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AUTHOR	Zorfass, Judith; And Others
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ABSTRACT

This final report documents Phase I of a federally funded, naturalistic study of how middle schools can integrate technology into mainstream instruction for mildly handicapped students. Phase I of the study, carried out from October 1986 through September 1989, examined teacher practices that create successful, computer-supported learning experiences for special needs students, and examined the larger school and organizational context that sustains those teacher practices. A total of 23 administrators and 25 teachers from 4 middle schools participated in the 3-year study. Phase II will involve the development and field testing of a school-based intervention to enhance technology use. The report provides an overview of Phases I and II, a description of Phase I research methods and results, a model for a school-based approach to technology integration, and a description of the Phase II technical method. Sixteen study findings are organized into the categories of teacher knowledge and practice, technology resources, teacher development, collaboration and communication, and school-based facilitation. The technology integration model includes the following key elements: a technology integration facilitator, a technology support team, a trainer, teacher dyads, a module-based teacher development program, and school-based facilitation workshops. (Includes approximately 90 references.) (JDD)

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EXECUTIVE SUMMARY

PURPOSE

From October 1986 through September 1989, Education Development Center, Inc. (EDC) and Technical Education Research Centers (TERC) have carried out an intensive, naturalistic study of how middle schools can integrate technology into mainstream instruction for mildly handicapped students. Funded by the U.S. Department of Education, Office of Special Education Programs (OSEP), this three-year study forms Phase I of a five-year technology integration project. The focus of Phase I has been to expand our understanding of (1) the teacher practices that create successful, computer-supported learning experiences for special needs students and (2) the larger school and organizational context that sustains those teacher practices. Phase I research forms the groundwork for Phase II, which will take place from October 1989 through September 1991, during which time the project will develop and field-test a practical, school-based intervention designed to enhance technology use with special needs students in middle schools. The EDC/TERC Middle School Project is part of a larger OSEP mission that has funded counterpart studies focusing on the elementary (Johns Hopkins) and high school (Macro Systems) levels.

Middle school is a challenging time for all students. Early adolescence ushers in dramatic social, emotional, physical and cognitive changes. At the same time, the middle school environment demands that students work more independently. Mildly handicapped students who enter this period with a history of learning problems can often find middle school overwhelming. They may need special support and monitoring to solidify their basic skills and apply them to problem solving, acquire the learning strategies they need to work more independently, and cooperate effectively with peers.

Close to a decade of research finds that computers have the potential to play an integral and powerful role in instruction for mildly handicapped students at this stage of their schooling. Word processing, mathematics, and social studies software can motivate students and promote fluency in skills and in problem solving. Computer-supported learning environments can reveal students' learning abilities more sharply to teachers. Yet despite these possibilities, we are only beginning to understand the processes required to successfully integrate computers into instruction for mildly handicapped students. The overall purpose of the Middle School Technology Integration Project has been to advance our understanding of what successful technology integration requires at the instructional level and what kinds and levels of support it requires at the organizational level.

Defining Successful Technology Integration

Our definition of successful technology integration emerged from ongoing project data analyses and self-examination, on the part of project staff, of the underlying educational values and assumptions in the project. Successful technology integration occurs when teachers use applications of technology in a sustained way to promote and support special needs students' progress and participation in mainstream learning. Sustained applications of technology are more likely to take place when technology integration occurs across a number of classrooms and content areas over time and is recognized as a school-based effort rather than the special interest of an individual teacher. We find that computers are "integrated" into the curriculum when they cause students to connect with content in a new way, or teachers to develop new approaches to teaching in a content area. Computer integration can take place in settings other than the mainstream classroom as long as it contributes to students' ability to acquire the full range of abilities and understandings included in the school curricula.

Major Research Questions

The overall question guiding Phase I research has been, What factors promote or hinder the technology integration process? Specific questions related to the organizational level include the following:

- What resources (e.g., computers, software, technical assistance) do teachers need to integrate technology? How do schools make decisions about the acquisition of, access to, and allocation of computers and software?
- What mechanisms, structures, and policies support teachers' efforts (e.g., opportunities for communication and collaboration, policies that promote links between special and regular education)?
- What types of training programs support teacher development? What types of collaborative working relationships support teacher development?
- How do administrators learn about and respond to teachers' emerging needs?

Specific questions related to the instructional level include the following:

- What types of knowledge do teachers need in order to integrate technology into the curriculum (e.g., knowledge about computers and software, knowledge about curricula, knowledge about instructional practices)? How do teachers obtain this knowledge? What contributes to translating knowledge into practice?
- What instructional practices contribute to effective technology use with mildly handicapped students? How do teacher practices change over time as teachers acquire or expand their knowledge?

- What patterns of access to computers and software help teachers use computers in their classrooms or computer labs? How do teachers' practices change in response to increased or decreased access?
- What types of technical assistance do teachers need in order to integrate computers into instruction?

One of the central goals of Phase I is to expand the current knowledge base about technology integration, as the foundation for designing and field-testing an intervention in Phase II that will guide middle school practitioners in enhancing technology in their schools. The report summarized here describes how we carried out our research in Phase I, our major findings, an emerging school-based approach to technology integration, and our Phase II plans for developing and field-testing a set of practitioner manuals that embody that approach. This executive summary focuses primarily on our approach and findings in Phase I and presents brief highlights from our plans for Phase II.

PHASE I RESEARCH METHOD

Naturalistic Approach

The general approach of Phase I has been to follow the technology integration process intensively in four diverse middle schools over a three-year period, at both the classroom and the larger organizational levels. The project proposed initially to undertake a series of large-scale quantitative studies of selected instructional and organizational factors. Early research in the four sites revealed a level of complexity in the integration process that was best studied holistically, through following the experiences of teachers, specialists, administrators, and students. Our goal became one of describing the integration process, including identifying key variables in the process and detailing the linkages among them. Specific features of our method were consistent with a naturalistic perspective: observing in natural classroom settings; building mutually beneficial relationships among researchers and teachers; using such qualitative procedures as observation, interviewing, and document collection; and incorporating ethnographic data into descriptive cases.

Early research in Year 1 revealed that integrating computers into the curriculum happens slowly. Though our longitudinal approach ensured that we would be observing an evolving process over three years, we decided to enhance our opportunities to observe the integration process by accelerating that process wherever we could. Within our roles as researchers, project staff actively intervened in the four sites whenever such intervention might advance technology use in ways that were consistent with practitioners' activities and goals for the school. These interventions were designed to further our understanding of what could effect change; they encompassed providing software, conducting software review and training sessions, and organizing meetings to facilitate decision making. In all cases, we intervened in ways that we anticipated would contribute to meaningful use of technology with special needs students, and we extensively documented those interventions and our own role in them.

Data collection and data analysis took place in two stages during Phase I. While the focus of Stage 1 (twelve months, from October 1986 through September 1987) was on the organizational context of computer use, Stage 2 (twenty-four months, from October 1988 through September 1990), focused on the instructional use of computers within the larger organizational context.

Research Sites

The four sites varied in school organization, demographic characteristics, and progress in using technology.

- Bromley is one of twenty-two middle schools in an inner city (Centertown) and has a 90 percent minority population. Although the school has two computer labs, its major innovation is an intensive focus on basic skills for all students, through extending the school day and holding classes on Saturdays.

- Located in a small urban center, Riverton is organized into clusters, with students organized into ability groups. One computer lab is devoted to language arts; another is available for other content areas on a flexible schedule. Resource rooms and substantially separate classrooms have one computer each.

- Hopeville, in a rapidly growing middle-class suburb of a small city, has been swiftly expanding its technology program to include computer specialists, to provide teacher support and training, and to find more curriculum-based uses of software.

- Greendale is an affluent suburb in which parents, who are largely professionals, advocate for extensive mainstreaming of their special needs children. Teachers are encouraged to develop their own curricula and programs; consistent with this approach, language arts teachers have integrated word processing into courses that bridge mainstream and special needs classes.

This variation in goals, population, structure, and use of technology across the four sites has contributed substantially to the possibilities and issues in technology integration.

Participants

Between five and seven administrators from each school (for a total of twenty-three administrators) and between six and seven teachers and specialists from each school (for a total twenty-five teachers) participated in the study for the three-year period. District-level administrators included superintendents, assistant superintendents, directors of special education, language arts coordinators, and computer coordinators, whereas school-level administrators included principals, assistant principals, computer teachers, cluster or team directors, and special education administrators. The teacher sample included resource room teachers, teachers of substantially separate special education classes, computer teachers and aides, mainstream mathematics and language arts teachers, and, in one school, a social studies teacher who had mainstream special needs students.

STAGE 1: THE ORGANIZATIONAL CONTEXT (1986-87)

The major purpose of Stage 1 was to understand the contextual and institutional factors that were influencing instructional computer use in the four sites. Staff focused on learning who the pivotal players were in each school, which policies and procedures contributed to computer integration, what role computers currently played in instruction, what training and technical assistance was available to teachers, what access teachers had to computers and software, and what concerns administrators and teachers had related to technology integration.

Methods of collecting data included conducting separate focus groups with teachers and administrators at each school and holding follow-up interviews with individual teachers and administrators based on the themes and questions emerging from the focus groups. In addition, members of the research team made between four and six visits to each school to meet staff members and observe placement and use of computers; met informally and held telephone discussions with participants related to the purpose of the project and data gathering procedures; inventoried software through a survey instrument; collected curriculum guides and planning documents; and visited classrooms. Classroom observations were carried out in order to gather a preliminary picture of how teachers organized instruction with and without computers, rather than for intensive observation of instruction.

Ongoing analysis was carried out to ensure that data gathered early in the first year would guide the data gathering and analysis that followed. Cumulative analysis at the end of Stage 1 included integrating data from each site into a preliminary site summary, reviewing the site summaries within the research team and with the Advisory Panel, and identifying a set of critical factors influencing the technology integration process within each school. Major results from Stage 1 included site summaries, a set of within-site factors, and a set of both general and site-specific research questions to guide intensive classroom observation in each schools.

STAGE 2: THE INSTRUCTIONAL CONTEXT (1987-89)

The main purpose of Stage 2 was to identify critical teacher practices that contribute to successful technology integration and to pinpoint those critical administrative practices, roles and responsibilities of computer specialists, and methods of teacher training and support which enhance such integration. Site-specific questions identified at the end of Stage 1 also guided research in each school--for example: How was word processing integrated into a course co-taught by regular and special education teachers (Greendale)? How would a resource room teacher and a special education classroom teacher evolve their use of problem-solving software (Riverton)? What were the roles and responsibilities of the school-based computer specialist (Hopeville)? How were decisions made around the donation of new computers to the special education teachers (Bromley)?

Stage 2 data collection took place between October 1987 and March, 1989. Consistent with a shift to a focus on classroom instruction, methods included classroom observation; follow-up debriefing interviews with teachers; longer periodic interviews with teachers, specialists, and administrators; and collection of student work samples. Ongoing data analysis included regular discussions of observation and interview summaries. An important undertaking throughout the first eighteen months of Stage 2 was the development and revision within each site of cases that portrayed administrative and classroom processes. The cumulative analysis, which took place between April and September 1989, was guided by recent developments in qualitative and "interpretive analysis" articulated by such researchers as Frederick Erickson, Michael Patton, Robert Yin, Tom Skrtic, Matthew Miles, and Michael Huberman. The analysis synthesized three years of data and consisted of five major steps:

- Completing and validating cases through additional data gathering and reviews by participants
- Identifying eight general cross-site factors that included the most critical variables within all the schools
- Developing assertions about the technology integration process, through a collaborative analysis of subsets of cases and additional field data
- Identifying constellations of assertions, arranged in categories that included school-based facilitation, teacher development, collaboration and communication, technology resources, and teacher knowledge and practice
- Developing a conceptual framework that encompasses classroom, school, and larger organizational levels and links the assertions

The results of the analysis are sixteen major findings about (1) the kinds of teacher knowledge and practice that result in successful technology integration at the classroom level and (2) the kinds of school and organizational factors that support such knowledge and practice.

PHASE I RESULTS

The sixteen findings are stated briefly here; they are explicated and supported with case material in the Phase I Final Report.

Teacher Knowledge and Practice

While some visions of computer use represent the teacher as being "freed up" by technology to focus his or her attention elsewhere, one of our strongest findings was that successful use of computers with special needs students requires that the teacher be highly knowledgeable in several areas and actively engaged in students' use of the software. This is true regardless of whether the software is used for skill practice, problem solving, or programming. Furthermore, successful use of computers in instruction with special needs students is closely associated with teacher opportunities to reflect with other teachers on their use of computers. Three findings related to teacher knowledge and practice reveal those results:

- In order to improve the way technology is used with special needs students, teachers need to gradually acquire and/or draw on and integrate knowledge about

  -special needs students' strengths and needs
  -the potential contribution technology can make to special needs students' learning
  -curriculum content
  -instructional strategies
  -assessment strategies
  -hardware and software

- In order to promote successful technology integration with special needs students, it is critical for the teacher to be actively involved with students' use of software, regardless of the type of software.

- When teachers engage with others in ongoing reflection about their instructional use of technology, they are more likely to critically evaluate their practice and redesign instruction to better meet student needs and curriculum goals.

Technology Resources

For technology integration to be successful, technology-specific roles and mechanisms must be in place to support teachers' efforts. Two findings related to hardware and software are the following:

- Someone needs to be responsible for ensuring that hardware is kept in good working condition and that technical problems are solved.

- When there is some mechanism for narrowing down their choices of software, teachers are more likely to try integrating technology into their classes.

Teacher Development

We found that traditional training that includes a series of after-school sessions, designed to appeal to a wide range of teachers and incorporating little follow-up or ongoing support, was of little use to teachers in our study. Rather, continuous access to people who could provide ongoing support--both specialists and peer teachers--makes the difference. Two findings in this area are the following:

- When novice computer users have someone to whom they can turn for knowledge about computers as well as emotional support and reassurance, they are more likely to begin integrating technology into the curriculum.

- In-service workshops can contribute to teachers' acquisition of knowledge, but are insufficient in helping teachers use this knowledge in their work with students. Teachers best learn to integrate technology successfully through ongoing school-based support and structures for collaboration and communication.

Collaboration and Communication

As the role of collaborative learning receives broad national attention in both regular and special education, this research highlights the importance of collaboration among teachers as they carry out innovations as complex as using technology in instruction. We found that teacher pairing was consistently associated with successful technology integration. Two findings in this category are the following:

- When two people work together collaboratively to try out software, technology use tends to be more successful.
- Regular, ongoing communication between regular and special educators who teach the same students often facilitates successful technology integration if the focus of the communication is on curriculum goals, instructional strategies, and student needs.

School-based Facilitation

Many teachers, on their own, have integrated technology into their particular classroom for a period of time without strong support from other teachers and administrators. If technology integration is to be sustained beyond the individual classroom or the one pioneering teacher, however, a climate of active administrative support and ongoing access to resources is critical. Further, the basic school structuring that promotes or inhibits links between regular and special education profoundly affects the way special needs students use and benefit from technology. A series of findings related to school-based facilitation helps to define the kinds of administrative roles, decision-making methods, and policies and practices related to special and regular education that contribute to successful technology integration:

- When decisions about hardware acquisition, hardware allocation, and scheduling focus primarily on curriculum goals and teacher experience and expertise, they are more likely to lead to successful technology integration than when they focus exclusively on issues of equity and access.

- Once a technology-related decision is made, it is unlikely to be implemented unless someone who is committed to the decision determines what steps must be taken and ensures that the next step happens at each point in the implementation process.

- Once a technology-related decision is made, administrators and teachers need to communicate directly with each other during implementation to determine whether the decision is working or needs to be revised.

- In order to support teacher development, administrators must put structures in place so teachers can communicate and collaborate on a regular basis.

- When administrators vary expectations according to teachers' individual needs, interests, and abilities and give teachers choices about how and when to implement technology-related curricula, successful technology integration across classrooms is more likely to occur.

- In order for successful technology integration to occur beyond individual classrooms, administrators need to:

  -have a vision of the value and potential of the computer in meeting students' instructional needs and curriculum goals; and

  -understand that integrated technology use implies instructional and organizational changes.

- When there are policies and procedures that promote links between special and regular education programs, then it is more likely that technology-related curriculum planning and implementation will meet the needs of special needs students.

Together, these findings argue that the teacher plays a central and critical role in the technology integration process but that teachers must be supported by a context that promotes teacher development, fosters collaboration and communication, and provides adequate technology resources. Administrators, teachers, and specialists must work together to put in place the policies, structures, and ongoing support that result in meaningful learning experiences for special needs students.

PHASE II

The purpose of Phase II is to design a school-based approach to technology integration, develop a set of practitioner manuals that embody the approach, field-test the manuals in several sites and with a wide range of practitioners, and lay the groundwork for disseminating the revised set of manuals to middle schools.

Based on the research findings from Phase I and other research on school innovation and staff development, we have identified several key elements of a school-based approach to technology integration:

- A Technology Integration Facilitator who takes the lead in overseeing and putting structures in place to promote successful technology integration
- A Technology Support Team composed of pivotal teachers, specialists, and administrators who identify and respond to emerging teacher needs
- A Trainer who plans and carries out a teacher development program

- Teacher Dyads whose members assist each other, in a peer coaching relationship, to acquire new information and practices and to reflect on their practices

- A Module-based Teacher Development Program that includes both workshops and follow-up activities for Teacher Dyads

- School-based Facilitation Workshops attended by the Technology Support Team and teachers participating in the teacher development program so that together they can address emerging issues related to supporting teachers' development

The Module-based Teacher Development Program will include a series of workshops that guide teachers and specialists in examining their current curriculum goals, identifying where technology could support or expand those goals, assessing how special needs students might benefit from technology applications, selecting software consistent with curriculum goals and student needs, developing effective instructional strategies that meet students' needs in the context of using software, and helping teachers engage in ongoing processes of observing, reflecting, and intervening with special needs learners.

A set of materials titled Integrating Computers into the Curriculum will guide middle school staff in a year-long intervention in which they implement this school-based approach. An Implementation Manual will help the Technology Integration Facilitator and the Technology Support Team carry out the school-based approach. A Training Manual will guide a Trainer in conducting workshops and follow-up activities that help teachers develop the kinds of knowledge and classroom practices and carry out the kind of ongoing reflection that the project found is central to successful technology integration.

These materials will be produced in three stages: materials development, field testing, and final materials production. The materials will be developed and written between October 1989 and August 1990. Key tasks will include developing initial specifications for the materials, based on Phase I findings and the literature on school-based change and teacher development; submitting those specifications for review by the Advisory Panel and OSEP; writing both manuals for field testing; and revising the manuals based on the results of the pilot testing and a review by experts. Between August 1990 and July 1991 the materials will be reviewed by an extensive national panel of practitioners and field-tested in two middle schools. Project staff will employ qualitative procedures to study the use of the materials. The study will be guided by formative evaluation questions about the design of the product and usefulness of its contents, and by impact questions about the effect of the approach on teacher development, access to technology resources, communication and collaboration among practitioners, and school-based facilitation.

Between July and September 1991, we will revise Integrating Computers into the Curriculum and produce camera-ready copy for publishing and distribution. During Stage 1 we expect to identify a commercial publisher for the product; during Stage 2, to work closely with the publisher, the Council for Exceptional Children, and other national groups to plan for the dissemination of the materials.

CHAPTER 1: OVERVIEW OF PHASES I AND II

Over the past three years, Education Development Center, Inc. (EDC), and Technical Education Research Centers (TERC) have carried out an intensive, naturalistic study of how middle schools can integrate technology into mainstream instruction for special needs students. Phase I (October 1986-September 1989) of this five-year study of technology integration, funded by OSEP, has been designed to expand our knowledge of the teacher practices that create successful, computer-supported learning experiences for special needs students and of the instructional contexts that support and sustain those practices. We have carried out this study by immersing ourselves in the classroom and organizational life of four middle schools in eastern Massachusetts. During two and a half of the three years, we studied the history and ongoing organizational context of computer use and followed teachers' evolving use of computers with special needs students in classroom and resource room settings. We tracked teachers' interactions with computer specialists and with one another, described conditions of access and scheduling that widened or hindered teachers' use of computers, and documented administrative actions and decisions that either responded to or constrained teachers' use of computers. The results of the first and second years of the project are available in the Year 1 and Year 2 annual reports (October 1987 and 1988, respectively).

The intensive research in Phase I lays the groundwork for Phase II (October 1989-September 1991), in which we will develop and field-test an intervention, a practical, school-based approach to technology integration that builds on our finding from Phase I. The approach will be embodied in a written product, a set of two manuals that guide school-based trainers of teachers, specialists and administrators in extending the ways they use computers with special needs students. The purpose of this report is to present the results of Phase I and relate them to a design for Phase II that includes both the development and the field testing of this school-based approach in several middle schools.

The work we have carried out over the past three years has been guided by a vision of technology as a potentially powerful support for learning at the middle school level, by an evolving definition of technology integration, and by a naturalistic research approach. The work we propose for Phase II is guided by a view of successful innovation in schools as a process of "mutual adaptation" between a new program or intervention and the school. Each of these themes is briefly discussed in this introduction in order to provide a context for the chapters that follow.

ENVISIONING TECHNOLOGY IN THE MIDDLE SCHOOL

Early adolescence is a critical period of biological and social change, a time when students are exceptionally vulnerable yet also open to new ideas, new skills, and new ways of thinking (Hill, 1980; Lipsitz, 1984). For mildly handicapped students, middle school poses a more challenging and intensive version of the tasks all students face at that time--making a transition from one teacher to several, organizing their work, strengthening their skills and applying them to problem-solving situations, finding acceptance from peers, and developing self-esteem and a positive identity (Center for Early Adolescence, 1984).

Many middle schools are conducting a process of self-examination in light of national initiatives that challenge them to provide smaller and more caring learning environments, interdisciplinary teaming, collaborative learning, opportunities for critical thinking, teaching of learning strategies as well as content, and closer monitoring of students' progress (Carnegie Report, 1989). These directions can vastly benefit those special needs students, who tend, for example, to be more accepted in settings where collaborative learning is combined with close monitoring (Center for Early Adolescence, 1984; Slavin, 1985).

Visions of how computer technology might support these new directions are emerging from research and from innovative schools. Envision students using simulation software in groups of three to develop navigation skills and apply them in a "rescue" game in which they locate and free a trapped whale (Voyage of the Mimi); using practice software to increase fluency in math skills; using geometry software to both pose and answer their own questions (Moses, Bjork and Goldenberg, 1988); and using word-processing, data base, and spell checker software to support their writing of a story or research report (Morocco, Dalton, and Tivnan, 1989). Envision computers networked so that students can communicate with one another and with the teacher in all combinations (Weir, 1989). These applications are in place in some middle schools across the country and are receiving research attention in a number of settings. Beginning research into the impact of these applications on special needs students suggests that computer environments can reveal students' abilities to the teacher in new ways (Weir, 1989). Well-designed interactive computer environments can also support a shift in teachers' roles from that of provider of content-specific information to that of facilitator of students' learning (LCHC, 1989).

In beginning our study of the technology integration process in middle schools, we suspected that realizing these possibilities in middle schools is no simple process, particularly if the benefits are to accrue to special needs students. We anticipated that in most schools such applications in fact pose an enormous challenge for the teacher and require important and complex kinds of support at all levels of the school. Nevertheless, the vision of computers supporting more personal, supportive, and collaborative learning environments for special needs students facing the demands of early adolescence has motivated our efforts over the three years.

DEFINING SUCCESSFUL TECHNOLOGY INTEGRATION

Our definition of successful technology integration has emerged both from our case analyses and from the project's self-examination of its educational values and assumptions. Although the research group began to work with certain shared experiences, knowledge, and assumptions, we were also affected by what we observed as we participated in the reality of four school systems over a three-year period. The definition we developed is central to our analysis an. to the reader's interpretation of our results in the chapters that follow, because it reflects both what we have learned from our work in the field and our philosophical and pedagogical stance.

We define successful technology integration in the following way:

> **Technology integration occurs when teachers use applications of technology in a sustained way to promote and support special needs students' progress and participation in mainstream learning.**

An important aspect of this definition is its focus on the use of technology at the classroom level. Studies of technology often use indicators, such as the number of computers in a school or the number of student contact hours per week (Becker, 1987); other systemwide markers, such as computer literacy competencies or computer course requirements, might also be used to gauge the type and amount of computer use. We, however deliberately distinguish <u>use</u> from <u>integration</u>. We believe that the only reliable indicator of integration is what is actually occurring at the student-teacher-computer level. Consistent with this view, we have found that the presence or absence of a certain number of computers or of particular mandates and requirements is not clearly related to student progress and participation. Technology integration can be judged as successful only when the use of technology (1) has a direct impact on students by enabling them to connect with educational content in new ways or (2) affects student learning indirectly through the teacher's development of new approaches and insights.

By including the word sustained in our definition, we are attempting to distinguish between technology use that is sporadic, inconsistent, and unconnected with students' ongoing education and technology use that provides students with a significant learning tool. Sustained technology use occurs when students have enough time to become familiar with a piece of software and then use it repeatedly to solve problems, explore content areas, or create original work. What constitutes sustained use is a matter of judgment and varies with the type and purpose of the software. For example, whereas three weeks of work with the Geometric preSupposer may be sufficient for students to become familiar with it and to use it for exploring a variety of geometric problems in the context of a geometry unit in their general mathematics class, a three-week exposure to word processing would not allow students to actually integrate computer use into the writing process. In the case of a general-purpose tool, such as the word processor, our definition of sustained includes continued availability of the tool for students to incorporate it into their work whenever appropriate.

We find that sustained applications of technology are more likely to occur when technology integration is occurring across a number of classrooms and content areas and when it is recognized as a school-based effort rather than the special interest of an individual teacher. For example, word processing applications are most successful when students can use the computer across the various content areas that require writing. This means not that all teachers have to be using computers as a part of their curriculum but that creative and appropriate applications are most likely to be identified for special needs students where there exists a pervasive climate of support, information sharing, and expertise around technology integration within the middle school.

Our definition also stresses mainstream learning. The term mainstream can refer to the goals and content of learning and also to learning settings, and our definition is meant to imply both. Technology integration is successful if it contributes to students' ability to acquire the full range of abilities and understandings that are included in the school curricula. Learning disabled students, for example, are not so engaged in mainstream learning if they use word processing only to correct mechanical errors while normally achieving students use the computer for composing. We believe that mainstream learning, in that sense, can occur in a variety of settings and we have in fact observed students using computers effectively outside the mainstream classroom. Ultimately, however, technology integration is successful if its use allows special needs students to gain access to and increasingly participate in learning in the mainstream classroom setting.

Our definition of successful technology integration provides the framework in which the cases and assertions resulting from our study can best be understood. It is important to keep in mind, however, that this definition provides a goal to be reached, not a filter to separate the "successful" from the "unsuccessful." We are working with a continuum of integration, not a dichotomy between success and failure. Although technology integration, at its best, consists of sustained, significant uses of technology that support special needs students' progress and participation in the mainstream, there are many partial successes along the way, successes that we want to acknowledge, learn from, and use as building blocks.

