a number of areas where further investigation would be of benefit. Deeper understanding of the processes involved and optimal strategies in each of the domains of organizational activity important for technology integration can have important practical implications. Detailed analyses and recommendations for operational action at all levels and positions in the schools also are indicated.

Perhaps most interesting to investigate, and least understood at present, will be the connections between personal attitudes and choices, and the emergence of new beliefs and norms in the school culture regarding technology use and the course of schooling generally. This area also seems crucial for understanding the documenting the process of institutionalizing changes in technology use and other aspects of the evolving experience of regular and special education.

Work in these broad areas could address a number of specific topics. These include an identification in more detail of the needs of administrators and coordinators for resources and training not only in technology but in the conceptual, leadership, and implementation skills that promote innovation and technology transfer.

An evaluation of the roles that technology does and can play in educational reform or school improvement also seems a worthy program for research and policy development. Macro's work suggests that technology integration is part of the larger process of progressive and effective educational endeavor on the part of schools. Both the pace and effectiveness of technology development depends on the ways in which educators guide the overall schooling process.

The personal experience and evolution of teachers confronted with instructional technology as new pedagogical tools is a key factor in effective use. The detailed and particular course of such experiences is not always appreciated, however. Research could be directed to the application of computer-based technologies to instruction and with the curriculum to see the course of teacher's experience. Impacts on teacher behavior and activity, and resulting implications for content and effectiveness of instructional practice would be analyzed. This investigation will require detailed and continuous observations of classroom activity and teacher practice over some time to accurately retrieve and describe the operational experience and changes in culture of teachers in the innovation process. One objective of the project would be to synthesize a model of the steps of teachers' personal evolution that will go beyond a simple chart of the stages of innovation acceptance (for example) to directly applicable findings about social, psychological, and cultural changes.

Macro's research consistently revealed the poor linkage of the technology producing and marketing community with the schools and classrooms where instructional technology actually is used. This situation may have important impacts on effective technology use in educational reform. In new research, analysts could focus on the current conditions, their implications, potentially more beneficial and effective models, and ways to move towards a more coordinated relationship that will better serve the needs of students and teachers.

Ongoing assessments of the state of knowledge in instructional technology and other research that addresses the domains of organizational activity that are the components of technology integration would provide a useful tool, primarily for researchers but also for computer coordinators and practitioners supporting the integration process. One vehicle for this effort is the Research Taxonomy format developed during Macro's evaluation work. This potential project appears to be one well-suited to a clearinghouse function, or perhaps to a university department where graduate students can incorporate maintenance of the data base into their training experience.

A crucial investigation for future consideration is to outline requirements or optimum strategies for the evolution of teacher roles in technology integration, the application of technology to the development of higher-order thinking skills, serving the needs of at-risk students, the use of distance learning, and other aspects of educational reform. Such research should specifically address implications of the models of teacher knowledge and roles for pre-service and in-service teacher education.