STUDYING THE TECHNOLOGY INTEGRATION PROCESS

The Phase I research approach and methods discussed in Chapter 2 derive largely from the project's shift to a naturalistic perspective in the first year. When we began our study in October 1986, we planned initially to investigate organizational factors that affect technology integration and then to undertake a series of large-sample quantitative studies of the impact of particular kinds of computer-based instruction on students' academic learning. We saw ourselves very much in the role of traditional researchers, observing carefully selected or constructed teaching situations and minimizing our influence on the treatments we were observing. Our early research in the four sites, however, revealed a complexity in the technology integration process not fully captured in previous research and a need to illuminate the integration <u>process</u> and the subtle <u>linkages</u> among variables, rather than the impact of a set of preselected variables.

Consistent with our need to study all evolving systems from the inside, we adopted a naturalistic perspective. This perspective assumes that reality is best studied holistically through the experiences of many different participants. Several features of our approach over the three years reflect a naturalistic perspective. These features include observing in natural classroom settings (Schatzman and Strauss, 1973); maintaining mutually beneficial relationships between researchers and teachers (Lincoln, 1985); using qualitative procedures, such as observation, interviewing, and document collection (Herriot and Firestone, 1983; Patton, 1980; Lincoln, 1985); and using the case study method (Hoaglin et al., 1982; Yin, 1984). In addition, we intervened in ways that coincided with emerging directions in each school (Loucks and Hall, 1977; Louis et al., 1984) in order to prod and illuminate the change process; and those interventions frequently became a focus of our study (Loucks and Hall, 1977). We viewed the relationship between researchers and teachers as a potentially beneficial source of information for the study (Casanova, 1989). The researchers provided active support for the teachers' use of computers in minimal ways--being attentive observers during classes, asking reflective questions following an observation, and encouraging the teachers to attend training sessions--and also in more active ways--holding software review workshops, training teachers in the use of new software, and holding team meetings. Within a naturalistic perspective, then, we contributed to the acceleration of growth in technology integration through collaboration and carefully planned interventions, and we studied the impact of those interventions as a way to understand the technology integration process.

Discovering in our first year that technology integration, like most innovation in schools (Berman and McLaughlin, 1978), tends to happen very gradually, we were grateful for the opportunity to take a longitudinal approach to studying the technology integration process in our four diverse sites.

Chapter 2 discusses the two stages of the Phase I research process with Stage 1 focusing on the organizational context of technology integration in the four sites, and Stage 2 focusing on teacher instructional practices. The chapter describes the key steps in our research method, which began with intensive gathering of interview, observation, document, and focus group data from many teachers, specialists, and administrators in four schools; progressed to the development of site-based case studies; and culminated this past year in both within- and cross-site analysis, resulting in the formulation of a set of well-supported assertions about the technology integration process. Consistent with a naturalistic perspective and approach, we have drawn extensively on recent developments in qualitative analysis (Erickson, 1986; Greene et al., 1987; Miles and Huberman, 1984; Patton, 1980); in both the analysis and the verification of data. Procedures including internal project reviewing and redrafting of cases as well as case reviews by site participants were used to enhance the reliability and validity of the case study content. Tentative findings that emerged from our observations, interpretive commentaries, and case studies have been subjected by the research team to rigorous testing against a data base of cases and field notes for confirming and disconfirming evidence. In this process, assertions are reformulated or discarded (Glaser and Strauss, 1967).

The assertions that survived this analysis are presented, with explication and supporting evidence, in Chapter 3. The assertions are grouped within a conceptual framework that places critical elements of teacher knowledge and practice at the center of the technology integration process and that relates those elements to group assertions about how the larger school context supports such knowledge and practices. Assertions about the larger school and organizational contexts are organized around technology resources, teacher development, communication and collaboration, and school-based facilitation. In reviewing these assertions, the reader should keep in mind that they posit linkages between factors at the instructional and organizational levels and that those linkages are not causal. The case studies represent a set of complex interactions among factors as they occur in actual school settings. The assertions emerging from across many cases describe our observations of the ways particular factors are related to the successful use of computers, but we have not established causal relationships. We cannot say, for example, that if a district hires a school computer specialist, the level of technology integration will automatically increase. We have seen that hiring a computer specialist may be helpful, but a great number of other factors also need to be in place in order to see effective change in computer use at the instructional level.

TRANSLATING PHASE I RESULTS INTO PRACTICE

In Phase II we will develop and field-test a school-based approach to integrating technology. Based on the research findings of Phase I and other research on school innovation and staff development, we have identified several key elements of a school-based approach to technology integration. We plan to embody these elements in a set of practitioner materials titled Integrating Computers into the Curriculum, which include an Implementation Manual and a Training Manual. These materials can guide middle school teachers, specialists, and administrators in conducting a year-long intervention aimed at enhancing the way teachers integrate computers into instruction with special needs students.

We will produce these materials in three stages: development, field testing, and final production. The materials will be designed and written from October 1989 through July 1990, with the guidance of an Advisory Board and several pilot sites. From August 1989 through May 1990, we will field-test the materials in two school districts. During the final months of Phase II, we will revise the materials to reflect field-test results and prepare Integrating Computers into the Curriculum for national dissemination.

ORGANIZATION OF THE REPORT

Chapter 2 discusses the Phase I methodology, with a special emphasis on how we developed assertions from a wealth of qualitative data. Chapter 3 presents the results of the Phase I analysis in the form of sixteen assertions or findings related to technology integration, each supported and illustrated with case material. Chapter 4 presents an overview of the school-based approach to technology integration which has evolved from the research. It also presents the product--two manuals, which will embody that approach for practitioners. Chapter 5 presents a work plan for the development, field testing, and production of Integrating Computers into the Curriculum.

CHAPTER 2: PHASE I RESEARCH METHODS

PURPOSE AND MAJOR RESEARCH QUESTIONS

The purpose of Phase I was to investigate the process by which technology was integrated into the middle school curricula for mildly handicapped students. Based on our assumption that technology integration involves dynamic interaction between instructional and organizational levels in schools, we sought to identify the critical factors contributing to technology integration at both levels and to understand the interplay among these factors. Based on a second assumption that the technology integration is evolutionary, we sought to understand how patterns of computers use at one point in time motivated new needs and concerns at the organizational and instructional levels at another point in time.

The major research question guiding our work is, What factors promote or hinder the technology integration process? This overarching question breaks down into the following set of specific questions related to the organizational and instructional levels:

- What are the critical organizational-level factors?

  What resources (computers, software, technical assistance) do teachers need to integrate technology? How do schools make decisions about acquisition of, access to, and allocation of computers and software?

  What mechanisms, structures, and policies support teachers' efforts (e.g., opportunities for communication and collaboration, policies that promote links between special and regular education)?

What types of training programs support teacher development? What types of collaborative working relationships support teacher development?

How do administrators learn about and respond to teachers' emerging needs?

- What are the critical instructional-level factors?

  What types of knowledge do teachers need to integrate technology into the curriculum (e.g., knowledge about computers and software, knowledge about curriculum, knowledge about instructional practices)? How do teachers obtain this knowledge? What contributes to translating knowledge into practice?

  What instructional practices contribute to effective technology use with mildly handicapped students? How do teacher practices change over time as teachers acquire or expand their knowledge?

  What patterns of access to computers and software help teachers use computers in their classrooms or computer labs? How do teacher practices change in response to increased or decreased access?

  What types of technical assistance do teachers need to integrate computers into instruction?

A major goal of the project during its first phase has been to develop a knowledge base for designing and field-testing interventions in Phase II that will guide middle schools in successfully integrating computers into the curriculum.

GENERAL APPROACH

EDC/TERC employed an approach that would allow us to capture the dynamic complexity of the technology integration process as it evolved over time. Over three years, we conducted an intensive naturalistic study of four diverse eastern Massachusetts school systems as they integrated computers into the teaching of language arts, social studies, and mathematics to students with mild special needs (Morocco and Zorfass, 1988).

Table 1 lists ten features of our research method, several of which Lincoln (1985) has identified as derivatives of a naturalistic perspective. The features include natural setting, grounded theory, emergent design, interactive researchers, intervention/analysis approach, qualitative procedures, case study method, triangulation of data and identification of emerging themes, negotiation of results, and multiple reporting modes. The table includes references to major researchers for each feature.

Natural Setting

By studying four diverse middle schools intensely over time, we were able to identify the variables that are critical in the process of technology integration. The schools differed along several dimensions. In addition to being geographically and demographically diverse, they differed in size, educational goals, school culture, and available resources that shaped the way technology was used and viewed. At each school we intensively followed administrators, specialists, and teachers as they engaged in a wide variety of computer-related activities, under differ circumstances, and in different settings. This variation across and within the four schools has been critical to meeting our eventual goal of developing practical guidelines for technology integration that reflect the different realities schools face.

Grounded Theory

Theory can dictate the questions researcher ask and the data they collect, or it can be constructed from the data collected. In

Table 1

FEATURES OF A NATURALISTIC APPROACH TO STUDYING TECHNOLOGY INTEGRATION RESEARCH

Feature	*Definition*	*References*
Natural setting	Entry into actual organization/system needed to understand multiple perspectives	Schatzman & Strauss, 1973; Schwartz & Ogilvy, 1979
Grounded theory	Having theory constructed from contextually rich data rather than having it dictate questions and data gathering	Lincoln, 1985; Schatzman & Strauss, 1973
Emergent design	Design decisions at one stage of the investigation reflect findings from the previous stages	Lincoln, 1985
Interactive researchers	Mutual influencing of researcher and subject become one focus of the investigation	Becker & Geer, 1970; Bruyn, 1966; Lincoln, 1985; Reinharz, 1979
Intervention/analysis approach	Implementation of changes introduced by the research team become a focus of study	Loucks & Hall, 1977
Qualitative procedures	Interviews, observation, document study, and historical study reveal processes, linkages, and system variables	Becker & Geer, 1970, Campbell, 1974; Geertz, 1973; Herriott & Firestone, 1983; Patton, 1980
Case study method	Strategy for investigating an existing context, organization, or situation within its real-life context, using multiple sources of data	Hoaglin, Light, McPeek, Mosteller, & Stoto, 1982; Wilson, 1979; Yin, 1984
Triangulation of data and identification of emerging themes	Basing interpretations on relating data from multiple sources, using multiple data-gathering procedures	Patton, 1980; Schatzman & Strauss, 1973
Negotiation of results	Use of subject's own viewpoint to establish the credibility of findings	Heron, 1981; Lincoln, 1985
Multiple reporting modes	Providing research results in different formats to meet needs of varied audiences	Miles & Huberman, 1984; Passow, 1979; Weiss, 1972

this research, data gathered and synthesized from the four schools both supports and contributes to theories of organizational change and teacher development.

Emergent Design

Phase I was carried out in two stages. In the first stage, coinciding with the first year of the project, we studied the organizational context to understand how technology was used, who were the key players, what policies and procedures had been established, what major issues concerned practitioners, and what goals motivated computer use with mildly handicapped students in each school. Analysis of this data led to the formulation of research questions that guided an intensive study of the instructional level in each site during Stage 2 (Years 2 and 3). Ongoing analysis in the first stage lead to a refinement of the research design in Stage 2, including research questions, participants included in data gathering, and procedures for data collection.

Interactive Researchers

Our approach was built upon developing trusting, mutually beneficial relationships between researchers and practitioners, providing active support when and where it was appropriate (see section immediately below). We understood that our data would be valid to the extent that we were able to have ongoing access to the decisions, concerns, and actual teaching practices of practitioners in the research sites.

Intervention/Analysis Approach

One of the most powerful features of our research approach was intervening and studying the impact of the intervention. Early in the project, we decided to broaden our data base by intervening in order to prod and encourage technology use and to study the impact of those interventions on technology use over time. Within our roles as researchers, project staff actively intervened when we could advance technology use in ways that were consistent with the practitioners' activities and goals for the school. These interventions were designed to further our understanding of what could affect change. Our interventions encompassed varying levels of activity. At a minimum, our ongoing presence in the schools as researchers concerned with technology and special needs students probably stimulated additional attention and energy around this focus. We took a more deliberate and active role in some sites by recommending software, providing or donating software, conducting software review and training sessions, providing technical assistance, encouraging teachers to reflect on practice, and organizing meetings to facilitate decision making and planning.

Two criteria guided our decisions about when and how to intervene: The intervention had to respond to an explicit request from teachers or administrators, or it had to take advantage of an opportunity to nudge teachers in a direction in which they were already moving. In all cases we intervened in ways that we perceived as contributing to meaningful use of technology with special needs students.

This combined role of researcher/interventionist brought special challenges to our data-gathering processes. Researchers had to document situations in which they were active participants, and that documentation included detailed descriptions of what they did, how participants responded, and how they themselves responded. Moreover, in their role as participants, researchers had to avoid becoming too invested in a particular outcome. When researchers provide training or give a helping hand in a computer lab, they naturally find themselves hoping that teachers will benefit and change. The danger to the research, of course, is that the researchers' desires and expectations may influence their perceptions of what actually happens at the sites. To minimize this problem, we included researchers' personal responses as part of our data base to help us understand the events that were observed. As part of our work in Year 3, in fact, we also shared the results of our initial analyses with the teachers and administrators by showing them versions of the case studies we had developed about their schools. This action helped us to validate the content of the cases and to clarify our dual roles as researchers and as interveners in the technology integration process.

Qualitative Procedures

Studying naturally occurring events, some catalyzed by us and others promoted entirely from within the system, required that we listen, talk with others, and observe interactions between practitioners (i.e., teachers and administrators, administrators and administrators, and teachers and teachers) and between teachers and students as the former implemented computer applications with special needs students. In addition, it was important to collect such documents as curricula, lesson plans, and student work that shaped and resulted from technology use. It was critical that we observed ourselves: how we interacted with practitioners, how others responded to us, and how they construed our actions. Several kinds of data were collected about each situation studied, including focus group discussions; interviews; debriefing meetings; observations of computer-based instruction, planning meetings, and training sessions; and documents.

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Case Study Method

Within each site, we integrated data around "stories," or cases, of the technology integration process. Research staff developed twenty-three cases that depict organizational- and instructional-level practices. While some cases described specific teacher practices or single classroom- or school-level events, others followed the process of change at the school or classroom level over time.

Triangulation of Data and Identification of Emerging Themes

In developing cases, we integrated multiple kinds of data, for example, interview, observational, and student work sample data to link events chronologically and formulate interpretations about instructional or organizational events.

Negotiation of Results

We shared our case studies with administrators and teachers so that they could verify the accuracy of factual data, provide additional information, and respond to our interpretations.

Multiple Reporting Modes

Our ultimate aim of the project is to provide practical guidelines to administrators, specialists, and teachers in using computers in instruction with mildly handicapped students in middle schools. In Phase II we will report project results in forms that meet the needs of different practitioner audiences and the larger research and special education communities as well.

SAMPLE

Sites

Four diverse school districts in eastern Massachusetts participated in Phase I. The pseudonyms for the communities/school districts are Centertown (an inner city), Riverton (a small urban community), Hopeville (a suburban/rural community), and Greendale (a suburban community). Table 2 presents the demographic characteristics of the four sites.

The four sites shared two characteristics. First, all four districts were committed to increasing special needs students' participation in mainstream learning and viewed computer technology as an important way to move toward that goal. Second, all four sites had already acquired sufficient computer equipment to give at least some groups of teachers opportunities to use computers in language, mathematics, and social studies curricula.

The differences among the four sites outweighed the similarities. The sites were selected to provide variation in composition of student population, organizational structures within the school, curriculum goals, special and regular education policies and procedures, and the ways in which computers were currently used in language arts and mathematics.

Schools

Centertown is a major urban metropolitan area on the eastern seaboard; it has a population of approximately 600,000 and contains twenty-two middle schools. The Bromley Middle School, our research site within the city, is situated in an inner-city neighborhood. The school serves approximately 500 sixth- through eighth-grade students. Minorities compose approximately 90

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Table 2

DEMOGRAPHIC CHARACTERISTICS OF COMMUNITIES/SCHOOL DISTRICTS

	Filmore	Hilton	WATERBURY	[illegible]
Population	39,580	46865	34385	2,162
P[illegible] der er [illegible]	[illegible]			6.3
Median family income	17,924	18,890	22 047	$37,103
Per capita income	9 766	12,512	16 058	$13,166
Percentage of persons below poverty level	12	10	6	2.8
White	38,270	45660	33,720	12,044
Black	605	504	160	41
American Indian, Eskimo, Aleut	56	46	2	0
Asian and Pacific Islander	105	128	285	48
Spanish origin	1095	931	507	1

1980 Census of Population
General, Social, and Economic Characteristics
Massachusetts
Washington, D.C.: United States Department of Commerce, Census Bureau, June 1983

percent of the student population, and at least half the students are bilingual. In 1986, the school was singled out by the system's superintendent to implement a major innovation that focuses on basic skills. Some features of that program are: lengthening the school day, extending the school week through Saturday, and organizing the school into semi-autonomous clusters. Some of the clusters group teachers and classes from a single grade level; one cluster involves teachers and students across grades 6-8. Two cluster directors manage the school's two computer labs (one housing IBM and the other Wang word processors).

A second site, Riverton, is a small urban center currently making the transition from an industrial base to that of high technology. The town has two middle schools: one houses the eighth grade, and the other houses the sixth and seventh grades. The latter school, with approximately 600 students, is organized into five clusters in which students are grouped by ability level. Most of the students receiving special services are in the low ability level. At the sixth- and seventh-grade school, the research school for the project, special services for students consist of two resource rooms and one substantially separate class. There are two computer labs in the school, one reserved for language arts use and the other available on a sign-up basis. The resource room and the substantially separate classroom are equipped with one computer each.

Hopeville is a rapidly growing middle-class suburban/rural community on the outskirts of a small city. The district's only middle school (grades 5-7) is substantially over-enrolled, with more than 700 students, and planning is under way to build an additional school. Our research site, the single middle school in the town, is organized into grade-level teams, with planning time built into each team's schedule to give teachers frequent opportunities to meet. Special education teachers are not members of the teams and do not have scheduled time for meeting with one another or with teams. The school has been swiftly expanding its technology program, providing additional hardware; increasing staff to include a computer specialist, a lab aide, and a media specialist; providing teacher support and training; and finding more curriculum-based uses of software. Each resource room and substantially separate classroom in the school has its own computer.

Greendale is an affluent suburb with one 500-pupil middle school (grades 6-8). Parents are influential in the school in demanding a competitive academic program and in advocating for their special needs children. The school functions autonomously in the district on several levels. For example, without a district-level computer coordinator, the school sets its own course for computer use, and although there is a special education director for the system, the middle school special education coordinator is clearly in charge of special needs decisions in the building. Within the school, the principal encourages staff to develop its own curricula and programs. Word processing for language arts writing assignments is the principal form of computer use for both mainstream and special needs students. In addition, for one quarter each year, students take a computer course that covers Logo, word processing, and data bases.

Participants

Across Stages 1 and 2, we included district- and school-wide administrators holding the following positions: superintendent and assistant superintendent of schools; director of special education; mathematics coordinator, language arts coordinator, and computer coordinator; principal and assistant principal; cluster or team director; and special education administrator.

The teacher sample included resource room teachers, teachers of substantially separate special education classes, computer teachers and aides, mainstream language arts teachers, and mathematics and social studies teachers who had special needs students in their classes. Table 3 shows the total number of participants in each site, across Stages 1 and 2.

During Stage 2, Years 2 and 3, we included in our sample mildly handicapped students who were receiving services in mainstream and special education classes. The decisions about which special needs students to focus on was usually made in collaboration with teachers. Parental permission was secured.

STAGE 1: THE ORGANIZATIONAL CONTEXT

Purpose and Questions

The major purpose of Stage 1 (October 1986 - November 1987) was to understand the contextual and institutional factors that were influencing the use of computers in instruction in each of the four sites. That contextual data formed the basis of the classroom-level research questions that we investigated during Stage 2, as well as questions relating to interaction between the instructional and organizational levels. Another purpose of Stage 1 was to introduce ourselves to the schools and to gain entry in such a way that we would be perceived as resources who were genuinely interested in understanding the uses of technology--the barriers and opportunities and the successes and failures.

The specific questions guiding Stage 1 were as follows:

Table 3

TOTAL NUMBER OF PARTICIPANTS IN EACH SITE

SITE	ADMINISTRATORS (District- and School-level)	TEACHERS AND SPECIALISTS
Bromley	7	6
Riverton	5	6
Hopeville	6	6
Greendale	5	7
TOTAL	23	25

- Who are the pivotal players?

  Which administrators from technology, special education, and regular education are key players in technology integration for special education students?

  Which resource room and mainstream teachers are using technology with mildly handicapped students in language arts and mathematics?

- Which policies and procedures contribute to technology integration?

  What types of policies and procedures link special and regular education?

  What types of policies and procedures govern access to technology resources?

  What types of policies and procedures have an impact on curriculum development and revision?

- How and why are computers used in instruction?

  In what ways have computers been integrated into the curriculum for regular and special education students? In which areas of the curriculum? For what purposes? By whom?

  What are current uses in regular and special education? For what purposes? By whom?

  What are the future uses of technology? When? By whom? For what purposes?

- What contributes to teacher development?

  What types of training programs exist for teachers? What are the goals? What are the procedures? When is training offered? Where? Who is the trainer?

  What types of technical assistance do teachers have access to?

- Do teachers have access to computers and software?

  Where are computers and software located? How many computers are there? Who has access? How is access determined? What software is currently being utilized with mildly handicapped students?

  How are decisions made and implemented about acquisition, allocation, and access? By whom? When?

- What are the current concerns about technology integration?

  What are the administrators' concerns about initiating, maintaining, or expanding technology use in the school?

  What are the teachers' concerns about using computers to meet curriculum goals for mildly handicapped students?

Data Collection

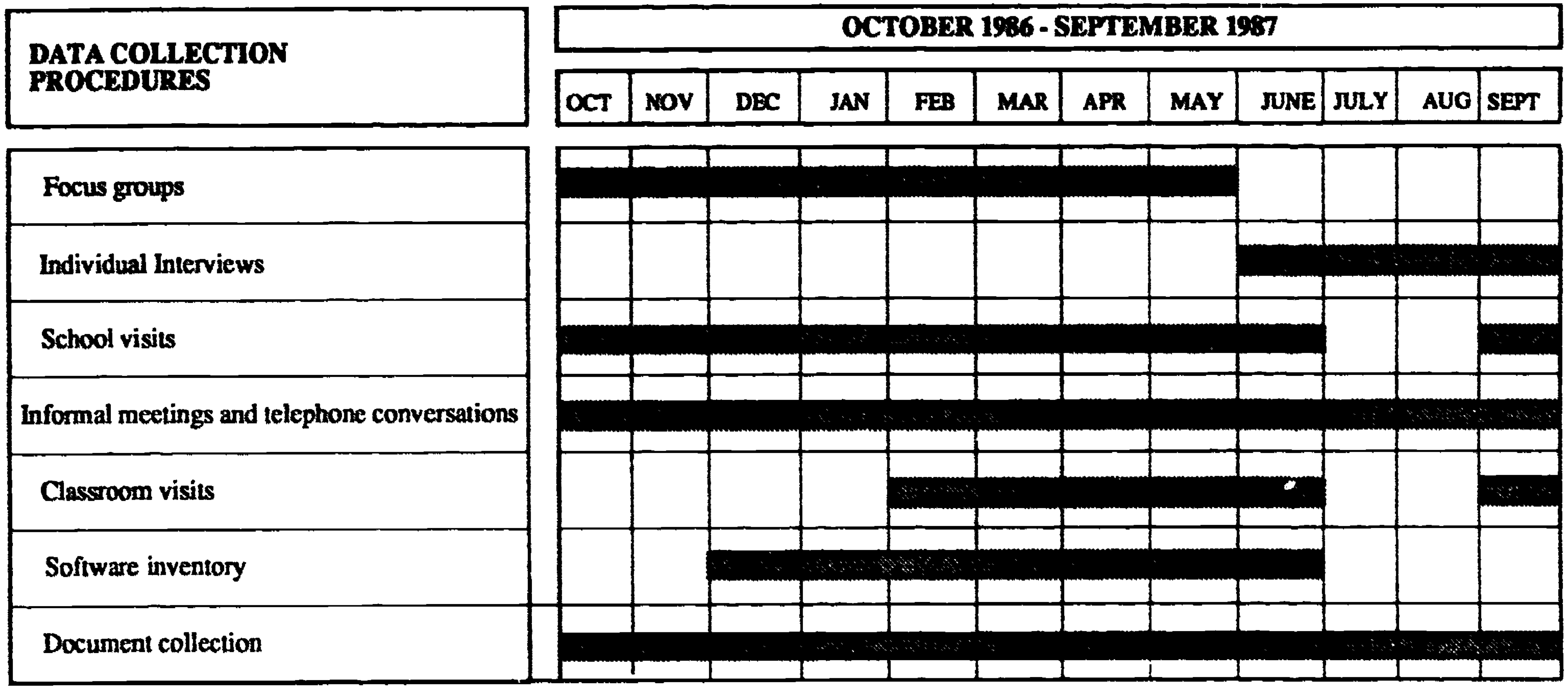
During Stage 1 the data collection methods included the following:

- Focus groups
- Individual interviews
- School visits
- Informal meetings and telephone conversations
- Classroom visits
- Software inventory
- Document collection

A timeline showing when data collection occurred in Stage 1 is presented in Figure 1.

Figure 1

STAGE 1 TIMELINE



Focus Groups

In each of the four districts, we convened two focus groups, one with administrators and one with teachers. This procedure is particularly useful when the goal is gathering in-depth information and eliciting perspectives through a discussion group atmosphere (Bellenger, Bernhardt, and Goldstucker, 1976; Cox, Higginbotham, and Burton, 1976). The administrator focus group brought together school- and district-level staff members who played a role in the technology integration process. The teacher focus group included regular and special education teachers who were using computers with special needs students.

Individual Interviews

We conducted sixty-one individual interviews with administrators, teachers, and specialists across the four sites. We designed interview questions for administrators and teachers in order to clarify, expand, and validate the information we had obtained from the focus groups. The format of these interviews varied, with some being highly structured and closely adhering to the interview schedule and others carried out more informally. We found that interviewee position/role, amount of information obtained from prior contacts, and time constraints contributed to the use of different formats. Research staff prepared a detailed written summary of each interview by reviewing field notes and audiotapes of the interview sessions.

School Visits

We made three to five prearranged visits to each site over the course of the year, separate from interviews or focus groups. Early in the year, the visits included tours of the schools and introductions to the teachers and other staff members. Several visits centered primarily on establishing rapport and clarifying our purpose. Tours of the school provided us with an opportunity to see the types of resources--computer labs, placement of technology-related equipment and so forth--available in the sites.

Informal Meetings and Telephone Conversations

We met or spoke with teachers and administrators on a formal, prearranged basis, as well as informally as opportunities or needs arose. Some of these discussions responded to schools' concerns about the project's purpose, the benefits of participation, when and where to hold meetings, and whom to invite. Other discussions centered on the different uses of computers by special needs students and by teachers.

Classroom Visits

Although detailed classroom observations were not a major emphasis during the first year of the project, we were able to visit and observe in computer labs, resource rooms, and language arts and mathematics mainstream classrooms. Our purpose was to learn how teachers organized and managed instruction with and without computers, what types of software different teachers used, and what students' overall academic level was. During each visit we took extensive field notes that were later used in writing up a summary of what we had observed.

Software Inventory

We conducted a survey in all four sites to identify all software used for instruction, particularly in language arts and mathematics. The inventory requested a key technology user in the school to provide the following information about each piece of software: title, type of class(es) in which it was used, the grade(s) where used, and whether the software was used with special needs students. All told, the sites submitted information on sixty-four different programs, including those used for drill and practice, for applications, for simulations, and as tools.

Document Collection

We collected and reviewed curriculum guides currently used in mathematics and language arts in each school district. At one site, we collected long-range plans of technology use in grades K-12 and brochures describing the district's vision of technology integration to meet curriculum goals.

Data Analysis

The data analysis process was carried out in two ways: (1) We engaged in ongoing analysis throughout Stage 1, and (2) we engaged in a cumulative analysis at the end of Stage 1. The ongoing analysis had a direct bearing on research design decisions. For example, by analyzing the transcripts of the administrator focus groups, we were able to determine who to include in the teacher focus groups and what questions to use in the individual interviews.

Several key steps were involved in the cumulative analysis: writing a preliminary site summary, having the summary reviewed and then modifying it accordingly, and identifying within-site factors and research foci to guide the Stage 2 investigation.

Preliminary Site Summary

Our goal was to synthesize data from our multiple sources in order to describe the organizational issues that contributed to the evolving "technology integration story" in each of the four sites. It was the strong consensus of our staff and our Advisory Panel that the project should focus primarily at this stage on developing in-depth knowledge of each site and that extensive cross-site analysis was premature and might lead to imposing a "technology integration model" that would not in fact fit the realities of the individual sites. These summaries incorporated information we had obtained on the roles of key administrators and their relationships, the history of computer and technology use, the relationship between special education and regular education, teacher training programs, and examples of software use in regular and special education classrooms. The summaries also provided an opportunity to assess the adequacy of the data collected during the year and to identify new areas to probe.

Review and Modification

We obtained input and reactions from discussions among the members of the research team, as well as from members of the project's Advisory Panel. These discussions helped us to identify some of the gaps in the data-gathering process and encouraged us to continue to develop more detailed information about each site.

In addition, we asked the sites for reactions to these site summaries. We felt it was crucial to have the reactions of those educators in the sites who were actively engaged in the process we were studying. We asked several persons in each site (the principal, the director of special education, or the computer specialist) to review the summary of their site, and we obtained both verbal and written feedback from them. Most of the reactions served to clarify information, correct for accuracy, or express a difference in perspective or interpretation. Based on the discussions and reactions to our initial summaries, we modified our initial drafts.

Identified Within-site Factors and Research Questions

Based on the summaries and the schools' feedback, we identified emerging factors and specific research questions for the next stage. For each site, we distilled a set of factors that served to describe its major characteristics with respect to technology integration for special needs students. These factors led us to formulate questions that served as a guide in the next stage of data collection and analysis.

Results

The results of Stage 1 are the within-site organizational-level factors and research foci for each site. The factors, listed by site, appear in Exhibit 1. (For a full discussion, see Year 1 Report, Zorfass et al., 1987.) The research foci, including issues at both the organizational and instructional levels, are described below in the form of research questions for each site.

STAGE 2: THE INSTRUCTIONAL CONTEXT

Purpose and Questions

In Years 2 and 3 we focused much more intensively on the instructional process (i.e., technology integration at the classroom level), while folding forward the organizational-level issues as the context for understanding the constraints and opportunities teachers face in using technology in instruction

Exhibit 1

STAGE 1 RESULTS

Within-Site Factors

BROMLEY

1. Vision that technology can meet student needs
2. Access to computers
3. Interaction with another school-based innovation
4. Technical assistance to teachers

RIVERTON

1. Decision-making processes
2. Curriculum goals: within and across content areas
3. Coordination between special and regular education programs
4. Access to computers

HOPEVILLE

1. Long-range planning
2. Coordination and communication (among administrators, among technology specialists, and among regular and special education teachers)
3. Training
4. Access to computers

GREENDALE

1. Mainstreaming policies and procedures
2. Teacher development though ongoing communication and collaboration
3. Role of computer teacher
4. Acquisition of computers
5. Technology use to meet curriculum goals

with special needs students. Research questions included questions common to all sites about how technology was being used and also questions specific to the issues and conditions we had previously identified for each site. We investigated the following cross-site questions:

- What common factors define successful technology integration?
- What are the critical teacher practices contributing to successful technology integration?
- What are the critical administrator practices that support teachers' efforts?
- What are the roles and responsibilities of technology experts?
- What types of training programs contribute to teacher development?

We identified the following site-specific questions:

- Bromley

  How did teachers with little or no computer experience acquire a beginning knowledge of computers?

  How were teachers who were comfortable with but not experienced in computer use integrate computers into mathematics and social studies instruction?

  What contributed to teacher development?

  What types of support did teachers require from computer experts in the school? How was the availability of support affected by the presence of another major innovation in the school?

  How were decisions made around the donation of new computers to the special education teachers?

- Riverton

  How would a resource room teacher and a substantially separate classroom teacher evolve in heir use of problem-solving software? What effect would their collaboration have on practice?

  How would teachers use the computer lab for word processing? What role would the writing teacher play?

  What decisions would be made surrounding the integration of LogoWriter as a cross-disciplinary piece of software for mathematics and language arts? What would be the result of that decision-making process?

  What coordination would there be between content specialists and special needs teachers around computer use?

- Hopeville

  What types of teacher practices contributed to the integration of computers into a report writing unit?

  How was Logo integrated into the curriculum?

  How did the use of computers in the resource room support the mainstream effort?

  What type of coordination was there among the district-level computer coordinator, middle school administrators, and computer experts?

  What factors promoted or hindered collaboration and communication between mainstream and special education teachers?

  What were the roles and responsibilities of the school-based computer specialist?

- Greendale

  How was word processing integrated into a course co-taught by regular education and special education teachers? When and about what did these teachers communicate? What impact did this communication have on the writing ability of those students who had varied writing problems?

How would problem-solving geometry software be integrated into a low-level mathematics group?

What role did the special education administrator play in promoting communication and collaboration between regular and special education teachers?

How were decisions made about the acquisition and allocation of computers and software?

Data Collection

Beginning in Year 2 (October 1987) and continuing into a second school year through the middle of Year 3 (until March 1989), we shifted to observing teachers and students using computers in classroom instruction. By continuing to collect instructional-level data for a second school year, we were able to investigate changes in teacher practices with a new class of students, new curriculum goals, and often additional computers and software.

As in Stage 1, we used a combination of data collection methods in order to obtain a complete picture of the technology integration process in each school over an eighteen-month period. These data collection strategies were designed to allow us to respond flexibly to differences across the sites. For example, in some sites we were observing teachers working in teams, while in other sites we were working with individual teachers. We adapted our observation methods to these differences. At the same time, however, we developed procedures that would ensure quality control and consistency and that would result in fruitful cross-site analyses and comparisons. We gathered in-depth information through the following field-based research methods:

- Classroom observations
- Debriefing meetings
- Interviews
- Document collection

Figure 2 presents a timeline of the data collection in Stage 2.

Classroom Observations

At each school, we carried out regularly scheduled classroom observations of between four and six teachers in a variety of classroom settings: the resource room, the mainstream classroom, and the computer lab. One researcher each was assigned to the Bromley and Hopeville schools as the primary observer; for the Greendale and Riverton schools, a pair of researchers shared the responsibility. Either singly or in pairs, researchers observed each teacher on a regular basis, with visits typically scheduled on a weekly basis.

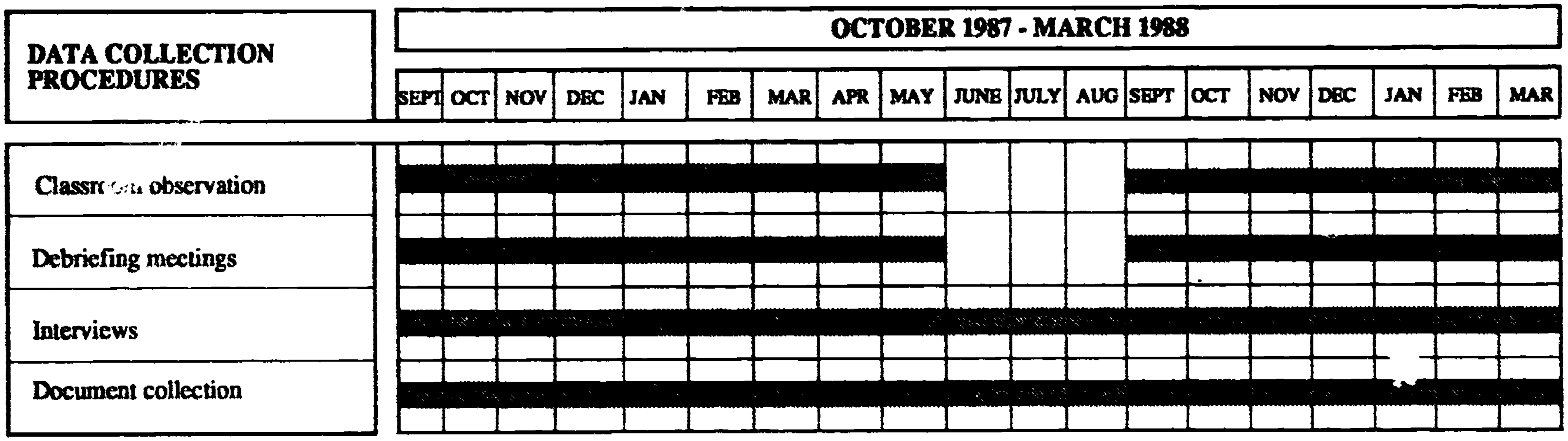
In addition to the regularly scheduled observations, it was often possible for researchers to visit teachers and observe informally for short periods. These spontaneous observations occurred only if they were convenient for the teachers. Such sessions provided an important opportunity to see teachers and students working under everyday circumstances and to gauge whether the fin. ings from the scheduled visits were consistent with what went on during the usual classroom routine.

The observers attempted to capture the major features of student-computer interaction at each session, with the focus of attention varying across settings and observations. Researchers sometimes concentrated on the relationship between teachers and special needs students, the interaction between special needs students and other students, or the way students interacted with computers. Written notes were always taken and some sessions were tape-recorded.

Observers wrote extensive field notes on each such session. As soon as possible after each session, observers reviewed their

Figure 2

STAGE 2 TIMELINE



notes and prepared detailed summaries of what they had seen. (There are sixty to seventy sets of field notes for each site.) These notes were then circulated to all other members of the research team and became part of an extensive data base. We discussed and reviewed these field notes at regularly scheduled debriefing meetings of the project team.

Debriefing Meetings

Researchers arranged meetings with teachers to gather specific information about classroom instruction, software use, student performance, and teachers' perceptions. Some of these meetings were held with individual teachers and other with groups or teams of teachers. In addition, we often had the opportunity to meet informally with teachers directly after classroom observations. We encouraged teachers to reflect on the instruction we had observed and to talk about the ways students responded to assignments.

We also attended more formal meetings when teachers and/or administrators gathered to discuss issues relating to the uses of technology, particularly by special needs students. Our records of these meetings (often tape-recorded and then summarized in written form) provide an interesting and important perspective on the different decision-making processes that occur in schools.

Interviews

Each of the teachers was formally interviewed at least once during each year. These interviews allowed the teachers to describe their perspectives on the use of technology, their goals for the school year, and their views of their successes and failures in integrating technology into the curriculum across two school years. These interviews usually lasted ninety minutes each. The interviews were audiotaped, and the tapes were then transcribed and circulated among members of the research staff.

Both formal and informal interviews were also carried out with administrators in each of the schools. These proceedings included discussions with school principals, directors of special education, computer specialists, and other administrative personnel. Such interviews provided a valuable complement to the teacher interviews and yielded valuable information about the ways in which school-level policies and goals are related to classroom-level practices.

In two schools, Greendale and Hopeville, we interviewed students to understand how they perceived their learning strengths and weaknesses, and whether and how they thought technology impacted on their school learning.

Document Collection

In sites where the research focused on the progress of individual students, researchers intensively documented students' work on several assignments. In following a writing unit, for example, we collected all drafts of student work, from the prewriting phases of planning and thinking, through the draft stages of rewriting and revision, to the final product.

In all of our sites we gained access to most of the schools' written plans for current and future computer use across regular and special education programs. These documents provided an additional, useful perspective that supplemented the views expressed in interviews and through our observations. The documents also helped us to identify the key channels of communication in schools, and they illuminated the discrepancies between an "official" position regarding use of computers and actual practice in classrooms.

Data Analysis

In Stage 2, as in Stage 1, we engaged in both ongoing and cumulative data analysis. Ongoing analysis included separate weekly discussions of classroom observations by EDC and TERC staff, focusing on instructional episodes in specific classrooms; periodic sessions of whole-staff analysis focused on critiquing sets of observations from individual sites. A key approach to ongoing analysis was the development and regular revision of case studies of within-site classroom and administrative practices.

The steps in the cumulative analysis were as follows:

- Completing and validating case studies
- Identifying cross-site factors
- Developing assertions
- Identifying constellations of assertions
- Developing a conceptual framework for technology integration

Completing and Validating Case Studies

The extensive data collection process carried out during Year 2 and the first half of Year 3 enabled us to develop a series of case studies that detail specific processes of computer supported instruction. Exhibit 2 presents a summary of the cases we developed in each of the four sites. We began writing both instructional- and organizational-level cases in the spring of Year 2 and continued through the summer of Year 3.

Exhibit 2

PHASE I CASE STUDIES

Instructional Practice in Regular and Special Education

Maria: Chronicles a bilingual social studies teacher's experiences using *Where in the World is Carmen San Diego?* over the course of a year and the persistence it took to make it work.

The Research Unit: Describes the integration of various pieces of software (including an electronic encyclopedia on CD-ROM, an on-line data base, outlining tool software, and word processing) as part of a research skills curriculum unit and the roles played by two mainstream teachers and one resource room teacher.

Deborah and Steve: Depicts one teacher's attempt to integrate technology for one special needs student mainstreamed into her language arts class. Describes the teacher's initial perception of the computer as a remedy to solve the student's writing problems and how the teacher's early expectations were not met.

Tricia: Describes a seventh-grade math teacher's initial reluctance to integrate technology into her curriculum and how she later chose appropriate math software to fit her students' needs as well as her curriculum goals.

Rebecca: Shows how a mainstream eighth-grade English teacher used word processing to complement her writing instruction.

Terry and Eleanor: Portrays how two special education teachers concurrently introduced problem-solving software into their classes for the first time and how their collaboration provided each with emotional support and encouragement.

Terry and Don: Presents a detailed description of computer use by one special needs student in a resource room setting, with a focus on the impact of the computer on the student's learning behavior and interactions with his teacher.

Naomi: Recounts the events leading up to a teacher's first attempts to use technology in the classroom, from her initial "fear" through the development of her self-confidence and leadership qualities.

Tim: Describes the role of a middle school writing specialist, his work with special needs students, and his influence on the use of word processing with other teachers.

Sally: Describes how a resource room teacher's own philosophy of special education instruction is reflected in her use of computers within her resource room setting.

Computers and Writing: Tells how a special education course was redesigned to be co-taught by regular and special education teachers and how the evolution of the course impacted on special education students' use of computers for writing assignments.

The Assignment Story: Chronicles a writing assignment given by a mainstream English teacher and the experiences of several special needs students as they attempt to complete the assignment with the help of a resource room teacher; shows the success of word processing when used in the context of a writing process approach.

Math Vignettes: Presents four vignettes of students using math software in two different settings: a sixth-grade classroom and a bilingual resource room. The vignettes describe in specific terms each student's use of the software, as well as any interaction with or intervention by the teacher.

Language Arts Vignettes: Presents several vignettes of students using language arts software (reading, word processing, problem solving) in special and regular education settings in two different schools. Each vignette portrays the interaction among student, software, and teacher.

Reading Writing Workshop: Chronicles the implementation of a special course that offers students an integrated thematic approach to language and the use of word processing as part of that course.

The Educational Context

Carl: Describes the roles and responsibilities of an inner-city school administrator who comanages a computer lab; shows how his many conflicting and varied roles affect technology use in the school.

Donation Story: Chronicles an eighteen-month period during which a total of six new computers were donated to an inner-city school; particularly emphasizes the decision-making process involved between school- and district-level personnel.

Special Education Teacher's Group: Illustrates the formation and growth of a grass-roots special education teachers' group and describes how part of the focus of their communication was on technology use.

Nancy: Depicts "a day in the life" of a very busy computer coordinator and the ways in which she is able to facilitate successful technology use on the part of regular education teachers.

LogoWriter: Recounts one school's decision-making process in implementing this unique piece of software and the impact of that decision on teachers and students.

Keyboarding: Illustrates a school's decision to teach keyboarding and how that decision influenced the use of word processing for writing instruction.

Technology Expert: Describes and compares the roles and responsibilities of technology experts across the four field sites.

Special Education Technology Center: Describes a district-wide technology resource center in terms of the training workshops and courses it offers and the other services it provides to special education teachers.

Following the principles suggested by Yin (1984), Miles and Huberman (1984), Skrtic (1985), and others, we made these cases a critical step in the data analysis process. Most of the cases centered on individual teachers, specialists, or administrators, describing instructional uses of computers in classrooms and/or labs. They depicted activities, decisions, or practices at the organizational level that interacted with what happened in classrooms. The cases incorporated observational and interview data, along with samples of student work, as appropriate, and were developed to provide detailed descriptions of the uses of technology and to illustrate change over time. The set of detailed descriptions became the data "elements" we analyzed in order to identify the key findings.

So as to validate the contents of the cases, those individual teachers, specialists, and administrators who were the subjects of the case studies were given an opportunity to read, reflect on, and respond to the materials. Project staff, in order to maximize the amount and quality of feedback, interviewed subjects after they had read their case study. In addition to enabling us to validate the information summarized in the cases, this process also gave us additional information and provided participants with feedback from the research. Such a process enhances the reliability and validity of case study content: Skrtic (1985) discusses in detail the advantages of adopting a process of reviewing and redrafting cases; Yin (1984) also argues that cases can often be stronger when developed sequentially, with a first set of cases forming the basis for later cases to fill in the gaps in the evidence; and Blase (1987) describes the usefulness of obtaining feedback from teachers on the results of preliminary analysis and findings. In our study, interviewees identified inaccuracies in the cases and supplied details that were originally missed by researchers. In addition, interviewees supplied updated information from the spring of 1988. On the basis of the interviews with case study subjects, we revised and updated our case studies to be as accurate and comprehensive as possible. This task involved not only rewriting the cases but also further analyzing our data and refining those factors which affect the successful integration of computers into the instructional process.

Providing our cases to the schools for their comments and reactions exemplifies how we combined our research and intervention roles. We found that furnishing the teachers and schools with drafts of our case studies was also a form of intervention that could influence teacher reflection, attitude, and use of computers for instruction. Responses during the case study interviews indicated that some teachers had thought about their use of computers as a result of reading the case studies and made plans to change or fine-tune their instruction when using the computer. The interviews also revealed that our perceptions of some interventions differed from those of school staff. Several teachers told us that our mere presence and our focus on particular uses of technology influenced their decisions and practices related to instructional computer use.

Identifying Cross-site Factors

The case studies gathered from our four sites portray a broad array of organizational and classroom practices related to computer use with special needs students. Many of the cases are based on the efforts of particular administrators and teachers and are in many ways idiosyncratic to a particular school setting. The challenge we faced was to identify more general, cross-site factors that influence the successful use of computers with mildly handicapped students. We initiated this process at the end of Year 2, when we began identifying factors critical to the technology integration process (for a full discussion see the

Year 2 Report, Zorfass et al., 1988). The factors fall within the following eight categories:

- Teacher development
- Critical roles
- Vision of computer use
- The place of special education in the school culture
- Communication
- Instruction: its interaction with technology
- Decision making
- Software

Developing Assertions

Our approach to analyzing the data has been guided by recent developments in qualitative analysis (Miles and Huberman, 1984; Greene et al., 1987; Patton, 1980), or what Erickson (1986) describes broadly as interpretive approaches. Erickson suggests that comprehensive analysis should provide

- particular descriptions of the situations and circumstances encountered (what others have called the "thick description" phase)
- general descriptions of the common themes, issues, or factors that appear to be present in more than just isolated situations
- interpretive commentary that integrates the findings and provides explanations and hypotheses about the connections among the findings

Because the features of naturalistic inquiry almost always preclude the unambiguous identification of causal mechanisms and the establishment of rigorous proof, Erickson (1986) argues that the analysis should proceed by developing empirical assertions about the phenomena and the findings and that these assertions should then be tested by searching for both confirming and disconfirming evidence. Findings or assertions that emerge as a result of several analyses or are supported by several lines of evidence are often those to which more credibility may be attached (Kirk and Miller, 1986; Miles and Huberman, 1984). Analyses of school-based data by Skrtic (1985), Smith and Shepard (1988), Blase (1987), and others provide excellent examples of the use of these approaches for combining data from a variety of sources. In our study, a focus on the in-depth information from one case study in one of our sites could be alternated with a view across our sites and cases.

Based on the factors identified at the end of Year 2 and further analysis of gathered data, we began to formulate assertions about the successful use of computers in the instructional process. The assertions are general statements that identify critical factors in the technology integration process and state how these factors impede or support the effective use of computers.

Each assertion was developed and tested through a collaborative analysis of a set of cases. The process involved formulating a tentative assertion based on an identified factor in the technology integration process, then searching our data base of cases and field notes for confirming or disconfirming evidence and reformulating or discarding the assertion (Glaser and Strauss, 1967). Not surprisingly, several iterations of this process were often necessary in refining the assertions.

Each assertion has been formulated by careful examination of the available evidence. As a result, positive and negative aspects of each assertion can be illustrated with multiple cases drawn from our data. The process of assembling evidence to support assertions further has validated and enhanced the analysis by making the links between assertions and data more explicit. This analytic process has yielded a total of sixteen assertions about the integration of computers into middle school instruction.

Despite the wealth of detailed information we have available, there are also some important limitations of the data. The process of identifying assertions about the key characteristics of technology integration draws on the entirety of collected data but cannot be expected to yield causal links between critical factors and the successful use of computers. The case studies represent a set of complex interactions between factors as they occur in actual school settings. As a result, the emerging assertions describe our observations of the way particular factors are related to the successful use of computers, but these relationships cannot be interpreted causally. We cannot say, for example, that if a district provides a series of workshops for teachers, then the level of technology integration will automatically increase. We have seen that workshops may be helpful, but a great number of other factors need also to be in place in order to see effective change in computer use at the instructional level.

Identifying Constellations of Assertions

The sixteen assertions--categorized as school-based facilitation, teacher development, collaboration and communication, technology resources, and teacher knowledge and practice--identify factors at the school organizational level, the teacher support level, and the instructional level. At the school organizational level, the assertions concern decisions about computer use, policies, and administrator practices. At the teacher support level, the assertions center on two issues: critical support that teachers need and types of communication and collaboration that enhance effective computer use. And at the instructional level, the assertions pertain to the types of instructional strategies teachers can employ to integrate computers so that positive learning outcomes for students result. These categories of assertions are described in detail in Chapter 3. Figure 2 in Chapter 3 illustrates the interrelationship of these five sets of assertions in ultimately affecting the success of instructional computer use for mainstreamed special needs students.

Developing a Conceptual Framework for Technology Integration

In addition to testing each assertion in isolation, we developed a conceptual framework that encompasses the relationships or connections we have drawn among the key findings. The framework takes into account the five constellations of assertions and defines the relationships between them, as well as the relationships between individual assertions.

Results

Consistent with a naturalistic approach, we present our main findings in the form of assertions about the important factors that lead to successful technology integration. Chapter 3 presents the sixteen assertions and the conceptual framework for integrating technology.

Throughout our work in analyzing the data, we have also been moving toward identifying ways of helping schools progress more quickly and effectively in utilizing technology to help students with special needs. Our work has culminated in a comprehensive school-based approach for intervening to facilitate the successful integration of technology into the curriculum in middle schools. Chapter 4 describes this approach.

CHAPTER 3: PHASE I RESULTS

INTRODUCTION

The major findings of the analysis described in Chapter 2 are captured in a set of assertions describing conditions that tend to foster successful technology integration for middle school special learners. The findings embodied in this set of assertions indicate that there exists a system of interactive factors that tends either to move toward successful technology integration or to inhibit its growth. The sixteen assertions (see Table 4) fall into five categories that our analysis indicates compose the major areas of impact on what ultimately occurs among teacher, student, and computer (see Figure 3).

The outermost circle in Figure 3, school-based facilitation, includes assertions about school- or systemwide decisions and actions concerning technology integration that affect more than a single teacher or single classroom. This category focuses on systems, mechanisms, and policies that influence communication among key personnel involved in schoolwide decisions affecting the acquisition and use of computers. For example, the purchase and placement of computers, the scheduling of the computer lab, the institution of a particular technology-based curriculum ("all seventh graders will learn word processing"), the hiring of technology support personnel, or the institution of teacher training falls within this category. Many of the assertions in this category focus on the role of building-level administrators in facilitating the technology integration process. Facilitation at this level may affect teachers directly or have an impact on the presence or absence of mechanisms and structures that support the three categories in the middle ring: teacher development, communication and collaboration, and technology resources.

Table 4

ASSERTIONS

Teacher Knowledge and Practice

1. In order to improve the way technology is used with special needs students, teachers need to gradually acquire and/or draw on and integrate knowledge about:

   - special needs students' strengths and needs
   - the potential contribution technology can make to special needs students' learning
   - curriculum content
   - instructional strategies
   - assessment strategies
   - hardware and software

2. In order to promote successful technology integration with special needs students, it is critical for the teacher to be actively involved with students' use of all types of software, regardless of the type of software.

3. When teachers engage with others in ongoing reflection about their instructional use of technology, they are more likely to critically evaluate their practice and redesign instruction to better meet students needs and curriculum goals.

Technology Resources

4. Someone needs to be responsible for ensuring that hardware is kept in good working condition and that technical problems are solved.

5. When there is some mechanism for narrowing down their choices of software, teachers are more likely to try integrating technology into their classes.

Teacher Development

6. When novice computer users have someone to whom they can turn for knowledge about computers as well as emotional support and reassurance, they are more likely to begin integrating technology into the curriculum.

7. In-service workshops can contribute to teachers' acquisition of knowledge, but are insufficient in helping teachers use this knowledge in their work with students. Teachers best learn to integrate technology successfully through ongoing school-based support and structures for collaboration and communication.

Collaboration and Communication

8. When two people work together collaboratively to try out software, technology use tends to be more successful.

9. Regular, ongoing communication between regular and special educators who teach the same students often facilitates successful technology integration if the focus of the communication is on curriculum goals, instructional strategies, and student needs.

School-based Facilitation

10. When decisions about hardware acquisition, hardware allocation, and scheduling focus primarily on curriculum goals and teacher experience and expertise, they are more likely to lead to successful technology integration than when they focus exclusively on issues of equity and access.

11. Once a technology-related decision is made, it is unlikely to be implemented unless someone who is committed to the decision determines what steps must be taken and ensures that the next step happens at each point in the implementation process.

12. Once a technology-related decision is made, administrators and teachers need to communicate directly with each other during implementation to determine whether the decision is working or needs to be revised.

13. In order to support teacher development, administrators must put structures in place so teachers can communicate and collaborate on a regular basis.

14. When administrators vary expectations according to teachers' individual needs, interests, and abilities and give teachers choices about how and when to implement technology-related curricula, successful technology integration across classrooms is more likely to occur.

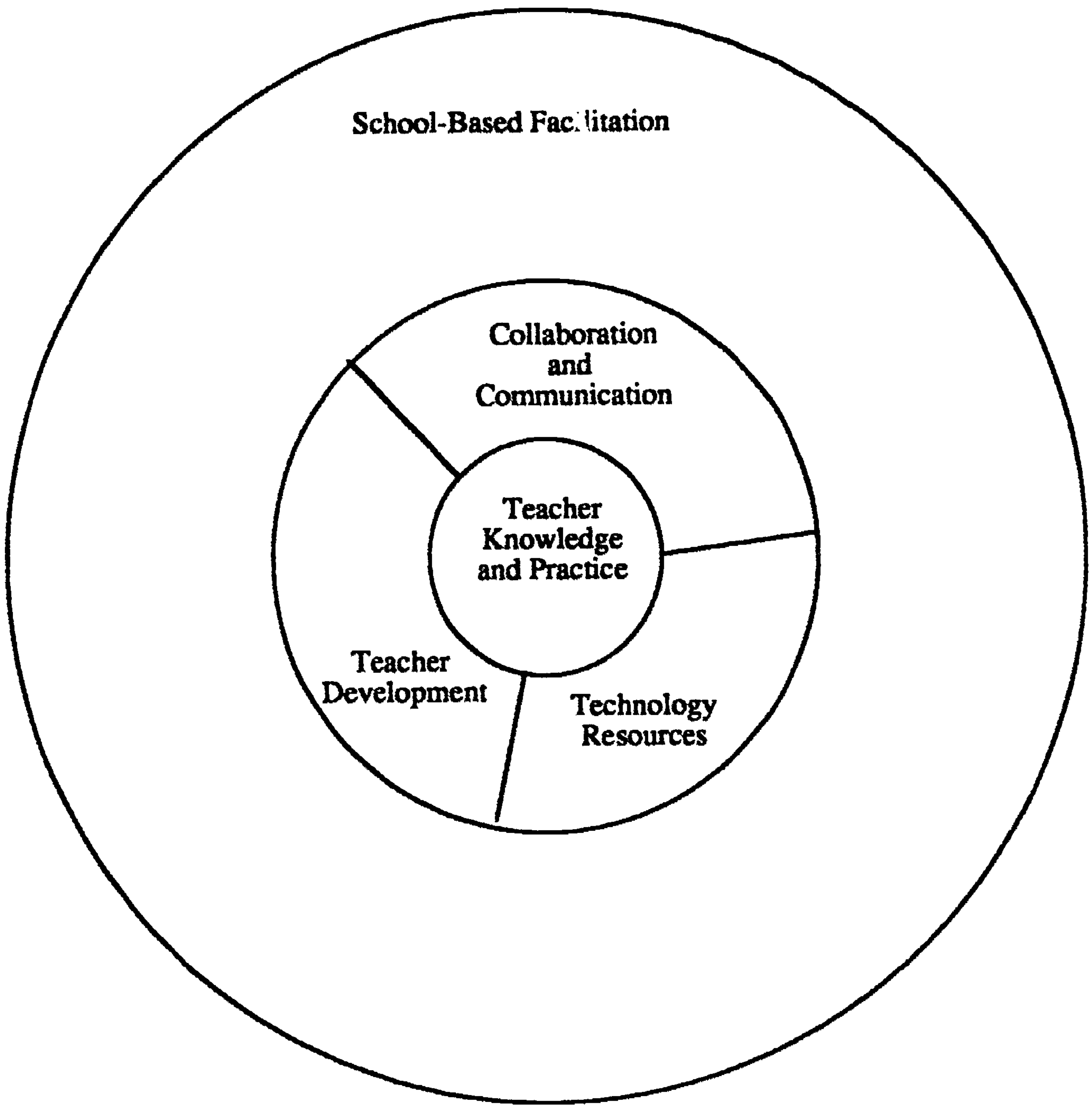
15. In order for successful technology integration to occur beyond individual classrooms, administrators need to

    - have a vision of the value and potential of the computer in meeting students' instructional needs and curriculum goals; and
    - understand that integrated technology use implies instructional and organizational changes.

16. When there are policies and procedures that promote links between special and regular education programs, then it is more likely that technology-related curriculum planning and implementation will meet the needs of special needs students.

Figure 3

CONCEPTUAL FRAMEWORK FOR INTEGRATING TECHNOLOGY



The middle ring in Figure 3 is made up of three categories that directly enable or inhibit the teacher's efforts to integrate technology. Enough of the right kinds of supports at this level make it possible for the teacher's energy and time to be focused on the students and curriculum; too few supports at this level can leave a teacher isolated, frustrated, and without enough knowledge or confidence to use computers successfully with her students. The teacher needs the right kinds of mechanisms and supports to be in place in all three of these areas. First, the technology resources, that is, the apprcpriate hardware and software, must be available, accessible, and in good working order. Second, appropriate support people or training opportunities enable initial and continued teacher development as teachers gradually acquire the knowledge, skills, and understanding they need to use technology in ways that support student learning and growth. Third, ongoing collaboration and communication among teachers and, in particular, between regular and special educators, provide support for risk-taking, opportunities for sharing knowledge, and coordination of efforts focusing on students' special needs and strengths.

However, while what occurs in these four areas is critical in supporting--or undermining--the successful use of computers with special needs students, it is the actual teacher-student-computer interaction that finally determines the success of technology integration. In this interaction, the teacher is a critical figure. From the beginning, this project has viewed the teacher as playing a key role in the integration of technology (see Year 1 Report, Zorfass et al., 1987). Far from being a time-saver or teacher substitute, software in the classroom demands as active and engaged a teacher as any other curriculum innovation with significant potential for student learning. The assertions in the center of Figure 2 focus on teacher knowledge and practice and their impact on the technology integration process.

We have represented these five categories as concentric circles because we do not see them as either sequential or hierarchical. Schools do not operate smoothly in a rational, top-down, technocratic fashion in which needs are assessed, decisions are made, and curriculum is implemented, evaluated, and revised (McDonald, 1988). Efforts to integrate technology may start with a school- or system-wide decision to buy hardware, but what ultimately occurs for students and teachers in classrooms results from a complex interaction of factors in all five areas, not a neat, unidirectional sequence of events in which the classroom is at the end of the line, the recipient of directives and the site of mechanical implementation. Rather, what happens in classrooms is, at the center, "more the root of schooling than its branch" (McDonald, 1988), and in the classroom the teacher deals with the minute-by-minute complexity of interaction and uncertainty that determines the real nature of the educational environment. The teacher's continued ability to perform this demanding job depends not only on her own resources but on what resources and support the rest of the system can provide, while the value of these resources and supports can only be assessed in terms of how well they enable the teacher to teach and the learner to learn.

In this chapter, we state and briefly explicate the 16 assertions that have emerged from our analysis. While each assertion is based on multiple cases, only one or two examples have been used in this chapter to illustrate each of the assertions. Although we might have chosen to draw on as many of the cases as possible throughout the chapter to indicate the range and variety of the cases, instead we have deliberately used some of the cases repeatedly. We hope that carrying some of the cases as examples across assertions will both provide a sense of the interrelationships among assertions and assist the reader in getting a better feel for some of the case material, even though we do not include entire cases in this document.

TEACHER KNOWLEDGE AND PRACTICE: ASSERTIONS 1-3

Knowledge and practice are intertwined. Just as our overall view of the school and how it works is not sequential and orderly, so teachers cannot proceed in a sequential, orderly way from a body of knowledge to instruction. Classroom practice is complex, uncertain, and unpredictable (Clark, 1988), dealing as it does with hundreds of student, curriculum, teacher, and contextual variables. Research indicates that teachers encounter decision situations every two minutes (Marland, 1977; Shroyer, 1981), decisions that require them to take into account the current reactions and behavior of the students, as well as content, objectives, and procedures. Experienced teachers do not use a simple rational model of instructional planning that starts from objectives and moves sequentially to curriculum strategies and evaluation (Morine-Dershimer and Vallance, 1976; Yinger, 1977); the model of instruction for experienced teachers is an interactive one in which decisions and actions are constantly modified. This process requires teachers to be engaged and active, observing and evaluating what is happening in the classroom. Practice and knowledge are always in flux, and each causes change in the other: "Teachers' actions are in a large part caused by teachers' thought processes, which then in turn cause teachers' actions" (Clark and Peterson, 1986, p. 258). The effective teacher is not only visibly active in the classroom but active in cognitive processing during teaching (Corno, 1981; Doyle, 1977; Joyce, 1978-79).

The assertions in this category characterize the actions, knowledge, and thought processes of the teacher who successfully integrates technology into her classroom practice for students with varying needs. These assertions emerge from our research on teachers' practice as they use technology but are also consistent with findings emerging from research on teacher planning, teacher interactive decision-making, and teacher thinking, which emphasize the complex and demanding nature of the teacher's work: "[this research] has documented the many heretofore unappreciated ways in which the practice of teaching can be as complex and cognitively demanding as the practice of medicine, law, or architecture" (Clark, 1988).

Assertion 1

In order to improve the way technology is used with special needs students, teachers need to gradually acquire and/or draw on and integrate knowledge about:

- **special needs students' strengths and needs**
- **the potential contribution technology can make to special needs students' learning**
- **curriculum content**
- **instructional strategies**
- **assessment strategies**
- **hardware and software**

These six topics include (although they may not exhaust) the key areas of knowledge that must come together for the special needs student to benefit from educational technology. Taken together, they cover the three types of content knowledge that Shulman (1986) cites as critical teaching knowledge: subject matter knowledge (curriculum content), pedagogical knowledge (special needs students' strengths and needs, instructional strategies, assessment strategies), and curricular knowledge (the potential contribution of technology, knowledge about hardware and software).

In order to begin using technology in their classrooms, teachers need to acquire new knowledge and integrate this knowledge with what they already know about teaching and learning. Depending on where they start, the kind of knowledge teachers need will, of course, differ. For example, an experienced mathematics teacher who is using technology for the first time with a low-level mathematics class may have a firm grasp of content and instructional strategies in her area and an understanding of the potential usefulness of technology, but she may know less about the way particular needs and strengths of the mainstreamed students in this group will interact with the software she has chosen. The computer teacher may know a great deal about hardware, software, and the potential of technology for learning, but may or may not be aware of curriculum content or assessment strategies. The resource room teacher who knows her students' needs may have little knowledge of the potential of the technology to address these needs.

One case that illustrates the acquisition and integration of new knowledge is that of Tricia, a mathematics teacher. Tricia is an experienced and confident teacher, with a strong background in mathematics content and clearly formulated instructional and management strategies developed over many years. She teaches all the seventh grade students who have not passed the state's Basic Skills test in mathematics at the end of grade 6. When we initially interviewed her during the first year of the project, she saw no reason to incorporate technology into her classroom. She felt that her systematic, individualized approach to mathematics instruction was demanding but successful and manageable; from what she had observed of much mathematics software, she did not see what computers would add to her instructional approach. "The bottom line," she told us in June 1987, "is that it will take a lot to convince me to put them in my room."

In the summer of 1987, Tricia attended a week-long mathematics workshop that included an introduction to a piece of software, the Geometric preSupposer. Tricia saw that this piece of software would fit well into her geometry unit. Although the software is an open-ended tool that allows students to construct geometric forms and explore geometric relationships, Tricia's sophisticated mathematical knowledge allowed her to recognize the conceptual power this piece of software could offer her students, rather than be intimidated by the open-ended nature of the software. Her knowledge of the kind of structures needed by her mainstreamed students when encountering new approaches led her to construct a variety of worksheets, modified for different levels of students, to help guide students in the use of the software. However, she also understood the importance of giving the students several sessions to explore the software freely both to increase their familiarity with how it worked and to give her a chance to assess students' needs and difficulties in using this new material. She used the one-to-one computer-child interaction as an opportunity to better understand her students' comprehension of the mathematical content. By integrating her new knowledge about a particular piece of software and how her students used it into the knowledge she already had about content, instruction, and assessment, Tricia was able to engage her students in more sophisticated mathematics than had previously been possible in her geometry unit.

Tricia was able to integrate knowledge from all six knowledge areas in her first attempt to use software with her special education students. However, for most teachers, acquiring and integrating the necessary knowledge to use technology successfully occurs gradually and includes, as does all new learning, false starts, dead ends, and even complete failures. New knowledge and enthusiasm about computers may provide a hook to get teachers started, but the links among students, computers, and curriculum are complex.

How difficult it is to use technology well is often not apparent until teachers and students are in the midst of beginning computer use. For example, one of our cases focuses on Steve, a special needs student who appeared to be a prime candidate for the word processor. Deborah, the mainstream reading teacher, had observed that although Steve's written work was riddled with spelling and punctuation errors and his handwriting was illegible, he had clear strengths in the areas of verbal expression and reception. As Deborah remarked, "I could not believe that the person I heard in the classroom, who could speak so well verbally, could not produce anything." Wanting to help Steve produce better written work, Deborah acted on a recommendation that was included in his IEP: she arranged to have installed in her classroom one computer specifically for Steve. She reasoned that Steve was an intelligent, articulate student who would be "released" by word processing--that if he had access to a word processor with a spelling checker, he could circumvent his illegible handwriting and poor spelling. Evidence from the field certainly confirms that this type of "release" has occurred for learning disabled students using the word processor (Morocco et al., 1989).

Deborah's knowledge of the potential of word processing for students like Steve led her to try what she had good reason to believe would, for him, be a powerful new approach to writing. For two months, we observed Steve's progress in writing assignments connected to Deborah's unit on ancient Egypt. Throughout the unit, Steve used the computer for all written work; however, by the end of the unit both he and his teacher were disappointed in what he had produced. Steve's final report on mummification, written on the computer, was certainly more legible than a handwritten version. The use of the spell checker allowed him to correct his spelling, which had been a major problem for Steve on handwritten assignments, and he did correct the punctuation and capitalization errors identified by Deborah on his first draft. But Steve's writing difficulties went beyond those mechanical problems of spelling, capitalization, and punctuation. His written work demonstrated the difficulties he had in processing information--extracting relevant ideas and organizing them. The computer specialist, who had worked with Steve on the second draft of this assignment, noted that "Steve has a problem in translating the question, then getting the information, and then processing that, and then putting it down on paper." Steve himself told us, "I have all this stuff that I want to type in my head. It's just that it's hard to get it down into the computer." Moreover, in a conversation with a researcher subsequent to the completion of the unit, Deborah acknowledged that Steve's emotional and behavioral problems interfered significantly with his ability to complete the assignment. Steve frequently lost disks storing his files, printouts of his work, and the copy of the text from which he was working; he often would not work on the assignment unless a teacher was sitting next to him. Deborah was unprepared for and lacked knowledge about the complexity and depth of Steve's processing problems and the emotional and behavioral problems interfering with his work. She tried to address Steve's writing problems by substituting the word processor for paper and pencil and by encouraging him to work without constant teacher supervision. But Steve, a student who had never produced good written work, needed new strategies for deciding on and organizing what he wanted to say, and he was unable to invent these means by himself (Morocco, 1987; Morocco and Neuman, 1988).

Steve's story provides a glimpse into how much teachers may need to know in order to make appropriate use of technology for special needs students. In this case, knowledge about technology needed to be integrated with knowledge about processing problems, writing strategies, and the interaction between emotional and behavioral problems and academic performance. As teachers gain more knowledge through classroom work, they also become more aware of how much they need to know.

We do not claim that each teacher must know everything about everything. While each teacher must know enough to act and think interactively with her students, some knowledge may reside in others with whom she can collaborate (see Assertion 8) or whom she can call on for specific kinds of help (see Assertions 4, 5, and 6). In fact, the successful teacher often draws on knowledge held by colleagues, by her students, and that which resides in the materials themselves, in addition to her own knowledge. This "distributed intelligence" is a means of coping with the increasing complexity of what there is to know (Pea, 1988). The sharing of knowledge becomes particularly critical with regard to the special needs student who straddles the "regular" and "special" education settings, each of which retains certain knowledge about the student's learning and development (see Assertion 9). And the necessity of distribution of knowledge is also heightened by the technology itself: individual teachers cannot take on maintenance, repair, or even the sifting through of potential uses of technology alone as they might with paper, pencil, and books (see Assertions 4 and 5).

In fact, in some cases, the technology may make available to the student (and the teacher) more specialized knowledge or new opportunities for access to content than the teacher has previously been able to provide. An on-line data base, for example, used in one of our sites, provides content knowledge beyond what is usually available to a middle school teacher. In Tricia's class, students were able to encounter mathematical content which had not been available when they had been limited to paper and pencil geometric constructions. The "intelligence" residing in the software led Tricia to offer her students mathematical experiences that she had not previously included in her curriculum. Tricia's work did not end with the new knowledge she had gained about software. She could not simply translate her acquired knowledge into new lesson plans and then go on exactly as she had in the past. Rather, Tricia remained active as her students began to use the software, observing and evaluating their responses and interacting with them as they worked, which leads to the second assertion in this section.

<u>Assertion 2</u>

In order to promote successful technology integration with special needs students, it is critical for the teacher to be actively involved with students' use of software, regardless of the type of software.

This assertion stresses ongoing, active teaching as technology is integrated into the classroom. Although the myth has persisted that computer use frees the teacher, in all our sites and with all types of software successful technology integration was accomplished only with the active participation of the teachers. Steeves (1988) found that students in grade 4 no longer need a teacher to introduce software or to be actively involved during its use. Nonetheless, although the sixth-, seventh-, and eighth-grade students in our study could operate software and complete some computer activities independently, teachers' active participation was necessary in order for students to be intellectually engaged in learning through use of the computer. This finding relates both to special educators and to those content area instructors whose classes include special needs students. Though prior research has focused on recommendations for special educators (Behrmann, 1984, 1988), it has largely ignored the particular types of problems that regular educators face in integrating technology into the mainstream.

Both special and regular education teachers need to be actively involved before, during, and after software use. This active participation does not mean that a teacher must be physically present during each student-computer interaction (an impossibility, given the usual classroom constraints). What it does mean is that teachers are most successful in integrating technology when they

- invest the instructional activity with meaning (this practice includes relating the activity to the wider curriculum and to the student's prior knowledge, experience, interests, and needs;
- challenge students to think about what they know, what they are doing, and how they are doing it (students are challenged to think about content knowledge, skills, and processing strategies; and
- extend students' knowledge of content and expand their repertoire of strategies and skills.

Those teacher practices which characterized such instruction in our cases include actively setting a context for the learning students are about to experience, engaging in ongoing observation of student activity, reflecting on what they observe and learn about students, intervening selectively according to students' needs, and linking computer activities to broader student and classroom goals. Teachers in our cases who used technology successfully engaged in all or most of these practices. For example, when Tricia introduced the Geometric preSupposer into her mathematics class (see Assertion 1), she introduced key geometric concepts that students would use at the computer, then gave them several days to "fiddle around" with the software before moving into more directed activities. This time allowance gave the students a chance to become comfortable with the software while affording Tricia the opportunity to observe students' initial concepts and difficulties. Once the context was set, she and her class were ready to move on to explorations of particular geometric constructions. For another example, Rebecca, an English teacher, spent several class sessions setting the context for each writing assignment before students used the word processor. Often she linked writing to a book the class was currently reading, using connections with situations and characters in the book to evoke students' ideas and feelings. For one assignment, students wrote a letter from a dying father to his teenage son, based on characters in a book they had just finished. Rebecca brought up her own family experience in which her terminally ill mother had prepared her thirteen-year-old sister for her death by taking private walks with her and having open discussions about what would happen. When Rebecca revealed that some of her relatives thought this action was wrong, students became involved in an animated discussion that prepared them for the writing they would be doing on the word processor.

Observing, reflecting, and intervening form a cycle in which active teachers are continually involved. Taken together, these three processes resemble the "diagnostic-prescriptive" approach, often seen as a basic tenet of special education (Wallace and Larsen, 1978). However, diagnosis and prescription can become codified, mechanistic, and rigid, proceeding mechanically from test results to remediation. Effective diagnosis is an "ongoing problem-solving process" in which teachers continually generate and revise hypotheses about the nature of children's learning difficulties (Baroody, 1987). The observing-reflecting-intervening cycle is flexible and responsive, taking into account both the teacher's goals and what actually happens during a series of learning episodes. Using new technology often leads to the unexpected and unpredictable, so that being ready to respond to the moment becomes especially critical. Leinhardt and Greeno (1984) found that experienced teachers are able to retain control of their planned instruction while simultaneously obtaining and using new information that becomes available through their interactions with students.

The case of Maria, a teacher who used Where in the World Is Carmen San Diego? with classes of bilingual students over a period of a year and a half, illustrates the observing-reflecting-intervening cycle across instructional episodes. Maria's first attempts with Carmen, a piece of software in which students solve a mystery by using geographical clues, were nothing short of disastrous. There were mechanical problems with the software, and even when the software worked, students had difficulty comprehending the text, extracting relevant information, and reasoning from the information to solve the mystery. Observing her students' difficulties, Maria remarked, "These kids are not from the suburbs. They don't know where [their own city] is, whether it's a city or a state, and don't have the slightest idea where the Grand Canyon is or where the Lincoln or Jefferson memorials are" (clues which had come up as students used the software). In the computer lab setting, Maria was unable to get around to students as they worked, and the students easily became frustrated by their difficulties and lost interest in the problem.

During the first months of software use, a researcher met regularly with Maria, asking her to reflect on what she had observed and encouraging Maria to develop interventions. Maria decided that the computer lab setting, with its one student per machine model, was compounding the difficulties of using this piece of software. In addition, she recognized that her students needed additional resources in order to develop the vocabulary and geographic knowledge needed for successful use of Carmen. She decided to move one computer into her classroom so students could work with her in small groups and to provide reference materials such as maps, atlases, an almanac, and a dictionary. With these changes, Maria was able to conduct successful group lessons using the software and, at the same time, integrate learning about the use of reference materials into the activity. As students worked, Maria observed their attempts to solve the mystery and offered suggestions and guidance. For example, when she noticed that students were copying text verbatim rather than extracting the needed information, she provided examples of selecting key words and phrases.

An active teacher engaged in the observing-reflecting-intervening process must often adapt or invent instructional techniques on the spot. Terry, a teacher of a self-contained special education class, was using The Factory with her students. The Factory focuses on spatial visualization and sequencing and requires students to specify particular amounts of rotation, such as 45 and 90 degrees. When Terry realized that some students could not visualize the rotation of a square, she found some cardboard squares in her closet and invented a manipulative on the spot, which provided the concrete embodiment of this idea that the students needed. Reflecting on what had happened in the classroom, Terry indicated that the next time she introduced this piece of software, she would have the cardboard squares ready in advance for the students to use.

Those teachers who were most successful in integrating technology were also active in connecting these computer activities to wider curriculum goals. For example, during Terry's use of The Factory in the resource room, students improved in their ability to do cooperative work and were engaged intellectually by the activity. However, while we might hope that students could use some of the cooperative skills they had acquired elsewhere, Terry was not active in helping them apply this learning to other situations. In contrast, Rebecca, the regular English teacher mentioned earlier, linked each assignment using the word processor to students' further work in writing. At the end of each assignment, she returned to the students an "editing pack" consisting of all their drafts and a comment sheet she had prepared. Students were required to copy Rebecca's comments and to add their own comments about what they had learned about their own writing. Rebecca discussed these comments with them and encouraged her students to consult them as they embarked on their next assignment.

When a teacher is not actively involved in setting context, observing, reflecting, intervening, and linking the activity to wider goals, even a promising use of the computer can fail. For example, in the case of Steve (see Assertion 1), Deborah did not engage in close observation and analysis of Steve's writing as he worked at the computer. In part, Deborah did not work closely with Steve because she was trying to facilitate his ability to work independently. Steve, as with many other learning disabled students, tended to be highly dependent on the direction and assistance of teachers (Schumaker, Deshler, and Ellis, 1986). He had spent many years in resource rooms working one-on-one with the teacher. Deborah thought that giving him a word processor, with spellchecking capabilities (one of his primary difficulties), would foster independence. In addition, with 25 other students in her mainstream reading class, Deborah had little time to sit with Steve. Steve produced three drafts of his report on mummification. Deborah reviewed Steve's first printout, returning it to him with written comments about his spelling and grammar errors. For his second draft, he worked with the computer specialist, who helped him use the spelling checker to correct his numerous spelling errors. Deborah reviewed this draft and returned it to Steve, marked in red ink to indicate format corrections, incomplete sentences, and capitalization errors. He worked on this third draft alone, making minimal changes. Unfortunately, Steve was not able to use Deborah's written feedback to help him improve the content of his writing; Deborah, for her part, did not observe Steve at work or talk with Steve about his writing, so she did not realize how much difficulty Steve was having in selecting and organizing information. The breakdown in this case relates in part to

Deborah's lack of active involvement with Steve, which might have led to new knowledge (see Assertion 1) about Steve's special needs.

It is not the choice of software, the placement of computers, or the amount of computer access per student that determines the success of the student-computer interaction. It is the nature of the interaction among student, teacher, and content that transforms the student's focus from what otherwise might be playing games, compliance, or marking time into thinking and learning. But if the knowledge and active involvement of teachers are critical and central, are we saying any more than that good teachers will successfully integrate technology and not-so-good teachers will have less success? In our study, as elsewhere, we have come across the exceptional teacher--the individual who finds ways to engage her students in learning under the most adverse of circumstances and flourishes in circumstances in which her efforts are supported and nurtured. However, most of us who are or have been teachers, while we may have had our exceptional moments, are human, fallible, and subject to being overwhelmed by the many demands and constraints of the school culture. Our assertions about knowledge and practice and the examples that relate to them indicate how much is demanded of a teacher's attention and involvement to integrate technology successfully and how, even with the best of intentions, these efforts can fail.

What can make the difference? As practice expands knowledge and knowledge, in turn, leads to changes in practice, lack of time for thinking about what is happening can lead to frustration. Teachers report that very little of the time they need to think and plan is provided officially (Clark and Yinger, 1979). Some teachers engage in a great deal of reflection about their practice on their own, but many others express how often the demands of the job leave them running to catch up with events. This links to the next assertion.

Assertion 3

When teachers engage with others in ongoing reflection about their instructional use of technology, they are more likely to critically evaluate their practice and redesign instruction to better meet student needs and curriculum goals.

New practice at first complicates instruction. New priorities must be set, new routines established, new opportunities for learning identified, and new strategies for evaluating student progress devised. Changes in practice lead to conflicting goals and priorities and to uncertainty about the best way to proceed: "Often these entanglements can only be sorted out as the teacher experiments with action and observes its outcomes (Lampert, 1985). By such experimentation, teachers build a store of personal practical knowledge about how to get their job done (Clandinin and Connelly, 1984; Clark and Lampert, 1986). In order for new knowledge to be used and integrated, teachers, just like students, need time to think. Ironically, schools are rarely characterized as places where teachers can also learn (Little, 1985; Sarason, 1986).

In the cases cited above, teachers were able to observe and reflect on what they had seen: Terry's reflection occurred later, after she had already chosen an intervention, while Maria (see Assertion 2) reflected on her difficulties, then planned an appropriate intervention. In both cases, their reflection was "occasioned" (Oberg with Field, 1986) by the opportunity to talk with someone about what was happening in their classrooms. Our research, consistent with Oberg's and others' findings (e.g., Hull, 1978), indicates that reflection often occurs when a particular time is set aside for it and requires at least one other person to act as a sounding board.

In our study, the "occasions" for reflection were often, although not always, stimulated by the presence of researchers. For example, in the account of Maria, her reflection on classroom difficulties and their solutions occurred during a series of conversations with one of the researchers who met with her regularly. The reflection sessions focused on her goals for using the software, the particular characteristics of her students, ways to alter her instructional practice, and ways of evaluating instruction. Over time, Maria's reasons and goals for using the program changed dramatically. While at first she planned to use the software to teach geography skills and to encourage "individualization" in learning these skills, by the end of the first year she was beginning to question these goals: "You know, I don't know what kind of evaluation I can do at the end of these two weeks to see if they have learned anything. What kind of a test could I give? I really don't expect that playing this game is going to teach them any new information. What is playing this Carmen game going to do for them?" By asking herself such questions and reflecting about what she was observing in her classroom, she gradually shifted her view of the value of this software. At the beginning of the second year, Maria had formulated a new plan. She would use the opportunity provided by the software to teach study skills, to reinforce note-taking (one of the school-wide goals), and, in conjunction with several other pieces of software, to assist her students in attaining a long-term goal, the writing of a research report by the end of the year.

Many individual occasions for reflection arose during our person-to-person or telephone conversations with teachers. Frequently, a teacher would remark to a researcher something like, "That's an interesting question, I haven't thought about that before, let me see ..." or "You know, I'm just thinking about this as I'm talking to you ...." This experience is a common one in research that involves close collaboration with teachers and focuses on teacher thinking. Clark (1988) sums up this phenomenon:

> A recurring theme in conversations between researchers and teachers collaborating in these ways concerns the powerful effects on teachers of reflecting on their own practice. Experienced teachers report that describing their plans and intentions, explaining their reasons underlying action and decision, and responding to questions and the presence of an informed, nonjudgmental adult seem to breathe new life and meaning into their teaching. Usually, teaching is an action-oriented, operational profession. But the intervention of researchers describing planning, thinking, and decision making has required that teachers stop and think, find words and reasons for their thoughts and beliefs, and take a second look at themselves and their teaching.... [the research techniques used in these studies] and the genuine human interest in understanding that accompany their use may constitute professional development activities of the broadest kind (p. 9).

A different case, in which researchers did not create the circumstances for reflection, occurred in one middle school where eight teachers--four content area teachers and four special education teachers--were involved in monthly meetings supported by a grant the school had obtained to support mainstreaming efforts. These meetings were organized and run by the teachers themselves. Topics that came up at the meeting often led to reflection about students' needs and difficulties across content areas. One month, a discussion began about the students' difficulties in preparing for quizzes in areas such as science or social studies. Teachers shared their perceptions that students had difficulty studying for these tests at home by themselves but also did not gain much from large group discussions designed to help prepare them for tests. One teacher volunteered what she had noticed, that when students were physically engaged with the computer during writing, they were more focused. Then Tricia, the mathematics teacher, described how some students had not been able to come up with a definition for an isosceles triangle when they measured and wrote down information on paper but were able to see that two of the angles were equal when they viewed the triangle on the computer screen. The discussion, as it continued, yielded some shared insights about special education students' learning across settings, including some advantages of technology and the problems some special education students have learning through the traditional whole class discussion format. The discussion engaged teachers in critical evaluation of their own courses and led them to consider the use of the word processor as an environment in which students could practice responding to test questions in a more focused way.

Our data indicate that reflection is not necessarily a regular, ongoing part of many teachers' practice. When reflection did occur, it was most often under the following circumstances:

- Time was set aside for reflection to occur.
- Reflection was undertaken with someone who was familiar with the teacher's students and curriculum (e.g., a researcher, or another teacher).
- Reflection occurred not just once, but regularly over time.
- Reflection required an orientation towards critical thinking about students and instruction.

TECHNOLOGY RESOURCES: ASSERTIONS 4-5

As teachers begin to work with computers, they encounter new demands and unexpected situations. While teachers have always held sole responsibility for myriad jobs in the classroom, from preparing curriculum materials to monitoring student progress to creating new approaches for reaching an uninterested student, we have found that there are some roles that are particularly difficult for teachers to fill with regard to technology integration. Teachers cannot be entirely responsible for gaining access to appropriate hardware and software. For technology integration to be successful, technology-specific roles and mechanisms must be in place to support teachers' efforts. So far, two assertions have emerged from our analysis that relate to technology resources. The first focuses on hardware, the second on software.

Assertion 4

Someone needs to be responsible for ensuring that hardware is kept in good working condition and that technical problems are solved.

The care and maintenance of materials has always been of critical importance in schools. Teachers are used to coping with the problems of damaged books, missing game pieces, or too few pencils. However, while teachers can manage many of these problems through changes in organization and scheduling or by inventing substitutes, it is impossible for a teacher to cope with technical computer problems. When a teacher has planned to take her students into the computer lab for word processing and six of the eighteen computers are not working, there is nothing she can do. The frustrations are similar to those associated with car repair or a broken light fixture. There are some aspects of these problems that we eventually learn to deal with ourselves; there are many others that require expert attention.

The key word in this assertion is "someone," that is, a particular person must be given and accept designated responsibility for break-downs, repairs, and other technical issues--locating an adaptor for the electrical outlet, diagnosing the problem when the disk won't boot or the printer spews out reams of blank paper. In several of our sites, this designation is clear. Those who are responsible know they are designated for hardware repair and upgrading, and teachers know who to go to with a problem. In Hopeville Middle School, Nancy, the computer specialist, and Kate, the computer lab aide, share responsibility for the care and maintenance of computers. Nancy is responsible for the installation, upgrading, and maintenance of hardware located throughout the school. When a computer is moved into a classroom, Nancy ensures that it is set up correctly; when the science teacher used telecommunications software with her students, Nancy oversaw the process of installing the necessary telephone lines and made sure the modem and software were working correctly. Kate is based in the computer lab and maintains hardware on a day-to-day basis. She also loads software before a class enters the lab and helps teachers if any technical problems arise. In this school, teachers know that if they have any hardware or software problems, whether they occur in the computer lab or in a classroom, they can readily turn to either Nancy or Kate.

In contrast, in another site, responsibility for hardware installation, upgrading, and repair are not clearly designated. In the fall of 1987, when the two special education teachers, Terry and Eleanor, first got their new IBMs, they were unable to begin working with students for several weeks because the computers were not hooked up and the needed adaptor for Eleanor's room had not appeared. Eleanor finally bought her own adaptor. In the fall of 1988, after Terry had spent the previous spring making significant strides in using the computer with her students, she returned to school to find a broken computer. After several attempts to get someone to attend to the problem and one visit by a computer repair person who did not fix the machine, she finally gave up, having many other demands to attend to. At this middle school, there was not a clearly designated person responsible for overseeing repair, nor was there an established process for when a break-down occurred. It was several months before Terry's computer was in working order again. By that time, the momentum from the previous spring had been lost, and it was six months into the school year before she began to use it again.

While the maintenance and repair process may still not always go smoothly when someone is clearly responsible for it, due to financial barriers or the lethargy of institutional response, there is at least a clear chain of command to follow. The process can be handled, and a crisis need not occur each time maintenance is necessary.

Assertion 5

When there is some mechanism for narrowing down their choices of software, teachers are more likely to try integrating technology into their classes.

A critical factor in the case study of Terry and Eleanor, two special education teachers, is what we might call the "hand delivery" of potentially useful software directly to them. The term "hand delivery" was actually suggested to us by Rebecca, who stressed the importance of this mechanism in her own consideration of prewriting software. Shortly after receiving computers in their classrooms, Terry and Eleanor were told by the computer coordinator that he had money available to order some software for them. The two teachers had no idea what they wanted to order. Terry expressed interest in software that would help with thinking strategies, visualization, or vocational and daily living skills. Eleanor was interested in a variety of topics but wanted software that seemed "grown up," that did not have the babyish feel of much remedial material. In response to their requests, the project staff brought the two teachers a small selection of software for preview. From these pieces, each teacher chose one piece of software, and later a couple of others, to try themselves and then with their students.

In Hopeville, Walt, the district computer coordinator, holds regular software review sessions for teachers. In these sessions Walt introduces the teachers to selected pieces of software that address needs they have expressed or that he knows to have potential for their students and content areas. For example, Walt knew that the middle school team had implemented a research report writing unit for the past several years and that organizing these reports was a difficult task for many students. When he came across an outlining program, he first mentioned it to Nancy, the middle school computer specialist, and then introduced it at a teachers' meeting, where it was enthusiastically received because it matched curriculum and student needs. Nancy also fills the role of narrowing down choices and matching teachers with particular software. As a school-based technology specialist, Nancy works closely with individual teachers and is able to make software recommendations based on what she knows about their curriculum, their students, and their teaching styles. When Nancy purchased several data base packages in different content areas, she made sure to demonstrate the mythology data base at a meeting attended by a teacher who did mythology units with her reading classes. A few months later, the teacher used the data base as part of her mythology unit.

Even when software is available within the school, for example, catalogued in the computer lab, teachers lack time, access, or enough prior experience to undertake the software selection task alone. Teachers in one school were surprised to find that a piece of software in which they had become interested had been in the lab all along. Choosing software out of the hundreds of available titles, based on the scanty or vague descriptions in catalogs, or by pouring through disks in the computer lab is an almost impossible task, especially for the novice--something like choosing a book from a library without previous exposure to books. But even experienced teachers value some mechanism that narrows down and focuses the range of choice. Someone who has a sense of what teachers need and what software is available can do an initial culling of possibilities for teachers to consider. "Hand delivery" of software makes the teacher's task manageable by reducing the complexity of initial software selection for the teacher.

TEACHER DEVELOPMENT: ASSERTIONS 6-7

As teachers become involved in technology integration, they need to gradually acquire new knowledge (see Assertion 1), have opportunities to use this knowledge by trying computer activities with their students, then continue to learn more about the potential of the technology and how to best use it in their classrooms. Whether teachers are novice computer users or have had some experience in computer use, they need support and time to be learners themselves. The traditional teacher training offered by schools typically consists of several after-school sessions, designed to appeal to a wide range of teachers and incorporating little follow-up or ongoing support. We have found that this kind of training was of little use to teachers in our study. Rather, access to people or mechanisms that could provide ongoing support made the difference as teachers acquired and integrated new knowledge and used it actively in their classrooms. The two assertions in this category focus on, first, the novice computer user, and, second, the role of in-service workshops, support personnel, and collaboration and communication in teacher development.

Assertion 6

When novice computer users have someone to whom they can turn for knowledge about computers as well as emotional support and reassurance, they are more likely to begin integrating technology into the curriculum.

Using the computer is still a completely new experience for many teachers. Working with an interactive, technological medium is unfamiliar, strange, and sometimes frightening. It is unclear to novices whether they have any knowledge or understanding to bring to this new situation, whether they will be able to meet the requirement of new tasks, or whether this new technology has anything to offer.

At the Bromley School, Naomi, a seventh grade resource room teacher, was interested in learning about the possibilities of technology but had never touched a computer. In June 1987, she hesitantly entered the computer lab at her school where a voluntary workshop was being held, saying, "I'm not sure I belong here." At that first session, she tried out a program with a more confident fellow teacher, gained further interest, and set herself a personal goal of using computers, although she alluded to her own "phobia" about working with these new machines. During the fall of the next year, Naomi attended several meetings designed for planning and professional development in computer use. In November she borrowed a piece of software from the district's special education technology resource center, brought it back to her school, and showed it to Carl, the co-manager of the computer lab. Carl told her she had made a good choice and helped her practice using it. Naomi described how comfortable she is with Carl--"he's almost like a big brother"--and how she feels she can call on him if she needs help. She noted that he does not make her feel "dumb." Later the same day that she had worked with Carl, she introduced the software to her students; she was able to engage the entire group in the activity and experienced no technical difficulties.

Naomi brought both motivation and hesitation to the task of beginning to use computers, but she received both the technical advice and emotional support she needed along the way. Until the novice computer user gains some experience and confidence, she is likely to be stumped easily because she does not remember (or never knew) a small piece of information (e.g., how to load an old file into the word processor). She is likely to spend a great deal of time trying to figure out what to do, perusing a less-than-helpful manual, becoming more frustrated and blaming herself for her lack of understanding. A knowledgeable and approachable guide can help the novice user solve the problem in a minute or two, allowing her to spend time pursuing the activity's usefulness and meaning rather than wasting the only half hour she has available trying to get set up. Having satisfying and productive experiences leads to the development of the knowledge and confidence that enable teachers to begin integrating technology into the classroom environment.

Assertion 7

In-service workshops can contribute to teachers' acquisition of knowledge, but are insufficient in helping teachers use this knowledge in their work with students. Teachers best learn to integrate technology successfully through ongoing school-based support and structures for collaboration and communication.

Teacher after teacher in our case studies described her initial computer training experiences as inadequate introductions that did not take into account her curriculum, her students, or her own need for extended experience and reflection. Rebecca, for example, who eventually developed a thoroughly integrated use of word processing in her English classes, spoke of her first encounters with computers in a previous school system. The five-session training course that she attended had not offered her any way to get started. The software demonstrated was neither compatible with the computer in her school nor applicable to the courses she taught. In another case, plans were made to have all middle school language arts teachers use word processing with their students. Some initial training was offered, but teachers did not leave the training feeling comfortable with either word processing mechanics or ways of using the word processor within the curriculum. No follow-up support was provided as these teachers began to take their classes to the computer lab for the mandated once-a-week word processing session. As a result, three years after word processing was implemented, few teachers had integrated the word processor into student writing activities.

In contrast, in Hopeville, ongoing support was built into the choice of a new piece of software. Nancy, the middle school computer specialist (see Assertion 4), often provided initial training for teachers interested in using a new or complex piece of software. However, after the introduction, Nancy was continually available to the teachers as they used the software themselves and then with their students. For example, at a meeting of Hopeville teachers, the district computer coordinator recommended a piece of software designed to help students do outlining in response to teachers' concerns about student difficulties in extracting and organizing relevant information during a research report writing unit. Nancy immediately offered to review the software and demonstrate it to the teachers, which she subsequently did. After working with the teachers, Nancy continued to provide support. She prepared laminated cards with the commands used in the software, was in the lab with the teachers when they used the software with their students, and helped teachers instruct students in its use.

Some teachers clearly gain knowledge about the potential of technology for their classrooms and about specific hardware and software uses through training experiences. Tricia, the mathematics teacher who used the Geometric preSupposer (see Assertion 1), learned about this software in a summer workshop, while Naomi (see Assertion 6) was able to choose a piece of software by going to a training session run by her school system. However, by and large, training sessions alone did not lead teachers to technology integration, whereas encounters with an individual who supported their desire to develop knowledge and experience made all the difference. Just as Naomi credited Carl with facilitating her growing confidence, more experienced teachers sought out support personnel rather than training when they wanted to learn something new about technology. Robert, the computer teacher at the Greendale Junior High, helped Martha, a special education teacher who was teaching a writing course, learn how to use Bank Street Writer so she would feel comfortable enough to use it with her students. In another school, when Terry, a teacher in a substantially separate classroom, accompanied her students into a Logo class, Ted, the mathematics teacher who was teaching Logo, spent time helping her learn this software. At the beginning, she sat at a computer just like her students; eventually, she was able to help Ted with all the students. Terry confided that it gave her a "boost" to become competent and that it was important to her that Ted's "regular" students came to see her as more than the "retard teacher."

While teachers gain new knowledge and confidence about using technology through people in the school who can provide ongoing support and expertise, they make further gains in integrating this knowledge into the classroom through collaboration and communication with peers. The next two assertions deal with this aspect of teacher support.

COLLABORATION AND COMMUNICATION: ASSERTIONS 8-9

Neither collaboration nor communication about substantive learning issues tends to go on to any significant degree among teachers in schools. This lack of peer collaboration has been attributed to lack of time for shared work and talk, an unspoken ethic of privacy, or an expectation that teachers must sink or swim on their own (Little, 1985; Zahorik, 1985). Whatever the reason, teachers are well aware of the missed opportunity to collaborate with each other and see it as a sign of the lack of professionalism. As a participant in one of Hull's seminars, which were structured as a time to reflect on practice, remarked, "I don't think anyone has said here, 'I don't have time to talk about it now,' which is sort of the ending of every conversation I have all day long at school" (Hull, 1978, p. 25). In our project, when the research staff met with all the mathematics teachers in one of the schools, it was the only time they had all been in the same room at the same time all year to talk about instructional strategies. Ben, one of the teachers, remarked, "There's a wealth of things we should be talking about, like what we're talking about today, just the teachers, and we're willing to talk about them, but we can't because we have to do these idiotic things we did the year before and the year before that....We need time...for stuff like this....The school system's notorious for: here's an idea...we'll do it tomorrow. And you wonder why a lot of things don't work!"

The two assertions in this category indicate the important role of collaboration and communication in the successful integration of technology into the education of the special needs student. As the role of student collaboration gains increasing attention in both regular and special education, we need to remember that teachers are learners as well and that the role of collaboration for them can be as significant as it is for their students.

Assertion 8

When two people work together collaboratively to try out software, technology use tends to be more successful.

A particularly interesting informal structure has occurred frequently in our data. Again and again, we have seen that a dyadic relationship between teachers has been associated with a step forward at the implementation level in the use of technology with special needs students. In many of these cases, two teachers who have a friendly personal and/or professional relationship work in parallel in their respective classes to use a particular piece of software. Terry and Eleanor, two special education teachers, are an example of this. The two teachers are friends as well as colleagues. They often talk about both school and personal issues together, their daughters attend the same elementary school, and their families are well acquainted. They both participated in the EDC/TERC project, and as they began to use computers with their students, their personal and working relationship provided them with company during this new and unpredictable venture. It allowed them to feel that "we're in it together," thereby supporting the taking of risks and alleviating the isolation experienced by many teachers. The existence of ongoing, informal communication led to Terry and Eleanor's joint planning and implementation of a geography unit in which they incorporated Where in the World Is Carmen San Diego?

In some cases, teachers actually co-teach or develop a course together, which they teach in separate sections. When the Greendale Junior High made a decision to develop an eighth grade special education course that would emphasize the use of the computer in writing, two teachers, Nan and Wendy, chose to help design and teach the course. They worked together during the summer to outline the course and began teaching their separate sections in the fall. Once the school year began, the teachers did not have time to continue planning together. They could only manage to exchange assignments and course ideas "on the fly." Independently, they began shifting the focus of the course to respond to their students' expressions of anxiety about English assignments, and they decided to expand the focus of the course to include work on students' mainstream writing. With this revised course design, Nan and Wendy felt the need for more common planning time and also realized the importance of including the English teacher in their discussions. After hearing their concerns, Emma, the special education coordinator at the junior high, released Nan and Wendy from some of the regular special education department meetings so they could meet with each other and the English teacher. In these meetings, the teachers explored new software and discussed how to tailor the course to meet the needs of individual students.

In a few cases, the dyadic relationship had been formalized, as in one site where a grant obtained to focus on mainstreaming supported four pairs of teachers--one regular and one special education--to work together around the needs of particular groups of students. However, even when the dyad is not formalized, as in the case of Terry and Eleanor, it appears to provide a base of support, a sense of sharing the risk in trying something unfamiliar, a person with whom to laugh about disasters and show off successes, thereby reducing frustration and isolation. The dyad appears to be a critical mechanism that facilitates many of the positive outcomes of technology integration, and it is one that could be deliberately built into any effort to integrate technology.

Assertion 9

Regular, ongoing communication between regular and special educators who teach the same students often facilitates successful technology integration if the focus of the communication is on curriculum goals, instructional strategies, and student needs.

Our definition of successful technology integration stresses students' progress and participation in mainstream learning. While it is certainly possible for appropriate and interesting use of technology to take place entirely within the special education setting, such technology use may provide students with positive but isolated experiences, unless students' learning and growth in this setting are connected to their learning and growth in the mainstream. For example, in one of our cases, a special education teacher engaged her resource room students in an interesting piece of social studies software, but there was no evidence that the students or the teacher ever made any link between this activity and work in their regular social studies classes.

In one school, Wendy, the special education teacher, and Rebecca, the mainstream English teacher, had been team teaching in one of Rebecca's English classes as part of a mainstreaming grant. Wendy attended half the meetings of one section of Rebecca's classes, which had a concentration of students who also attended the Computers and Writing course she taught. Both teachers used word processing with these students. The teachers originally set aside one planning period every six days, but in reality, they spent two or three hours a week planning together. Despite the intense time commitment, both teachers were enthusiastic about their collaboration. Wendy found that she could coordinate her Computers and Writing course with Rebecca's assignments because she was aware of each student's progress in the English class. Wendy was able to help Rebecca structure writing assignments to better meet the needs of special education students. For example, Wendy suggested that the class do group brainstorming as an introduction to the writing assignment; this prewriting activity led to better writing on the assignment. In turn, Wendy learned from Rebecca about the English department's use of a process approach to writing and used specific techniques to help her students develop better writing strategies. As Wendy and Rebecca continued to work together, they were able to use the word processor in a more consistent and integrated way in both the special education Computers and Writing course and the mainstream English class.

SCHOOL-BASED FACILITATION: ASSERTIONS 10-16

The final category of assertions focuses on school-based facilitation. Many technology-related decisions and actions must take place on at least a schoolwide, if not a systemwide, level. Acquisition and allocation of hardware, scheduling, provisions for training and support, curriculum policies, and systematic procedures for collaboration are often not in the hands of teachers alone but do profoundly affect what actually happens in the classroom. It is at this level that administrators in a variety of roles must become involved with decision making, implementation, and monitoring. Administrators' actions are critical in establishing pedagogical, organizational, and financial priorities and in putting into place policies and systems that support technology integration. A climate of support, participation, communication, and access to resources--an atmosphere that can be established with the help of key administrators--is what ultimately provides a context for the expansion of technology integration beyond the single classroom or the one enthusiastic teacher. Although we have known teachers (outside of this study) who have integrated technology into their classrooms in the absence of a supporting context, those teachers have typically tired of the frustration and isolation and, if unable to promote interest in their school, have found a setting more conducive to their pursuit of effective technology use in education. The assertions in this section deal with decision making at the school level, with communication between administrators and teachers, and with the significant role of key administrators in the technology integration process.

Assertion 10

When decisions about hardware acquisition, hardware allocation, and scheduling focus primarily on curriculum goals and teacher experience and expertise, they are more likely to lead to successful technology integration than when they focus exclusively on issues of equity and access.

This assertion may at first appear counter to our focus in the special education world on the importance of issues of equity and access. However, we see in our case material that an exclusive focus on equity often misfires; equity through equalization does not necessarily result in true equity. In one school, for example, one Apple had been placed in each of the two special education teachers' rooms in order to give equitable access to special education students. Since special education students were often scheduled for the resource room while other students went to the computer lab in their mainstream classes, these students had less exposure to the computer than their mainstream peers. Placing a computer in the resource room appeared to address some of the equity and access issues for special education students. However, the computer labs in the school, used by the mathematics and English departments, were equipped with IBM PCjrs. Because the system as a whole used IBMs, the teachers, Terry and Eleanor, had a difficult time obtaining software to use on their Apples. In addition, they had little experience with computers and felt inadequate and less than knowledgeable in this area. Terry commented that she was embarrassed when she took a group of her students to join in a Logo class given by one of the mathematics teachers because she herself had a hard time understanding what was going on.

In another school, three computers were donated by the director of the district's special education technology center to be used by middle school special education teachers. She stipulated that the machines were to be located in an area and scheduled in such a way that all teachers would have equal access. The school staff concentrated their efforts on finding a space in their very crowded building where they could place this "mini-lab." In all the discussions that took place about finding a location for the machines, none of the teachers considered what they were likely to be used for, or what combination of scheduled time and flexibility might best serve students' and teachers' needs for access. They concentrated instead on meeting the perceived demand for "equal access."

A more positive example of combining equity and access issues with concerns for teacher and student needs comes from a case in another site about the implementation of a keyboarding course for all sixth graders. The original plan was that all sixth graders would be given instruction in keyboarding during their English and reading classes. At a meeting of "key players" in September, before the course began, several issues arose. First, two special education teachers who had not been involved in the original decision were worried because the keyboarding program would decrease availability of the computer lab and, they feared, would prevent needed access to the lab by special education students who had come to depend on the computer as a tool for writing. In addition, one of the reading teachers, who was new to the school, felt overwhelmed and was reluctant to take on a new and time-consuming preparation as she began her first year. The assistant principal, who was taking responsibility for implementing the keyboarding decision, suggested piloting a keyboarding class in one of the English classes before implementing it school-wide in order to give the school staff a chance to assess its value and work out the scheduling problems it might cause. Everyone agreed to this plan. While it was not immediately "equitable" in a narrow sense, that is, not all sixth graders would be offered keyboarding during this school year, the plan took into account a variety of needs and balanced them as flexibly as possible within the constraints of available resources.

Our cases reveal that decisions about acquisition, placement, and scheduling of computers are often made in response to a demand, sometimes from within the school and sometimes from parents, for equitable access. When equity concerns are not combined with a careful look at the real needs of teachers and students--what the computers will be used for, how often they are needed for that particular use, what kind of computer configuration makes sense to meet goals for students, and which teachers are prepared and willing to use computers--the mere placement of computers or scheduling of computer courses may not lead to any real technology integration.

<u>Assertion 11</u>

Once a technology-related decision is made, it is unlikely to be implemented unless someone who is committed to the decision determines what steps must be taken and ensures that the next step happens at each point in the implementation process.

Making the next step happen is a role that emerges--and fails to emerge--throughout the range of cases we have studied. A "next step" may be small--scheduling a meeting, drafting a letter, or having a conversation with the right person. But someone must take responsibility for identifying the next step and making sure it is carried out. While the person who takes on this role can be someone with official responsibility for the kind of action needed, she or he can be someone whose role does not explicitly include this responsibility but who is committed to seeing the decision through. Of course, in some cases, no one is committed enough to take responsibility for the next step, and the ball is dropped.

Such was the case in the attempt to implement the use of _LogoWriter_ in one school. The mathematics department had been teaching a five-week unit on Logo in their mathematics classes. Two of these teachers had previewed _LogoWriter_ were excited about its possibilities, and so persuaded George, the computer coordinator, to purchase it for the school. George approved the purchase because he felt that _LogoWriter_ could be a vehicle to achieve an integrated curriculum and, because of its word processing capability, it could be used by both mathematics and English teachers. At the beginning of the school year, George dropped off some training videotapes at the school and conveyed to project staff that everyone was "getting excited about _LogoWriter_." The mathematics teachers planned to use _LogoWriter_ starting in November. Because the language arts teachers had not given input to the _LogoWriter_ decision, the writing specialist at the school was designated to expose these teachers to _LogoWriter_. The mathematics teachers did not find time to look at _LogoWriter_ during the fall, and the language arts teachers were unenthusiastic and unclear about its relevance to their program. By March, the mathematics teachers felt that they were behind in their curriculum and did not have time to spend on _LogoWriter_.

In addition, the school's self-evaluation was demanding much of their time. Said one teacher, "LogoWriter is just not a priority right now." In the meantime, George had purchased LogoWriter for the two special education teachers in the school. These teachers assumed that the students would be working on LogoWriter in their other classes. They did not have the time or the confidence to explore this software on their own.

In the LogoWriter case, both a key administrator and some teachers were initially enthusiastic about implementing this new tool. However, no steps were taken to provide training, free up teacher time, or work out conflicts with other priorities. No steps were taken to include or inform the language arts teachers, the language arts supervisor, or any of the mathematics teachers who were not part of the initial decision. Because no one who was committed to the decision continued to monitor or manage the implementation process, it simply slid away among many competing demands.

In a second case, cooperation between a district-level administrator and a school-level administrator resulted in a series of steps that lent support to the growth of technology integration for special needs students at the middle school. Based on discussion with EDC researchers about the efforts of a number of middle school teachers to integrate technology into the educational programs of their mainstream special education students, Walt, the director of technology, with the support of Barbara, assistant superintendent of instruction decided to hold a meeting to discuss instructional strategies and uses of technology with special needs students in mainstream classrooms. In the nearly two-month process leading up to the meeting, Barbara took care to invite all interested teachers, administrators, and specialists and to include key representatives of these groups in the planning process. To set the meeting's focus and agenda, she organized and ran a planning session two weeks before the gathering. Then after the meeting, Barbara took a "next step" by communicating to the vice principal of the middle school that he should expedite "whatever the teachers requested" in order to promote better integration of computers into the education of mainstreamed special needs students. Whereas teachers requested additional time to evaluate software, the vice-principal arranged for substitutes, allowing the resource room teacher, two mainstream teachers, and the computer specialist to spend a day reviewing and trying out software. In this case, the administrators facilitated a "next step" that the teachers identified.

In another school, a decision had been made to expand the "mini-lab" into a second, larger computer lab to respond to increased needs for access as more teachers became involved in computer use. The main lab was used almost entirely by the computer teacher for teaching regular computer courses, and the mini-lab had only eight machines. While some additional machines were to be allocated to the school for the coming school year, there would still not be enough for a full lab that could accommodate an entire class. The principal and many of the teaching staff supported the decision to have a second lab that would be available to classroom teachers. Ken, the assistant principal, took it on himself to negotiate with the system's business manager for more machines. Ken spent hours on the phone attempting to transfer funds to enable the school to purchase additional machines. He was finally able to succeed, and by January, the school had twenty-four computers in the second lab. But soon a new problem arose. All computer supplies, including software and blank disks, had always been stored in the original lab. Since there was no storage facility in the new lab, disks were constantly being carried back and forth and were getting misplaced between the two locations. Ken acquired a storage cabinet, enabling the teachers who used the new lab to store their disks there. Ken also kept on top of the scheduling conflicts and priorities that arose around the use of the new lab. When it appeared that the implementation of a typing course for all sixth graders was jeopardizing other teachers' access to the lab for their classes, he proposed a compromise that was enthusiastically accepted by all parties. He kept in communication with all key players throughout this process.

In most of our cases, the next steps related to a particular decision were taken by, or at least monitored by, a single individual at the school level. In most cases, this person was an administrator; however, on occasion, this individual was a teacher.

Assertion 12

Once a technology-related decision is made, administrators and teachers need to communicate directly with each other during implementation to determine whether the decision is working or needs to be revised.

This assertion seems to embody an obvious statement, yet practitioners have not paid attention to its implications. Technology-related school-wide or district-wide decisions can be made and, to some degree, implemented, without resulting in the desired impact on learning at the classroom level. Unless administrators who make such decisions are in direct, ongoing contact with teachers, implementation may flounder and finally fail before any efforts have been made to evaluate difficulties and revise decisions accordingly. When there is no allowance for interaction and communication following an administrative decision to be implemented in the classroom, the results can be a disaster. For example, when we first met with administrators and teachers in one school district, we were told that, among other things, all middle school students used word processing regularly. The impression given from the top was that word processing was well-integrated into the English curriculum at every level and in all grades. As we began to work in the schools, we found that, indeed, English teachers were required to take each of their classes into the computer lab once a week for word processing. Most complied, but they resented the time taken away from their curriculum, did not see the value of word processing, found the particular word processor that had been chosen cumbersome and unfriendly, and, at best, used the word processor as a "copy-it-over" tool or a way to practice spelling words. One English teacher finally exploded at a release-day in-service session, asserting that it made no sense to do writing in a once-a-week time slot. Writing assignments need intense chunks of time, as students work through several drafts of a written piece; there was no way she could incorporate the word processor as a writing tool into the once-a-week time slot. Following her strong statements, an attempt was made by the computer lab manager to set up a meeting with key people in the English department to talk about these concerns; however, for one reason or another, key administrators never became involved in these talks, and the same situation existed months later with respect to the use of word processing that existed in the past two school years.

Assertion 13

In order to support teacher development, administrators must put structures in place so teachers can communicate and collaborate on a regular basis.

From this study and others (as discussed above under Assertions 3, 8, and 9), we see a great deal of evidence that teachers have little time to talk with each other about students and curriculum. Teachers catch each other as they pass in the halls or in the teachers' room to exchange only the most necessary and critical information but have neither time nor mechanisms which support more extended communication. This lack of collaboration impacts especially on the special needs students who see a number of teachers. When teachers are trying to integrate technology into the education of these students, lack of communication or collaborative structures impedes the potential impact of technology use.

When Deborah, the mainstream English teacher, attempted to integrate word processing into the program of one of her special needs students, Steve, she was not aware of the kinds of supports and structuring the student would need to be able to make appropriate use of the word processor (see discussion under Assertion 1). Sue, the resource room teacher who worked with Steve, had no avenues of direct communication with Deborah. The teams within this middle school meet regularly, but the special education teachers are not part of the team meetings. Sue and the other resource room teachers depend on chance encounters in the hallways with the mainstream teachers or on information they obtain from students to keep up-to-date about major classroom assignments and upcoming tests. Sue did not provide any advice or support that could have helped Deborah integrate Steve into her mainstream class.

Many people in various positions in this school have expressed dissatisfaction and frustration with the lack of regular contact between special and regular education teachers. Mainstream teachers would like to meet regularly with special education teachers, but the special education teachers have overwhelming caseloads that leave little time in their schedule. The principal has asked special education teachers to try to attend team meetings but has made no provision that would allow them to do so. The special education administrator expressed dissatisfaction with the lack of collaboration and hired an additional special education teacher to reduce the size of caseloads. However, the resource room teachers still have not found available time to meet on a regular basis and want to make sure that such time, if scheduled, would be worthwhile. Says Sue, "It's just impossible now, but even so, I never believe in meeting for the sake of meeting, so I [just] like to meet if there's a reason for it. It would be useful, I'm sure; it sure beats running around bumping into people in the corridors, lunch room, restroom, whatever room ...."

While teachers try to communicate informally, they are often frustrated in their attempts by conflicting schedules and lack of time. In the case mentioned above, administrators are aware of the issues but have not yet put in place any mechanism that would adequately address the problem. In contrast, in a different school, the special education coordinator responded to Nan and Wendy's dilemma by reallocating time from her department meetings, because she considered it a priority for them to be able to meet together to discuss their course on computers and writing (see Assertion 9).

In order for technology to be truly integrated into special needs students' education, regular and special educators must communicate about computer use and its interaction with student learning. They need to coordinate their efforts to make computer use a meaningful part of students' educational programs. Within the usual structure of schools, teachers rarely have time to talk about student needs and curriculum content, nor do they have the authority and control to rearrange or allocate time so that such conversations can occur. Administrators must take an active role in supporting regular-special education communication if the potential of technology is to be realized for the special education student. Time for collaboration and communication are also essential to support reflection (Assertion 3) and the teacher dyads (Assertion 8), which we know tend to lead toward successful technology integration. These are sometimes established by individual teachers but are rarely sustained without administrative support. Terry and Eleanor's dyadic relationship, which worked so well during one school year, did not continue during the following year when they no longer had the same lunch period and rarely crossed paths during the school day. Similarly, in examples from our data in which teachers and administrators have communicated during implementation of technology-related decisions (see Assertions 11 and 12) and have been able to re-evaluate and modify instruction appropriately, it has almost always been an administrator who has initiated or set up a mechanism for the communication to take place.

The administrator's role is different from but as critical as the role of the teacher. By and large, teachers and administrators do not have enough informal or formal mechanisms to keep in touch about ongoing implementation issues. Regular and special educators do not have structures that give them time to talk with each other about students and instructional strategies. Even teachers who teach the same subject matter do not have mechanisms that support peer interaction around the teaching of a particular content. Teachers do not have the time or the authority to set up channels for these interactions. It is in creating and/or supporting these critical structures for communication and collaboration that administrators can have a major impact on successful technology integration.

Assertion 14

When administrators vary expectations according to teachers' individual needs, interests, and abilities and give teachers choices about how and when to implement technology-related curricula, successful technology integration across classrooms is more likely to occur.

This assertion addresses the question, How does one facilitate the spread of computer use throughout a school? Typically, a school has one or two early adopters, individual teachers who are personally enthusiastic about computer use and begin to try things out with their students (Canning, 1989). It is often these early adopters who provide the energy and interest that attracts others in the school to the possibilities of computer use (Hanley, 1983). Yet, at some point in the course of a school's or system's consideration of how to integrate computers into its curricula, decisions are made to promote more widespread use, to give more students experience with and access to the computer. Often these decisions result in the adoption of particular courses or emphases at particular grade levels. For example, a computer literacy course might be instituted for all sixth graders or word processing might be introduced in all English classes.

Expanding the use of computers throughout a middle school or school system provides more opportunities for students, but it sometimes brings about unwelcome burdens for teachers. When teachers are required to include technology in an already-full curriculum and have little time to plan, they may have a hard time bringing enthusiasm to the task. Certainly, many teachers, given the opportunity, do become "hooked" on computers, but not all do. Therefore, spreading computer use by mandate has built-in difficulties.

These difficulties are illustrated by the decision at one of our schools to teach Logo in mathematics classes. The districtwide decision required all middle school mathematics teachers to take their students into the computer lab for Logo instruction once a week for ten weeks, a format that was modeled on another school system's Logo program. Although teacher reaction varied, many of the teachers were reluctant to participate, describing computers as being "forced" on them. These teachers were uncomfortable using computers in general and Logo in particular. One teacher tried to trade her Logo instruction with another teacher who knew Logo well, in exchange for teaching some of his regular mathematics classes. In addition to feeling inadequately prepared to teach Logo, many of the mathematics teachers felt they did not know where Logo fit into their curriculum. One teacher said that perhaps Logo should be part of the art curriculum or be taught in sophomore geometry, but he did not see its place in what he was currently teaching. The ten sessions of Logo als cut time out of the regular mathematics curriculum, and teachers still felt pressure to cover the standard curriculum. At the monthly departmental meetings, the mathematics teachers expressed their dissatisfaction with the Logo decision, in which they had not participated, but said they felt their opinions had fallen on "deaf ears." They felt the decision would stand regardless of their opinions. Whereas one or two of the teachers were personally excited about the potential of Logo and worked hard at finding interesting ways to teach the ten-session unit, others went through the motions of satisfying the requirement, doing the best they could, given their own lack of experience and enthusiasm.

What is to be done if the goal of expanding computer use conflicts with individual teachers' preferences, experience, and interests? If we expect teachers to take into account individual students' needs and strengths, teachers themselves must expect to be treated as individuals, as thinking professionals who may make different choices and have different strengths. In another of our school sites, Logo is also a mandated part of the curriculum for sixth graders. In this school, as in many middle schools, the staff is divided into interdisciplinary teams. Although teams have certain responsibilities to cover required curricula, they can also make choices within that framework. In the case of

Logo, it is left to the discretion of each team who will teach the Logo unit and how time will be allocated for it. In some cases, a mathematics teacher might teach the unit; other teams might choose the English or social studies teacher to teach Logo. Time might be taken from mathematics or from a combination of subjects. In situations where no teacher has experience or interest in teaching Logo, the computer teacher teaches the unit to that team's students, often with the assistance of a team member who has expressed interest, so that the person will learn how to teach the unit. This system allows teachers to have control over allocating time and resources, to make collaborative decisions about the best uses of everyone's time, to see others model the teaching of new content, and to become intrigued--or not--in their own time and at their own pace. Even scheduling of the computer lab in this school is based on variation rather than uniformity. Rather than scheduling teachers or teams for set blocks of time, the schedule is a mixture of time blocks that are reserved for certain courses, such as Logo or keyboarding, and time blocks that are open for more flexible scheduling.

Administrators can take individual teachers' needs, interests, and abilities into account from the very beginning of the decision-making process. In Greendale, the English Department raised concerns about the need for keyboarding instruction for sixth graders. Several English teachers wanted to integrate word processing into their curriculum but felt frustrated by their students' lack of familiarity with the keyboard. In response to their requests, Ken, the assistant principal, organized a series of planning meetings with teachers and school-level administrators. A decision was then made to institute keyboarding instruction in all English and reading classes the following fall. When the school year began, however, a number of problems emerged. One of the reading teachers was new to the school, and though she agreed in principle with keyboarding instruction, she began to feel overwhelmed by all the demands of her new curriculum. She expressed her wish not to teach keyboarding that year. One of the English teachers was unfamiliar and uncomfortable with computers. The special education teachers were concerned about keyboarding instruction because it would require a great deal of scheduled lab time and could interfere with the access to computers needed by those of their students who used word processing. Ken began to feel that too many concerns had been raised to justify going ahead with a full-scale implementation of keyboarding instruction. As an alternative, he proposed that keyboarding be piloted in one of the English sections to give everyone time and more information about the potential advantages and difficulties of putting keyboarding in place for all sixth graders. Everyone agreed with this proposal.

In this situation, Ken respected the varying needs, interests, and experience of the staff members affected by the keyboarding decision. He listened to their opinions and included regular and special education teachers in the decisions. The pilot keyboarding instruction, taught by staff members who were enthusiastic and skilled enough to undertake a reasonable initial effort, was quite successful. These staff members were able to make mistakes without getting discouraged or feeling inadequate, work out some of the problems they encountered, and provide a model and structure for other teachers who might be ready to try teaching keyboarding the next year. Although we can never know for certain, our analysis suggests that the route Ken rejected--mandated, across-the-board implementation of a keyboarding program--might well have led to resentful or overwhelmed teachers and, ultimately, unsatisfactory experiences for students.

Assertion 15

In order for successful technology integration to occur beyond individual classrooms, administrators need to

- **have a vision of the value and potential of the computer in meeting students' instructional needs and curriculum goals; and**
- **understand that integrated technology use implies instructional and organizational changes.**

Several of the assertions in this section deal with making schoolwide decisions about technology integration that affect special education students. Assertion 10 indicates that decisions about hardware and scheduling must be based on goals for students; Assertion 11 illustrates how decisions about technology can fizzle unless someone committed to the decision, often an administrator, monitors the implementation of a technology-related decision; and Assertion 14 shows how implementation of decisions about technology must take into account teachers' varying needs and strengths. All these assertions involve administrators taking active roles. Although a few of the administrators who have taken on important roles in supporting technology integration are technology specialists, many of them--a vice-principal, a special education coordinator, an assistant superintendent for instruction--have quite diverse responsibilities, among which they must continually establish and reestablish priorities. Despite many competing responsibilities, these administrators have become committed to promoting technology integration within their areas of authority because they have come to believe that computers offer significant education opportunities for middle school students.

It appears from this study that at least one such key administrator must be active in the technology integration process and that, in order to act effectively, he or she must have a vision of what technology integration could be and must understand that real integration requires change at both the instructional and the organizational levels. A vision of what is possible, in conjunction with the knowledge that significant change is necessary for that vision to be realized, results in an attitude of determination and persistence in bringing about technology integration. Administrators with this attitude see technology integration as a process that requires effort, energy, and time. They engage in long-term planning, work at expanding the participation and experience of teachers in the technology integration process, and view that process as occurring over an extended period during which changes can be implemented gradually. To be effective, an administrator who chooses to play a key role in technology integration must have vision, expect and support slow but significant change, and have the authority to take steps toward that change.

Over the past six years in Hopeville, the school system has developed a series of reports that specify the system's long-range plans for technology integration in three- or five-year chunks. Developed primarily by Walt, the computer coordinator for the system, but also strongly supported by the assistant superintendent for instruction, these long-range plans offer a vision of the possibilities of technology integration and show an understanding that moving toward this vision requires instructional change. The opening paragraph in the 1988 report, entitled Plan for the Coming Years, states:

> What we teach and how we teach and how we teach it have always reflected the times we live in. Electronic technology, which began as an interesting adjunct to instruction, is gradually changing our notions of what might be taught and how it might be learned.

The reports make recommendations about staff, resources, and training needed to support the goals for technology integration, and they identify ways in which the curriculum can be restructured to take advantage of different tools and approaches made available through the use of computers. The 1988 report describes Hopeville's vision of using technology as a tool in all curriculum areas and grade levels:

> In a number of our classrooms, computers and VCR's are thought of, not as an innovation, but as a normal classroom tool, no different from a textbook or the blackboard. Over the next few years, such normal use of technology should be common to all classroom environments. Every student will write and revise compositions using a word processor. All students will have the capability of carrying out research using CD-ROM disks and video disks to access large collections of text and video images. Students will extend their communications and research skills through the exchange of information with students and scholars from all over the world. In science labs, students will use microcomputers as regularly as they use any other single piece of lab apparatus to collect, display, and analyze laboratory data. Art and music students will employ computer-based electronic tools to create musical scores and to draw in a new "electronic media." Special education students will use their new technological tools to help them overcome physical and learning disabilities that made learning a chore. The critical and creative thinking by students will be further extended through the use of in-house video productions which will incorporate and blend the many different disciplines.

With the support of other committed administrators, Walt has had the authority to carry out the plans across schools. Gradually, over a period of several years, he has involved teachers, provided training, and acquired resources. At the high school, he urged a special education teacher who had no experience with computers to attend a computer education conference at a local college. She reluctantly attended, became excited about some of the special education work she saw there, and, later, supported by Walt, wrote a successful grant to obtain computers and start an innovative "Classroom of the Future" for special education students.

Having designated responsibility for coordinating technology use does not, however, guarantee that an administrator has both a (1) vision of technology integration that relates to students and the curriculum and (2) an understanding of the effort, energy, and time needed to bring about real change. George, a systemwide computer coordinator, teaches programming courses at the high school, supervises all hardware and software purchases for the system, and oversees the implementation of computer use in all schools. Through his efforts, computer labs are in each school, and he is primarily responsible for establishing a computer lab schedule in which teachers are expected to work with their students in the lab once each week at the elementary and middle schools. George is a firm supporter of computers in schools and is personally excited by continuing advances and new possibilities in the technology itself. He reports that he spends much of his time on "new technology," keeping up with recent software and hardware innovations. His decisions and priorities are influenced by his "high tech" view of computer use. George is proud of the high school's offering of computer programming courses that will prepare students for jobs in the high-tech industry. But he argued successfully against the teaching of keyboarding at the elementary school level because of what he sees as the imminent introduction of alternative keyboards, even though the language arts coordinator believed that keyboarding instruction was needed to support more effective integration of the computer as a writing tool.

George certainly has a vision of the significance of technology and the authority to act on this vision within the school system. Still, his vision does not seem to be clearly connected to student needs and curriculum goals, at least at the middle school level. At the middle school, there is very little integrated computer use. Although two mathematics teachers have been given responsibility for coordinating the two computer labs, both have other full-time teaching or supervisory duties, and so there is little ongoing, school-based support for teachers. When a new computer application was being introduced in the school, George sent the two math teachers a training videotape about the application, but no other training was offered by the system. No mechanisms exist for involving teachers in the planning or evaluating of computer use, and little communication takes place between George and the content area or special education coordinators about the integration of technology. Although he is in a position to plan for bringing the computer into the middle school curriculum in significant ways, George has developed neither a vision that is closely tied to the needs of middle school students nor a series of actions to bring about changes that would move the school closer toward technology integration.

We have found that administrators who lack such explicit responsibility for technology integration may choose to promote it if they have both vision and an understanding of what is needed to move toward that vision. At one school, the assistant principal, Ken, like most assistant principals, has primary responsibility for the budget, scheduling, and discipline. "I took it on," he states about his advocacy of computer use at the school. Ken knew nothing about computers until a computer teacher, Robert, was hired at the school. The computer lab was located in what was a shortcut from the main office to a classroom of students with emotional and behavioral problems. Since crises often developed in that classroom, Ken found himself walking through Robert's room frequently. Ken became aware that students in the computer lab seemed fascinated with what they were doing and did not even notice his presence. He decided to participate in a section of Robert's Logo course along with the students. Over the next few years, as computer use grew, Ken saw that teachers were frustrated over limited access to computers. He made up his mind to funnel any available money toward computers over the following three to five years; he hoped to create a second computer lab so that classroom teachers could have access for their classes. Over the years, Ken acquired additional computers by "nickel and diming it," by convincing groups such as the student council to raise money for computers, and by working with Robert to acquire computers both for Robert's lab and for the proposed second lab. The second lab grew gradually until it could almost accommodate a full class. Ken continues to support expansion of computer use and plays a key role in bringing people together to make decisions about maintenance and use of the lab, including the recent efforts to establish keyboarding instruction at the school. His vision of improved education results in concrete efforts to bring about the kinds of changes at an organizational level that will make the possibilities he envisions realities.

A vision of concrete goals related to students' use of technology provides a context and framework for making decisions about next steps in technology integration. Envisioning a goal, even if achieving it appears to be a long way off, allows the construction of a path toward that goal. Even if the path is a long one, progress can be measured by small changes and gradual shifts that close the gap between the reality of the present and the vision of what is possible.

Assertion 16

When there are policies and procedures that promote links between special education and regular education programs, then it is more likely that technology-related curriculum planning and implementation will meet the needs of special needs students.

The final assertion that results from our research returns to our definition of successful integration for the mildly handicapped middle school student. This definition reflects the research team's viewpoint that the ultimate reason for integrating the computer into the education of the mildly handicapped student is to promote that student's "progress and participation in mainstream learning." The computer may actually be used in a variety of settings--for example, in the resource room, in an English or mathematics class, or in a media center--but its effectiveness as a learning tool increases the more closely its use by the student is tied to achievement and self-confidence in the mainstream. To coordinate effective computer use in the sometimes fragmented educational life of the mildly handicapped student who straddles special and regular education settings, links between regular and special education programs are critical. We have found that the closer and more systematic these links, the more likely it is that technology use will truly meet the needs of special education students.

One of our sites provides an ideal example of links between regular and special education that are strong, consistent, and systematic. The Greendale Middle School is divided into "houses" staffed by teachers of different subjects who teach a common group of students. A special education teacher and a counselor are also part of each house. As house staff members, special education teachers perform the same duties as regular education staff--accompanying students on field trips, taking part in fund-raising activities, and serving as house leaders.

House members meet regularly to discuss students, thereby providing special education teachers with a built-in mechanism for sharing their concerns about students with mainstream teachers. The links between departments within the house structure has resulted in some co-teaching. Low-level mathematics classes have been taught by both mathematics and special education departments, and English teachers have combined with special education teachers to teach particular units.

Emphasizing mainstream learning for special needs students is a schoolwide policy. The principal of Greendale Middle School, supported by the systemwide administrator, has been instrumental in promoting links between the special education teachers and the regular education teachers. As the principal stated, "We don't have a tutorial model, where they just come in to do the tutoring and leave; it's a very integrative model." Even the students in the school's two substantially separate programs spend most of their days in regular classrooms. The resource room has been strategically situated in the center of the school and is adjacent to the main computer lab. Because word processing is the focus of the school's computer program, it is important for special education students to have access to computers for their resource room and mainstream work. During the past year, when a full second lab was created, increasing computer access for special needs students was considered a priority in working out the schedule for the new lab. A committee including regular education and special education teachers was formed to oversee the management of the lab.

In explaining the place of special education in the school's culture, the principal offered the following example:

> We have a new teacher in the teaching of special needs this year, who taught at a nearby system . . . for eight years. I asked her just the other day what she saw as the difference, out of curiosity. And she said the major difference is not the kids and not the teachers. It's the fact that no one makes a big deal about the distinction between special ed and regular ed . . . so she doesn't feel like she's in a separate part of the school; she feels like she's just one of the teachers.

The organizational links between special and regular education fostered by the administration at Greendale Middle School are the exception rather than the rule. In the other schools in this study, the special education department and the regular education staff function much more separately. For example, budgets may be distinct for each department, or decisions about curriculum and training may be made by each department without consulting the other.

In some sites, special education teachers may not be members of the team groupings, and so there may not be a regular communication structure that includes special education. The "on the fly" dialogue between teachers does not take the place of ongoing communication regarding curriculum planning and student needs. At one school, the resource room teachers have such full caseloads that they cannot schedule regular meetings with teachers. In one instance, when students were in the middle of a research unit in their mainstream class the resource room teacher was unaware of both the deadlines for the various stages of the assignment and the difficulties individual students were encountering with the report.

In some of the schools, administrators and coordinators have made decisions about training and technical assistance that served to hamper progress toward technology integration for special needs students. In one site, special education teachers were excluded from training sessions on Logo and word processing; when their students were working in the lab with mainstream classes, these teachers were unprepared to offer assistance. Even when technical assistance is readily available in a school, the separate structures of the two departments may prevent special education teachers from availing themselves of these resources. Nancy, a computer specialist, has little involvement with the special education department. The resource rooms in the schools have their own computers and do not use the lab. Nancy remarked, "I don't deal with special ed, except to supplement materials." She seemed unsure as to whether or not her mandate included working with special education teachers. No special education teachers had, in fact, attended Nancy's workshops, although she said that they potentially could.

In each of these schools, individual teachers, both regular and special educators, worked hard to give special education students worthwhile educational experiences through use of the computer. But in most of these cases, the individual classroom experience remained just that--individual, isolated, disconnected within the student's total program. Those aspects of the experience which could have helped students in other situations were not communicated to other teachers or used in other classes. Even if students used the computer in, for example, both the resource room and the social studies class, it was encountered as a different activity in each instance, as different as the textbooks used in the different courses. Only where school policy and structures supported and sustained coordination across special and regular education was technology use consistent in some content areas to bring about special education students' "progress and participation in mainstream learning."

CONCLUSION

The findings of our research on the integration of technology into the educational programs of middle school special needs students are embodied in the sixteen assertions outlined in this chapter. These assertions provide a set of factors that support technology integration. Although teacher knowledge and practice remain in the center, the teacher must be supported by a context that promotes teacher development, fosters collaboration and communication, and provides adequate technology resources. In order for the computer to become a real learning tool for the special education student, it must move beyond the classrooms of one or two enthusiastic teachers to become an available, flexible, consistent part of the student's education. Administrators, teachers, and specialists must work with one another to provide the policies, practices, and structures that put meaningful technology use in place, support and extend teachers' and students' explorations of technology, and encourage review and evaluation of those proceedings.

When schools plan for technology integration, they often plan for acquiring hardware and software, and minimal training. But they may not think about the structures that need to be in place to support the ongoing integration of technology in a way that truly enhances the learning of the special needs student. By illuminating the web of factors associated with successful technology integration, across a variety of schools and classrooms, we hope not only to add to the knowledge base about special education students' computer use but to construct guidelines, principles, landmarks, and approaches that would support a middle school's effort to plan sensibly for its special education students.

It is clear from our data that successful technology integration does not always look the same; it is a continuum of many partial successes rather than a dichotomy between success and failure. Our findings do not lead to a precise sequence of steps towards technology integration. However, the "applicability" (Guba and Lincoln, 1981) of our results is firmly embodied in the assertions described in this chapter, thus connecting Phase I and Phase II of the project. The assertions become guidelines for pursuing technology integration in the sense we have defined it here: sustained use of the computer that supports special needs students' progress and participation in mainstream learning.

CHAPTER 4: A SCHOOL-BASED APPROACH TO TECHNOLOGY INTEGRATION

OVERVIEW OF THE APPROACH

Based on the research findings from Phase I, we have designed an approach to promoting successful technology integration in middle schools. In accordance with our definition, promoting successful technology integration means helping teachers use technology applications in a sustained way with special needs students in their classrooms. It also means promoting the kind of school-based support teachers need to carry out the process. The overall goal of our school-based approach, then, is to promote change at both the organizational and the classroom levels--to enable successful classroom-based technology integration practices to flourish within a supportive school environment.

The school-based approach builds directly on the research findings of Phase I. The key elements of the approach are as follows:

- A Technology Integration Facilitator, a school-based administrator, takes a leadership role in overseeing, monitoring, and putting structures in place to promote successful technology integration.
- A Technology Support Team, a group of pivotal players--teachers, administrators, and specialists from special education, regular education, and technology--collaborate in assessing and responding to the teachers' emerging needs.
- A Trainer, who may or may not be the same person as the Technology Integration Facilitator, carries out the teacher development program.
- Teacher Dyads, pairs of teachers, work collaboratively in peer coaching relationships to acquire new information, support each other's efforts to translate knowledge into practice, and reflect on practice.

- A Module-based Teacher Development Program includes workshops and follow-up activities for the dyads to carry out.

- School-based Facilitation Workshops for the Technology Support Team and other participants are held to ensure that together they identify ways to support the technology integration process.

The Technology Integration (TI) Facilitator

In Phase I we found that in schools that integrated computers most successfully into the curriculum, there was at least one school-level administrator who played a critical role in promoting technology use. Assertions 11-16 describe the types of critical roles these administrators engaged in:

- Helping practitioners establish criteria for making decisions about hardware acquisitions, allocation of resources, and scheduling

- Having a vision of how computers can be used in ways that meet student needs

- Understanding that technology integration implies change at the instructional and organizational levels

- Varying expectations for teachers' use of computers; giving teachers choices and providing them with support

- Putting structures and mechanisms in place to encourage teachers to talk and work together

- Taking the next steps to follow through on decisions

- Creating policies and procedures that promote links between special and regular education programs

- Monitoring and evaluating the process of change

The literature on school-based change strongly supports these roles, and views the principal or other school-based administrator as a central figure in providing leadership and support and in sanctioning technology use with special needs students (Cannings and McManus, 1987; Cox, 1983; Hanley et al., 1984; Sparks, 1983). Consistent with Phase I findings and the supporting literature, we propose that one school-based administrator (this designation includes specialists and coordinators) have overall responsibility for managing, orchestrating, and evaluating the technology integration process.

Technology Support Team

Within the middle schools we studied in Phase I, a group of administrators, specialists, and teachers from special education, regular education, technology, and curriculum development played pivotal roles when computers were integrated most successfully. In those successful cases, these people provided technical assistance to teachers, scheduled access to the computer lab, modified the curriculum to include uses of technology, arranged meetings that facilitated communication among teachers, or ordered software. An administrator who could link mainstream and special education teachers, influence the school's vision, or wield budgetary control was typically a key participant. Within our approach a Technology Support Team, composed of these key people, will meet regularly with the TI Facilitator. Like a "cabinet," they will address technology-related issues and offer advice. This notion is consistent with the "change facilitator team" described by Hord et al. (1987).

Trainer

The Trainer's role is multifaceted. Not only does the Trainer make all the arrangements for the training, provide information, and select the appropriate materials, but he or she also monitors the teacher development process and provides technical assistance. This last item means, for example, conferring with teachers, helping Teacher Dyads complete follow-up activities, and encouraging teachers to translate training experiences into computer-based student activities within their own classrooms.

The Trainer may or may not be the TI Facilitator. If not, then the Trainer is in direct communication with the TI Facilitator and the Technology Support Team, in order to identify ways to support teachers' efforts based on an ongoing assessment of teachers's concerns.

Teacher Dyads

The participants in the Module-based Teacher Development Program will be mainstream teachers (representing language arts and mathematics), special education teachers (who share students with the participating mainstream teachers), and technology specialists/teachers.

Phase I findings indicate that, across schools, having teachers work in pairs is a powerful learning strategy, corroborating conclusions in the literature on peer coaching (Garmston, 1987; Legget and Hoyle, 1987; Showers, 1985; Wu, 1987). Assertions 3, 6, 8, and 9 emphasize the important role collaboration and communication play in teacher development. Where teachers are working together and reflecting on their teaching, giving each other emotional support and reassurance, choosing and trying out software, and together talking about their students in terms of curriculum goals and teaching practices, they are also likely to be using computers more effectively. A dyad might consist of a regular and a special education teacher who share the same students, two content area teachers, or a teacher (mainstream or special education) and a computer teacher.

Module-based Teacher Development Program

Assertion 7 argues that inservice workshops alone are insufficient for helping teachers to acquire new knowledge and to translate that knowledge into practice. Joyce and Showers (1982) recommend that a comprehensive teacher training program include several cycles of new knowledge and ongoing support to help teachers translate knowledge into instructional strategies. Kuerbis and Loucks-Horsley (1988) endorse staff development programs that require teachers to test out ideas in their classrooms. Teacher training that involves theory alone has been found to result in only 5 to 10 percent implementation, whereas adding hands-on practice and individual coaching results in 90 percent application of new skills (Joyce and Showers, 1983).

Drawing on our own findings and on the literature concerning staff development, we have designed the training around cycles of "learning/learning by doing" so that teachers gradually acquire and integrate knowledge about special needs students, curriculum, and technology. Each cycle, or module, includes a set of activities geared to training, follow-up, peer coaching, and technical assistance. A set of sequentially ordered modules will form the core of the teacher development program, with each module addressing a separate issue or aspect of the technology integration process at the classroom level. Each module will build on the previous one(s). A tentative sequence is as follows:

- Module 1--identifying places within the curriculum where technology might make a contribution
- Module 2--assessing special needs students
- Module 3--selecting software that meets the assessed needs of students
- Module 4--developing effective instructional strategies based on software features and student needs

- Module 5--helping teachers engage in the ongoing and interactive processes of observing-reflecting-intervening

Each module will include two components: (1) a workshop and (2) postworkshop follow-up activities to ensure that practitioners expand their knowledge base, translate new knowledge into practice, and reflect on practice.

Workshops

Each workshop will be divided into two parts. The first part will include a teaching case and discussion questions, in the tradition of the case method used at the Harvard Business School (Christensen, 1987). Drawn from the Phase I research cases dealing with instructional issues, these teaching cases will serve as the catalyst for reflection and analysis. The Trainer's role will be to facilitate discussion so that practitioners relate the case episode to their own situations, identify relevant problems, and recognize possible strategies for their own classrooms.

During the second part of the workshop, teachers will engage in activities aimed at helping them make the transition from generating ideas to gaining new information to actually planning action steps for their own classrooms. Depending on the direction of the discussion following the case (e.g., what area was identified as requiring attention), the Trainer will select a relevant activity for the group from a pool of three or four possible workshop activities.

Postworkshop Follow-up Activities

The purpose of the follow-up activities will be for the Teacher Dyads to test out new practices within a supportive context, shortly after having attended a workshop. Once again, the Trainer will tailor these activities to participants' needs and interests and will provide technical assistance.

School-based Facilitation Workshops

One strong finding of Phase I is that teachers and administrators need to meet on a flexible basis to discuss emerging issues, solve problems, and make decisions. The training program is designed to encourage these issues to surface and become active discussion topics. Issues may relate to improving computer access, selecting and purchasing software, supporting mainstream/special education collaboration, or modifying the curriculum to include computer applications. To elicit and address these issues, the Technology Support Team will intermittently attend workshops along with the regular participants of the Module-based Teacher Development Program. The timing and agenda of these workshops will depend on the teachers' emerging needs. Together, the Trainer and the TI Facilitator will be responsible for identifying when these more "ad hoc" workshops should take place. The workshops will follow the same two-step format as the teacher development workshops: (a) discussion of a teaching case and (b) follow-up activities. The Trainer and the TI Facilitator will select relevant cases from a "library" of cases.

Several national initiatives have identified the need to strengthen community building and teamwork among staff in middle schools (Carnegie Report, 1989). These elements of the approach respond to that need, providing a collaborative context for using computers in instruction.

We have operationalized the school-based approach in an intervention that middle schools can implement over the course of one school year. Below we describe the product that will embody this approach. Titled Integrating Computers into the Curriculum: A School-based Approach to Technology Integration for Middle School Special Needs Students, the product will be developed, field-tested, and produced in Phase II (see Chapter 5). The school-based approach will be presented in two manuals: an Implementation Manual and a Training Manual. The goal of the Implementation Manual is to promote school-based facilitation of teachers' efforts to integrate technology into the curriculum for special needs students. The Training Manual will focus on teacher development; its goal is to help mainstream and special education teachers successfully integrate technology into language arts and mathematics instruction. The two manuals are closely linked in order to foster strong interaction and support between the organizational and instructional levels.

THE IMPLEMENTATION MANUAL

Goals

The overarching goal of the Implementation Manual is to help the TI Facilitator, in collaboration with the Technology Support Team, facilitate teachers' efforts to successfully integrate technology into the curriculum. Based on the Phase I findings, a more specific set of goals for this manual is to help practitioners

- develop a shared vision of successful technology integration and a commitment to translating the vision into practice
- create a forum to address issues surrounding the acquisition of, allocation of, and access to computers and software
- determine the school's need for resources, collaboration, training, and leadership

- institute and support a training program
- create structures and mechanisms to facilitate communication and collaboration among staff
- examine and strengthen policies and procedures that promote links between special and regular education
- monitor the outcomes of decisions and evaluate the changes at the school and classroom levels

Content of the Implementation Manual

Exhibit 3 displays a tentative table of contents for the Implementation Manual. As shown, the first part of the manual presents an overview of the school-based approach; the second part sets forth guidelines to help the TI Facilitator address logistical issues in start-up; the third part contains guidelines to help the TI Facilitator support successful computer use; and the fourth part provides additional information and resources.

Overview of the Approach

Defining Successful Technology Integration. The first section of the manual defines successful technology integration, using vignettes drawn from Phase I case materials as images of what is possible.

Describing the Elements of the School-based Approach. This section describes the key characteristics of the approach and shows how they were derived from Phase I findings. The section also presents a discussion of the concepts underlying the major characteristics of the approach: the role of the TI Facilitator, the role of the Technology Support Team, the rationale for teachers working collaboratively in dyads, the design of the Module-based Teacher Development Programs, and the purpose of the School-based Facilitation Workshops.

IMPLEMENTATION MANUAL

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* Tentative

Getting Organized

Forming the Technology Support Team. This section guides the TI Facilitator in forming the Technology Support Team by drawing together key players in technology use with special education students.

Conducting a Needs Assessment. This section guides the TI Facilitator and the Technology Support Team in conducting a needs assessment. The goal is for them to develop a tailored agenda that reflects the school's needs and to set priorities for using computers in ways that benefit all students, including mildly handicapped students in the mainstream.

Organizing the Training Program. This section guides the TI Facilitator in planning and organizing the training. These guidelines focus on identifying a qualified trainer (the trainer may or may not be the same person as the TI Facilitator), accumulating software and hardware, and scheduling the workshops across an academic year. The guidelines will also help the TI Facilitator (in collaboration with the Trainer) organize teachers into dyads by taking into account personal and professional relationships (e.g., teachers who share students, are on the same team, or are friends).

Recommended Timeline. Suggested timelines will recommend when certain events and activities should take place across the school year. They will indicate, for example, when the TI Facilitator should arrange and institute the teacher development program, form the Teacher Dyads, and schedule meetings with the Technology Support Team.

School-based Facilitation

Promoting Communication and Collaboration. This section guides the TI Facilitator in promoting communication and collaboration among the members of the Technology Support Team, the dyads, the TI Facilitator, and the Trainer. The guidelines identify the focus of communication (e.g., student needs, curriculum goals, procedures that link special and regular education), outline strategies to enhance communication and collaboration, and give tips for locating hidden pockets of time for meetings within the middle school schedule.

Ensuring Access to Technology Resources. This section first presents guidelines for making effective technology-related decisions--that is, for making, carrying out, and monitoring decisions related to giving teachers access to the hardware and software they need, as well as access to technical assistance. The section then sets forth guidelines for scheduling the School-based Facilitation Workshops in response to teachers' emerging needs.

Evaluating Change: Organizational and Instructional Levels. This section guides the TI Facilitator and the Technology Support Team in recognizing, appreciating, and responding to change. Phase I has confirmed our initial assumptions that technology integration is a complex process that evolves over time (see Year I Report, Zorfass et al., 1987). One goal here is to ensure that administrators acknowledge the small incremental changes that take place as the technology integration process evolves and that they set realistic expectations for change. A second goal is for the TI Facilitator and the Technology Support Team to be ready to respond to change. Phase I findings indicate that administrators need to understand that integrating technology implies change at both the organizational and the instructional levels. For example, there may be a need to modify the curriculum, the policies governing placement of mildly handicapped students, or the ways in which teachers work together when computers enter the classroom.

Resources and References

This last section provides information and extension activities to ensure that the technology integration process continues to evolve beyond the year-long intervention. It identifies ways for teachers to network with others through, for example, SpecialNet; provides listings of annual conferences; and gives information about clearinghouses that disseminate information related to computer use. It will also provide lists of recommended software for various content areas.

THE TRAINING MANUAL

Goals

The Training Manual will focus on promoting teacher development. At the heart of our conceptual framework for integrating technology are three assertions concerning teacher practice, knowledge, and reflection (Assertions 1-3). These assertions translate into the following set of goals for teachers:

- To acquire knowledge and translate it into practice--knowledge about the potential contribution technology can make to special needs students' learning, the strengths and weaknesses of special needs students, curriculum content, instructional strategies, assessment strategies, and hardware and software
- To be actively involved in students' use of software--setting a context for instruction, engaging in ongoing observation, reflecting on students' performance, intervening as necessary, and linking computer activities to broader goals

- To be engaged in ongoing reflection about one's own instructional use of technology so as to critically evaluate practice and redesign instruction for better meeting student needs and curriculum goals

Content of the Training Manual

Exhibit 4 presents a tentative table of contents for the Training Manual, with its four major parts: General Guidelines to the Trainer, Teacher Development Modules, School-based Facilitation Workshops, and Supplementary Materials for Teachers.

General Guidelines to the Trainer

The Training Manual will include background and orientation materials to help the Trainer successfully carry out the workshops. This information includes, for example, the rationale for and design of the modules, the Trainer's role, ways to coordinate efforts with the TI Facilitator (e.g., scheduling modules and School-based Facilitation Workshops, locating and gathering resources), principles of adult training, ways to facilitate peer coaching, effective use of the case method (including discussion strategies), and ways to evaluate the teacher development program.

Teacher Development Modules

Each module will provide directions to guide the Trainer in preparing for implementing and evaluating the teacher development program as follows:

- Preparation--helping the Trainer to familiarize himself or herself with cases and follow-up activities; gather necessary resources; arrange for computers; hand out materials, such as a cases for review prior to workshops; assign tasks to teachers in preparation for workshops; and select relevant teaching cases.

Exhibit 4

TRAINING MANUAL

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*Tentative

- Implementation--helping the Trainer to use provocative questions to stimulate discussion; facilitate cooperation and communication in peer coaching situations; and select appropriate follow-up workshop and postworkshop activities.

- Evaluation--helping the Trainer to determine whether the cases have stimulated thinking; whether there was a link between the case and follow-up activities; whether there was a link between the workshop and postworkshop activities; and whether the Teacher Dyads were able to work collaboratively and support each other.

Each module will also include all the necessary training materials: teaching cases and follow-up activities.

Teaching Cases. Teaching cases, drawn from the Phase I case studies, will be easy to read, range in length from two to five pages, and capture a classroom-based situation. The aim in constructing these cases is to ensure that they are provocative, lend themselves to a variety of perspectives, and have no single "correct" solution. Each workshop will include several cases. The TI Facilitator and the Trainer can select cases that "ring true" with the current needs of workshop participants.

Follow-up Activities. Each module will include the follow-up activities the Trainer will use during or after workshops. For example, in the first module, "Where in the Curriculum Can Computers Play a Role?" participants might first discuss two cases related to word processing. As a follow-up activity during the workshop, teachers might compare their curriculum goals, discuss new ways in which the word processor could be integrated into instruction, and set a goal for one new use of the word processor. The materials to accompany this task might be a "Curriculum Appraisal Form" containing a set of probing questions for teachers to ask one another. After the workshop, the Teacher Dyads will carry out a follow-up activity that might consist of having each member of the pair observe the other to see how word processing actually fitted into the instructional cycle; the accompanying material here might be a form to guide the observation.

School-based Facilitation Workshops

The Training Manual will contain directions and materials for each School-based Facilitation Workshop. The directions will follow the same three-part format as the modules: preparation, implementation, and evaluation. For these workshops the preparation phase will be of particular importance, since the Trainer and the TI Facilitator will need to carefully identify an appropriate topic for the workshop, select the cases to be used, and schedule the date.

For each workshop, the manual will include a pool of cases drawn from the Phase I cases focusing on organizational level issues. In addition, it will contain follow-up activities aimed at creating opportunities for the Technology Support Team and teachers to plan action steps that could later be carried out by the TI Facilitator, the Technology Support Team, and other key practitioners. For example, one activity might be to give participants a list of possible scenarios depicting the need for technical assistance and asking "Who in your school could help with this problem?"

Supplementary Materials for Teachers

These materials might include, for example, lists of software by content area, management strategies related to computer use in classrooms or labs, a form on which to record observations, tips for introducing word processing functions, self-appraisal forms, or tools for tracking the progress of individual students. The underlying goal is to provide teachers with useful resources that contain pertinent information to foster their continued growth and development as technology users.

RELATIONSHIP BETWEEN THE IMPLEMENTATION AND TRAINING MANUALS

The overall goal of Integrating Computers into the Curriculum is to promote school-based facilitation for teacher development. Given that each manual will embody different aspects of the total approach, it is critical that both manuals be designed to promote ongoing interaction between the organizational and instructional levels. For example, the Implementation Manual will guide the formation and work of the Technology Support Team--a collaborative team composed of administrators, specialists, and teachers who play a pivotal role in technology use. This team will meet regularly to discuss technology-related issues, solve problems, tailor and refine the training process to meet the schools' specific needs, and make decisions. It will also guide the TI Facilitator in monitoring the training program, working closely with the Trainer, and keeping abreast of changes at the classroom level.

Further, the Training Manual calls for the Technology Support Team to join teachers in the training workshops that directly address such emerging topics as the types of support teachers need to translate new knowledge into practice. For example, one of these workshops might focus on access--adding computers or making more efficient use of existing computers; others might focus on ensuring technical support during those times when new technology-based instruction is being implemented, or on establishing a schedule and structure that ensures collaboration among teachers.

Given the dynamic interaction between the organizational and instructional levels in technology integration, use of one manual without the other cannot promote successful technology integration. In implementing Integrating Computers into the Curriculum, a middle school must commit itself to an all-encompassing effort to have the practices recommended in one manual support those recommended in the other.

In the next chapter, we describe the technical method for developing, field-testing, and producing Integrating Computers into the Curriculum over a two-year period.

CHAPTER 5: PHASE II TECHNICAL METHOD

OVERVIEW

In Phase II, EDC will develop, field-test, and produce Integrating Computers into the Curriculum. Phase II is designed to have three stages (see Figure 4). Stage 1 involves refining our conceptualization of the approach, the way the approach is embodied in manuals, and the content to be included in the manuals; writing specifications; developing draft manuals; piloting the manuals and having them reviewed by experts; and producing the manuals for field testing after making the recommended revisions. In Stage 2, we will field-test Integrating Computers into the Curriculum in two middle schools to determine (1) how the product can be improved and (2) what its impact is on the technology integration process. In Stage 3, we will produce the product in its final form, develop plans for disseminating it, and prepare the Final Report describing the entire five-year research and development effort, the product, and the plans for dissemination. This chapter describes the major tasks in each stage (see Exhibit 5).

STAGE 1: DEVELOP INTEGRATING COMPUTERS INTO THE CURRICULUM

In Stage 1, we will develop Integrating Computers into the Curriculum. Tasks 1-3 are concerned with refining the conceptualization; Tasks 4-7 with creating the product for field testing. The timeline for Stage 1 is shown in Figure 5.

Task 1: Gather and Synthesize Information

In order to refine our conceptualization of the approach, the way in which the approach is embodied in manuals, and the content of the manuals, we will gather and synthesize information from a

Figure 4

PHASE II STAGES

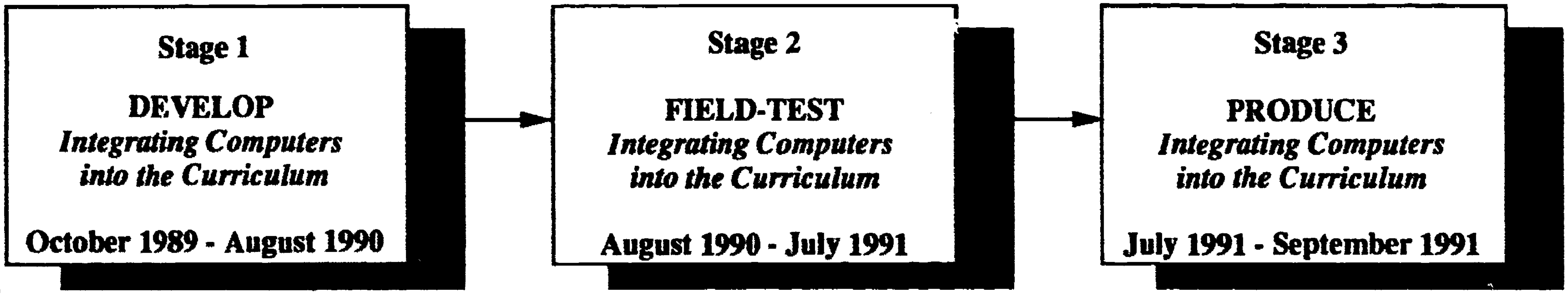


Exhibit 5

PHASE II TASKS

STAGE 1: DEVELOP INTEGRATING COMPUTERS INTO THE CURRICULUM

Task 1: Gather and Synthesize Information
Task 2: Hold Advisory Panel Meeting
Task 3: Meet with OSEP
Task 4: Prepare Specifications
Task 5: Prepare Manuscript
Task 6: Pilot-test and Review by Experts
Task 7: Revise and Produce for Field Test

STAGE 2: FIELD-TEST INTEGRATING COMPUTERS INTO THE CURRICULUM

Task 8: Conduct Field Test
Task 9: Report Results

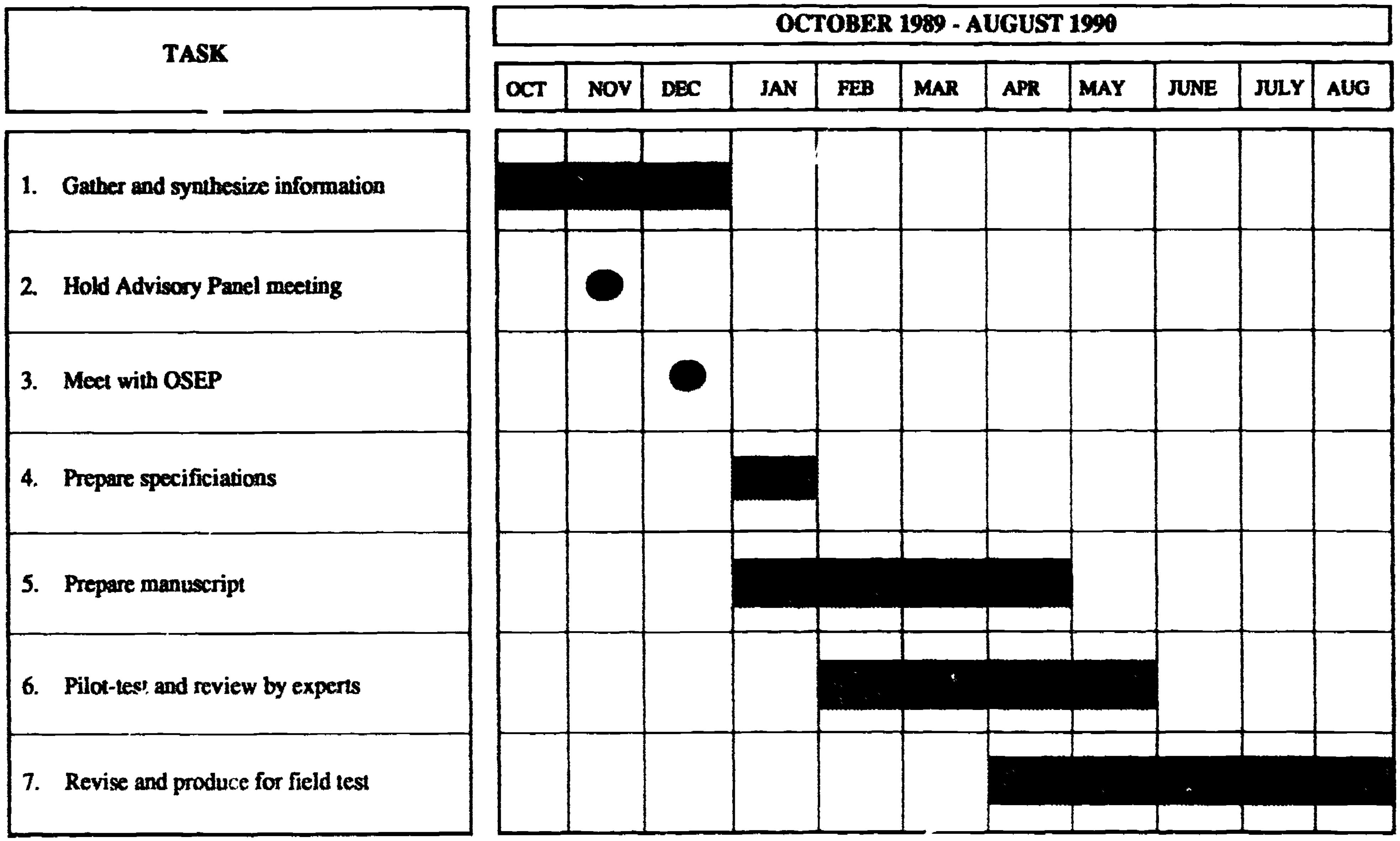
STAGE 3: PRODUCE INTEGRATING COMPUTERS INTO THE CURRICULUM

Task 10 Hold Advisory Panel Meeting
Task 11: Meet with OSEP
Task 12: Produce Integrating Computers into the Curriculum
Task 13: Prepare Final Report

EVALUATION

Task 14: Implement Performance Measurement System

Figure 5
STAGE 1 TIMELINE



variety of sources. First, we will continue to review the literature on promoting school-based change and teacher development. Second, we will confer with potential publishers of the product to determine their assessment of market needs and to discuss possible formats for packaging. Third, we will review manuals, implementation guides, and reference books developed and produced by others to guide school-based change and teacher development in technology use.

Task 2: Hold Advisory Panel Meeting

During the second month, we will hold an Advisory Panel meeting at our Newton offices. The advisors will be potential users of the product, such as principals, trainers, and district- and school-level technology experts. In preparation for the meeting we will provide the advisors with relevant information from the Phase I Final Report (Zorfass et al., 1989) so that they can review the results of Phase I, understand how the approach embodied in Integrating Computers into the Curriculum builds on Phase I findings, and become familiar with our preliminary conceptualization of the format and content of the Implementation and Training manuals. At the Advisory Panel meeting, we will share our most current thinking about the manuals, informed by our literature review and appraisal of other products. The major part of the meeting, however, will be devoted to having advisors respond to our ideas and generate suggestions for product design. Within ten working days of the meeting, we will submit a report to OSEP summarizing the key recommendations emerging from the discussion of product design

Task 3: Meet with OSEP

The Year 4 Annual Meeting at OSEP, to be attended by the principal investigator, the project director, and the Contracting

Officer's Technical Representative (COTR), will be held after the Advisory Panel meeting and within the first quarter of Year 4. Agenda items will include (1) discussing the overall design of Years 4 and 5 and (2) refining the conceptualization of Integrating Computers into the Curriculum, based on the information we have been gathering and on the advisors' recommendations. A summary of the meeting will be prepared and submitted to OSEP within fifteen working days.

Task 4: Prepare Specifications

In this task we will translate our refined conceptualization of the product into a detailed set of specifications to guide development. Specifications will describe

- the overall goals of each manual
- how the approach will be operationalized
- the content to be included
- the format

The specifications will pay attention to product design, including the overall format of the manuals and any design features such as illustrations and graphics that must be incorporated in the final camera-ready copy. Well-designed products have a number of advantages. They can

- create clarity and help get the message across
- create consistency in presentation, thereby eliminating any confusion
- enhance the materials by giving them style and making them eye-catching
- increase readability
- simplify use and production

The specifications will be as detailed as possible to provide the foundation needed to prepare the manuscript.

Task 5: Prepare Manuscript

Working directly from the specifications, we will develop the manuscript for the manuals. We will work on both manuals simultaneously to ensure that the links between them are as strong as possible. The project director, research assistants, and writers will all contribute to the writing, each taking responsibility for separate components or sections of the manuals. Each person's work will be reviewed by other writers, and the entire team will meet frequently to ensure that a coherent product is being developed.

Task 6: Pilot-test and Review by Experts

Product components will be evaluated as they are developed. As relevant and appropriate, they will be pilot-tested in middle schools and reviewed by experts. We will identify two school districts to serve as pilot-test sites: a middle school that has already participated as a field site in Phase I of the project and a new site. We will identify the new site based on our extensive network of schools involved in past and present EDC projects. The review panel of experts will be composed of those practitioners who attended the Advisory Panel meeting in Task 2, as well as others. We will identify other experts by asking the Advisory Panel for recommendations, by contacting practitioners participating in EDC projects, and by contacting colleagues around the nation involved in technology and special education research. For example, as soon as a section of the Implementation Manual is completed, we will send it out for review to administrators and technology specialists; as we finish a module in the Training Manual, we will ask schools to pilot-test it with teachers. Every component of each manual will undergo outside evaluation; some components will be both pilot-tested and reviewed.

When a component is sent to reviewers or given to a school for pilot testing, it will be accompanied by a feedback form. This form will ask users or reviewers to respond to a set of prompting questions and to include their own reactions in an open-ended section. We will ask the evaluators to return the forms to us, and once the forms are received, we will analyze the comments and recommendations.

Task 7: Revise and Produce for Field Test

Based on our analysis of the feedback, we will decide what changes are to be made in the manuals. If there are major discrepancies in reviewers' evaluations, we will confer with members of the Advisory Panel to resolve those issues. We will discuss the recommended changes with the COTR in a telephone conference. Once agreement has been reached, we will make the final revisions and produce camera-ready copy. The EDC print shop will print the manuals in preparation for field testing.

STAGE 2: FIELD-TEST INTEGRATING COMPUTERS INTO THE CURRICULUM

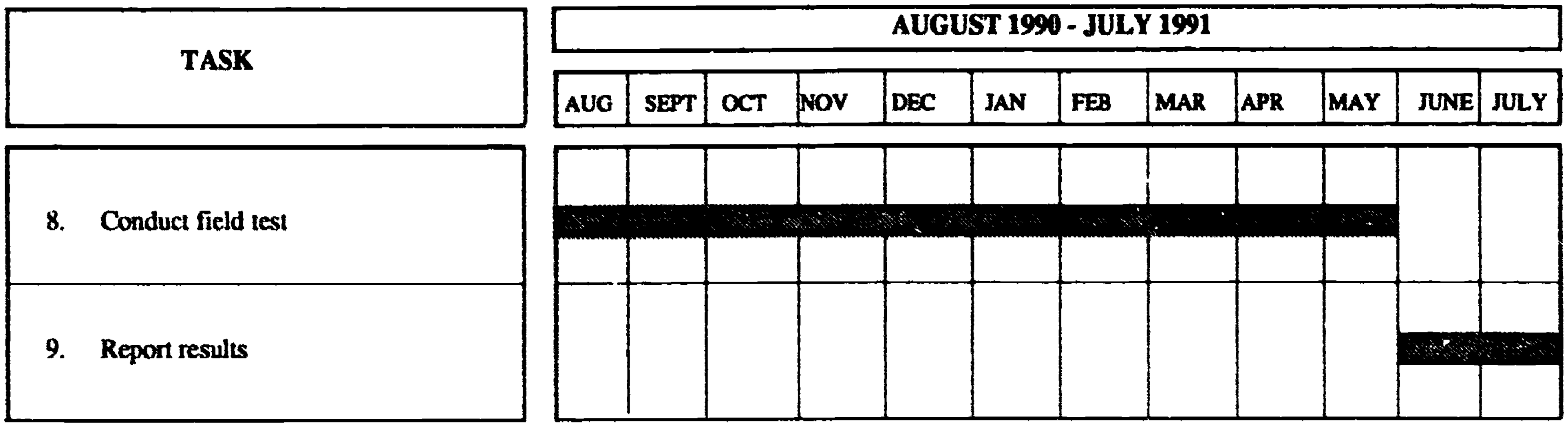
There are two main tasks in this stage:

- Conduct field test
- Report results

Figure 6 presents the timeline for Stage 2.

Figure 6

STAGE 2 TIMELINE



Task 8: Conduct Field Test

Preparations for field testing will begin during the last three months of Stage 1, concurrent with developing the manuals. During that time, we will contact potential sites and finalize site selection (see the criteria below). We will also develop and pilot-test the instruments to be used for data collection, such as the interview protocols.

Below we discuss the research approach, the research questions, the sample, the data collection procedures, and the data analysis for the field test.

Research Approach

During field testing, the research team will become "sufficiently part of the situation to be able to understand personally what is happening" (Patton, 1976). The validity and reliability of our data rest on building a trusting and mutually beneficial relationship that encourages users of Integrating Technology into the Curriculum to reveal ongoing processes to the researchers (Lincoln, 1985). The field test will have two conditions: with technical assistance (TA) and without TA.

In one site, the research team will go beyond participant observation to provide TA in ways that respond to the expressed needs of participants or in ways that prod the process (Morocco and Zorfass, 1988). This approach might consist of coaching, debriefing, or nudging--for example, clarifying what is meant in the manual, meeting with the Trainer to discuss the workshops, or prompting the TI Facilitator to schedule a meeting with the Technology Support Team. Whenever TA is given, the researcher will record when the assistance took place, the type of assistance given, and the outcome (as appropriate). Two research assistants will be assigned to the site receiving TA; one will intervene as the TA provider, and the other will be the objective observer and interviewer. Separating these roles in past projects has increased our ability to make clear comparisons. In the non-TA condition, the researcher will observe the process and refrain from intervening.

Research Questions

There are two sets of research questions: one set guides the formative evaluation of the school-based approach and the second set guides the investigation of the impact of the approach on the organizational and instructional levels. As shown in Exhibit 6, the formative evaluation questions focus on how participants use and respond to Integrating Computers into the Curriculum. The goal in asking these questions is to understand whether the set of materials is working as intended, and to identify ways it can be improved (Patton, 1986; Scriven, 1967; Weiss, 1972). Results will be used to revise the product. Questions concerned with investigating the impact of the approach (see Exhibit 7) focus specifically on how the intervention affects teacher development, access to technology resources, communication and collaboration among practitioners, and school-based facilitation (Loucks-Horsley et al., 1987; Rossi and Freeman, 1985).

Sample

Sites. We will include two middle schools in our sample. Given that the field test has two conditions (with and without TA), we will try to match schools to the extent possible in order to make meaningful comparisons. We recognize that with only two sites, generalizeability is an issue. Accordingly we will select middle schools that reside in low- to middle-income communities, have diverse student populations, are committed to using technology to

Exhibit 6

RESEARCH QUESTIONS: EVALUATION OF THE APPROACH

1. Are the guidelines to the TI Facilitator in the Implementation Manual useful and relevant
   - for start-up?
   - for promoting communication and collaboration?
   - for planning and supporting training?
   - for facilitating access to technology resources?
   - for linking special and regular education?
   - for monitoring and evaluating change?

2. Does the TI Facilitator need additional support for carrying out his or her role and responsibilities?

3. In the Training Manual, are the general guidelines to the Trainer useful and relevant?

4. For each module, are the directions to the Trainer clear and helpful?

5. Do the cases elicit discussion that lead practitioners to reflect, identify problems, and suggest action plans to solve problems?

6. Do the follow-up activities logically follow the cases?

7. Do the follow-up activities promote peer collaboration?

8. Do the dyads have enough support to carry out the activities, or do they need additional support?

9. Are directions to the Trainer for the School-based Facilitation Workshops clear and helpful?

10. Is there enough coordination between the TI Facilitator and the Trainer in order for them to jointly schedule the workshops on an as-needed basis and to select an appropriate topic?

11. Are the organizational-level cases for the workshops useful and relevant?

12. Does the Trainer need training or technical assistance in planning, carrying out, or evaluating the modules or workshops?

13. Are the supplementary materials for teachers useful and relevant?

14. Do the manuals foster communication and coordination between the TI Facilitator and the Trainer?

Exhibit 7

RESEARCH QUESTIONS: IMPACT OF THE APPROACH

1. What is the effect of the intervention on teacher development?

- Have teachers acquired knowledge (e.g., about technology, curriculum content, instructional strategies, special needs students, assessment) and translated this knowledge into practice?
- Are teachers actively involved in special needs students' use of software?
- Do teachers engage in ongoing reflection to modify instruction to better meet student needs and curriculum goals?

2. What is the effect of the intervention on access to technology resources?

- Is someone responsible for ensuring that hardware is kept in good working condition and that technical problems are solved as they arise?
- Is there a mechanism for helping teachers narrow down the choices of software?

3. What is the effect of the intervention on communication and collaboration among practitioners?

- Do novice computer users have someone to turn to for knowledge and emotional support?
- Do teachers work together collaboratively to try out software?
- Do regular and special education teachers engage in ongoing communication that focuses on curriculum goals, instructional strategies, and student needs?

4. What is the effect of the intervention on school-based facilitation?

- Do decisions about hardware acquisition, allocation, and scheduling focus on curriculum goals and teacher experience and expertise, in addition to emphasizing equity and access?
- After the school makes a technology-related decision, is there someone who takes the next steps to ensure follow through?
- Do teachers and administrators communicate with each other during implementation of a technology-related decision to determine whether the decision is working or needs to be revised?
- Do administrators put structures in place so that teachers can communicate and collaborate on a regular basis?
- Do administrators vary expectations for teachers' use of technology according to teachers' individual needs, interests, and abilities and give teachers choices about when they will use technology?
- Do administrators have a vision of successful technology integration and an understanding that technology use implies instructional and organizational change?
- Are there policies and procedures that promote links between special and regular education?

enhance the learning of mildly handicapped students, and have an established program of computer use in operation for at least three years.

Site selection will be a three-step process. Step 1 involves screening potential sites according to the criteria listed above. We will follow two routes in identifying potential sites: (1) contacting sites that have participated in Phase I or (2) contacting new sites. We will consider two Phase I sites, Hopeville and Riverton, since they meet the above criteria. In terms of locating new sites, several local school districts have recently approached us about volunteering as sites and we can also draw on the extensive network of schools affiliated with other past and present EDC projects. Step 2 involves a second-round screening according to the following criteria:

- The school system is willing to participate for one academic year, beginning in August and running until June.
- The school is willing to carry out a training program, provide staff with meeting time, and support peer coaching.
- The school is currently implementing technology as part of classroom instruction in language arts and mathematics.
- Teachers have access to computers and software, as well as to experts and specialists in technology and special education.
- One administrator is willing to serve as the TI Facilitator.
- Teachers, specialists, and administrators are willing to participate as members of the Technology Support Team.
- Teachers are willing to work in dyads.
- Someone is willing to serve as the Trainer.

Step 3 will be to identify two sites from the remaining candidates. We will (1) consider each site in terms of its size, location, economic status, educational goals, student population, and level of technology use with special needs students and then (2) select two sites that are as similar as possible.

Participants. The participants will include the TI Facilitator, the Technology Support Team (teachers, specialists, administrators), the Trainer (if separate from the TI Facilitator), and the teachers involved in the training. This last group will include mainstream language arts and mathematics teachers, special education teachers, and computer specialists/teachers.

Data Collection Procedures

We have designed an approach that will allow us to collect data about (1) the context, (2) the process being carried out, (3) the impact, and (4) the users' evaluation of the product.

- Context. For each site, we will collect demographic and programmatic information about the school's size, location, economic status, educational goals, student population, and level of technology use with special needs students. In addition, we will collect data about the roles and responsibilities of key players, the mechanisms for communication and collaboration among staff, the availability of technical assistance, and access to computers and software.
- Process. We will collect data about who was involved in the intervention, what components were used, who used them, and how often they were used.
- Impact. We will collect information about changes in teacher development, access to technology resources, communication and collaboration, and school-based facilitation. Exhibit 8 lists the expected outcomes in each category.

Exhibit 8

EXPECTED OUTCOMES

Teacher Development

- Teachers translate knowledge (e.g., technology, special needs students, curriculum content, instructional strategies, assessment) into instructional practice.
- Teachers are actively involved when special needs students use software.
- Teachers reflect on practice with others on a regular basis.

Access to Technology Resources

- Someone has responsibility for hardware maintenance and upkeep.
- A mechanism is in place to help teachers narrow down software choices.

Collaboration and Communication

- Novice computer users have support—someone to help them acquire knowledge and provide emotional support.
- Teachers work together collaboratively to try out software.
- Regular, ongoing communication between special education and regular teachers focuses on curriculum goals, instructional strategies, and student needs.

School-based Facilitation

- Technology decisions are based on criteria that involve curriculum goals, teacher experience, and expertise, in addition to equity and access.
- Someone follows through on technology decisions.
- Administrators and teachers communicate during implementation of decisions.
- Administrators put structures in place to foster ongoing communication and collaboration among staff.
- Administrators vary expectations for teacher(s) use of technology.
- Administrators develop a vision of successful technology use and understand the implications for instructional- and organizational-level change when programs to promote technology use are initiated and sustained.
- Administrators develop policies and procedures to promote links between special and regular education.

- User's Evaluation. We will collect data about users' perceptions of the materials and their recommendations for improvement.

The methods of data collection will include observation, interviews, questionnaires, document collection, and feedback forms. Table 5 shows which procedures will be used to gather each type of data.

Observation. In both sites, we will observe the Technology Support Team meetings, the workshops and follow-up activities from the teacher development program, and the School-based Facilitation workshops. In order to follow teacher development, we will observe each participating teacher five times as he or she uses approaches and activities from the workshops. These observations will center on the teacher's interaction with two "focal" special needs students identified by the teacher and researchers together.

During all observations, researchers will take brief written notes so that they can devote their attention the proceedings of meetings or workshops or to the classroom practices and interactions between teachers and focal students. Immediately after an observation, researchers will record detailed information, including their interpretations, on an audiotape. Using their notes and the tape to jog their memory, they will write detailed field notes.

Interviews. We will conduct two semistructured interviews with the TI Facilitator and the Trainer, as pre- and postmeasures. The interview questions will focus on these individuals' roles and responsibilities, their view of technology integration within the school, and their perception of what facilitates change.

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Table 5

PROCEDURE	TYPE OF DATA			
	Context	Process	Impact	Evaluation
Observation	√	√	√	
Interviews	√	√	√	√
Questionanires	√	√	√	√
Document collection		√	√	
Feedback forms				√

The teachers involved in the training will be interviewed on an ongoing basis. Researchers will conduct follow-up interviews after each of the five classroom observations. Teachers will be asked (1) to reflect on planning, implementing, and evaluating instruction and (2) to identify ways in which collaboration and communication with others in the school, access to technology resources, training, and school-based facilitation are affecting the way they carry out computer-supported activities with special needs students.

Researchers will take brief written notes on a semistructured interview schedule. All interviews will be tape-recorded and the tapes reviewed as researchers summarize the interview.

Questionnaires. Participants will fill out questionnaires both before the intervention begins and again when it ends. These questionnaires will focus on participants' perception of the technology integration process at the school and classroom levels.

Document Collection. To study instructional change at the classroom level, we will collect the materials teachers used during the workshops and follow-up activities, their lesson plans, and student work samples. To study the process at the organizational level, we will collect meeting notes from Technology Support Team meetings, memos, and materials used in the School-based Facilitation Workshops.

Feedback Forms. Each time participants use one of the components of the manual, we will ask them to fill out a feedback form to identify which component was used, when it was used, and whether it was used individually or in collaboration with others. The form will contain a series of questions focusing on relevancy, effectiveness, and usefulness of components of the manuals; in addition, it will have a section asking for suggestions for improvement. We will transfer comments from these forms onto an overall coding form.

Data Analysis

The goal of the analysis is to develop a set of recommendations for revising the product, based on the users' evaluation and the impact the product has had on the technology integration process. In analyzing the field notes, summaries of the interviews, documents, and summaries of feedback, we will look for when, why, and how the components of the manuals were or were not used and what evidence indicates whether those components had an impact on the process. We will also study the users' evaluations of the materials. Our qualitative analysis will be guided by the following questions:

- Can the materials be implemented without TA? If not, what type of support is needed? Would there be a need for outside consultants, a training-of-trainers program, or training institutes?

- What characteristics of the approach facilitate technology integration--for example, having a TI Facilitator? having a Technology Support Team? having a module-based training program that includes workshops and follow-activities? having teachers work in dyads to try out practices, reflect, and support each other?

- What impact does Integrating Computers into the Curriculum have on teacher development? access to technology resources? communication and collaboration among staff? school-based facilitation? Within this category we will make the following comparisons:

  How do the teacher and administrator practices at the end of the intervention compare with practices before the intervention was implemented? How does the impact of the intervention in one site compare with that in the other? Was the impact greater in the site where outside TA was available?

How does the impact of the intervention on administrators compare with the impact on teachers?

What is the impact of having the Trainer be a different person than the TI Facilitator?

- How can the materials be revised and improved so that they better meet users' needs and are as effective as possible?

The product of the analysis will be a set of recommendations for revising the manuals.

Task 9: Report Results

The report of the field test will include four brief chapters: Chapter 1, "Overview of the Intervention"; Chapter 2, "Methodology"; Chapter 3: "Results"; and Chapter 4, "Recommendations for Revisions." We will submit the report to OSEP and to a group of advisors, requesting that both bodies review the report in preparation for the annual OSEP and Advisory Panel meetings (see Tasks 10 and 11 below).

STAGE 3: PRODUCE INTEGRATING COMPUTERS INTO THE CURRICULUM

In Stage 3 we will revise Integrating Computers into the Curriculum based on the field-test results and recommendations from advisors and OSEP. Our aim will be to ensure that the final product, based on the fruits of a five-year research and development effort, reaches a national audience of middle schools. To that end, from the outset of Year 4 we will be in contact with potential publishers of the product and with representatives from organizations having dissemination capabilities. By the time Stage 3 begins, we expect to have solidified publishing plans. Then, during Stage 3 we expect to develop a dissemination plan in conjunction with the publisher and representatives of organizations that can reach middle schools, curriculum, special education, and technology audiences (e.g., CEC, ASCD, and the National Association for Middle Schools). Below we describe the tasks we will carry out to ensure that we meet these goals. The timeline for Stage 3 is shown in Figure 7.

Task 10: Hold Advisory Panel Meeting

We will convene the Advisory Panel in Year 5 to evaluate the recommendations for revision based on the field-test results. We will invite (1) advisors who attended the Advisory Panel meeting during the previous year when we discussed the initial conceptualization of the product and (2) reviewers who evaluated the product in Stage 1. In addition, if we have reached agreement with a publisher to publish the product, one or more of its representatives will also be invited to attend the meeting and participate in the discussion of the revisions. A summary of the primary recommendations will be sent to OSEP within ten working days of the meeting.

Task 11: Meet with OSEP

The Year 5 Annual Meeting with OSEP will have two main purposes: (1) to reach agreement on revisions and (2) to discuss dissemination efforts. Those attending the meeting will include the COTR, the principal investigator, the project director, representatives of the publishing company, and members of organizations having dissemination capabilities. A summary of the recommendations for revision and dissemination will be prepared within fifteen days of the meeting.

Figure 7

STAGE 3 TIMELINE

TASK	JULY 1991 - SEPTEMBER 1991		
	JULY	AUG	SEPT
10. Hold Advisory Panel meeting	●		
11. Meet with OSEP		●	
12. Produce *Integrating Computers into the Curriculum*	▬	▬	▬
13. Prepare Final Report		▬	▬

Task 12: Produce Integrating Computers into the Classroom

Revisions will be based on the recommendations contained in the field-test report, and on those made by the advisors and OSEP. Once the revisions are made, we will produce camera-ready copy of Integrating Computers into the Curriculum.

Task 13: Prepare Final Report

By the middle of Month 59, we will prepare a draft Final Report for submission to the COTR, including the following:

- An overview of the five-year research and development effort
- An overview of Integrating Computers into the Curriculum
- A summary of plans for publication and dissemination

The draft report will be sent to the COTR for review and revised accordingly. In Month 60, we will submit the Final Report to OSEP.

EVALUATION

Task 14, spanning both years of Phase II, consists of implementing the performance measurement system. We will continue using the same system used in Phase I. Each month we will submit to OSEP a narrative of the progress attained within the relevant tasks and will provide monthly reviews of the budget and expenditures to ensure that the project is spending at an appropriate level and rate for the tasks.

There are two methods by which OSEP will be able to monitor the completion of the tasks described above. One method is reviewing a set of deliverables; the second is reviewing progress as it is described in the narrative section of the Monthly Report. Table 6 shows, for each task, the reporting method and expected date of completion.

Table 6
EVALUATION

TASK	EVALUATION METHOD	DATE
STAGE 1		
1. Gather and synthesize information	Description in Monthly Report	October 1989 - December 1989
2. Hold Advisory Panel meeting	Deliverable: Summary of Advisory Panel meeting	November 1989
3. Meet with OSEP	Deliverable: Summary of Annual Meeting	December 1989
4. Prepare specifications	Description in Monthly Report	January 1990
5. Prepare manuscript	Description in Monthly Report	December 1989 - April 1990
6. Pilot-test and review by experts	Description in Monthly Report	February 1990 - May 1990
7. Revise and produce for field test	Deliverable: Draft Product	August 1990
STAGE 2		
8. Conduct field test	Description in Monthly Report	August 1990 - May 1991
9. Report results	Deliverable: Field-test Results	July 1991
STAGE 3		
10. Hold Advisory Panel meeting	Deliverable: Summary of Advisory Panel meeting	July 1991
11. Meet with OSEP	Deliverable: Summary of Annual Meeting	August 1991
12. Produce *Integrating Computers into the Curriculum*	Deliverable: Product	September 1991
13. Prepare final report	Deliverable: Final Report	September 1991
14. Implement performance measurement system	Monthly Report	October 1989 - October 1991

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