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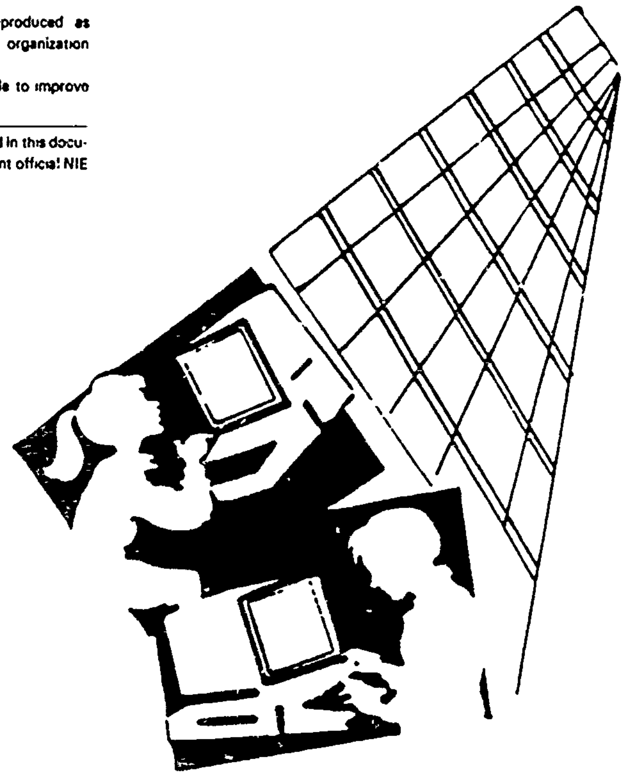
ABSTRACT

This report presents the design, organization, and findings of a federally funded project implemented in three Northeastern Massachusetts towns (Burlington, Lunenburg, and Tewksbury), which demonstrated the application of computer technology to school improvement, specifically in the areas of writing, problem solving, and research/study skills in grades 6 through 8. Project purposes are given, as well as reasons for the study, which was designed to address these specific problems: purchase of computer hardware without adequate instructional systems design; introduction of microcomputers and plans for computer literacy instruction with minimal attention paid to present subject matter curriculum; little staff instruction on how to integrate the microcomputer into the existing curriculum or how the technology might alter the curriculum, and lack of systematic methods for courseware evaluation. The project background and setting are described, as well as a list of findings from the first year. Components of the project design are given, including a rationale for the project, project needs, the program development model, the assumptions for the conceptual approach, and the flexibility of the instructional program. Program implementation in each of the three school sites is described, with particular attention given to specific information on technology and the curriculum; hardware, software and other materials; and staff development and training. The report's concluding sections include descriptions of project assistance, project organization and management, and evaluation methods for determining the success of the program implementation. The latter half of the report presents a six-page bibliography and 10 appendices, which include learning module formats, a summary of hardware and software, teacher development college course descriptions, teacher computer skills inventory, and lists of program and behavioral objectives. (JB)

TECHNOLOGY APPLICATIONS IN BASIC SKILLS



TECHNOLOGY APPLICATIONS IN BASIC SKILLS (TABS)
YEAR ONE REPORT — 1984

Submitted to:

Division of Education Technology
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Washington, D.C.

Submitted by:

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PROJECT TECHNOLOGY APPLICATIONS IN BASIC SKILLS (TABS)
Improving Education Through the Application of Technology

TARGET AUDIENCE

This project is a school-based demonstration of the application of technology to school improvement, one of twelve such projects funded by the U.S. Department of Education. The project is being implemented in Burlington, Lunenburg, and Tewksbury, Massachusetts in grades 6 through 8, with each school applying technology in a specific basic skill area. The schools have revised their existing curriculum to incorporate the use of technology. Training is provided to teachers in the utilization of technology, program development, and implementation support.

SUMMARY

Technology Applications in Basic Skills is a project of the Merrimack Education Center designed to implement programs that use the microcomputer and related technologies to increase student competencies in the basic skills areas of writing, problem solving and research/study skills at the middle grade levels (grades 6 through 8). The purposes of this project are to: (1) develop a comprehensive process for integrating technology applications into the curriculum; and (2) develop replicable programs that use microcomputer technologies to enhance instruction in these basic skills areas. Supported by a grant from the U. S. Department of Education, the project addresses the issues associated with efforts to introduce computer technology into the instructional program of the typical junior high or middle school. The project was designed to address these specific needs in three typical school districts:

- Computer hardware is often purchased without adequate curriculum planning or instructional systems design.

- Plans for the introduction of microcomputers and scope and sequence outlines for computer literacy are often developed without attention to the subject matter curriculum presently in use in most schools.

- Staff development is focused primarily, if not exclusively, on technical training or programming; little attention is given to how the microcomputer can be used within the context of the existing curriculum or how the curriculum might be changed because of the availability of computers.

- Courseware is evaluated and selected without attention to pedagogical principles or features of instructional systems design. As a result, most courseware used is inadequate and fails to advance the state-of-the-art of teaching.

The recommended framework for integration of technology constitutes a set of procedural skills that parallel the procedural knowledge and skills thought to need increased emphasis in the curriculum at this time. This demonstration project has explored transitional structures, the "how to" steps, that make the integration process sound. In doing so, we have considered (a) the technical cost and capacities of hardware and integrated software; and, (b) the staffing and organizational issues for successful integration to take place in the typical middle school.

The project is designed to yield benefits in the effective use of educational technology for school improvement at three levels:

- Teachers and students develop new skills and competencies in computer utilization; students improve their basic skills in the areas of writing, problem-solving and research/study skills.
- All district staff have a model to use in developing a district-wide computer instruction program.
- The integration of computer technology into the total curriculum will support school improvement efforts in the area of basic skills.

QUESTIONS FOR THE STUDY

Several major questions were addressed in the first year of this project:

- How can curricula existing in the schools be designed to accommodate and make maximum use of technology, particularly microcomputer and minicomputer-based education?
- How can the computer be used as a motivating catalyst to revitalize existing curricula across all basic skil areas?
- What configurations of hardware and software are appropriate to carry out instructional tasks?
- What instructional delivery systems and instructional strategies make maximum use of technology?
- What staff development and support models are most appropriate for local school implementation?

MAJOR PRODUCTS

- An implementation guidebook on how technology can be integrated into the curriculum of basic skills
- Teacher training syllabus in each of the three skill areas
- Instructional modules and lesson plans developed or modified for technology applications

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PREFACE

A number of recent indicators point to the need for major focus on the improvement of instruction in the "basic skills". In 1983, twelve exemplary projects were funded by the U.S. Department of Education to develop demonstrations and to make the resulting knowledge of practical applications available to educational managers and decision makers. Over a two-year time span these funded projects are expected to:

(a) Build upon programs that are currently operating in local schools that show potential for students to be able to access information and to apply kowledge.

(b) Help students acquire computer literacy and incorporate the unique features of the technology into the learning program. The broad definition and scope of computer literacy appears to be shared (cf. NCES definition) with an emphasis on information age communication and tool skills.

(c) Include an ongoing staff development component so that all staff are competent in the new interactive learning technologies.

(d) Provide a demonstration site(s) and dissemination of information about the technological applications.

(e) Evaluate student learning in the priority of basic skills and publish implementation guidelines.

(f) Make available on-site access for visitation and produce a case study that will be available to interested practitioners and suitable for widespread distribution.

The MEC case study is in response to the sixth goal in the previous listing. Data for this case study were gathered through document review, on-site observation at the three school districts, planning meetings and inservice training sessions at Merrimack Education Center and interviews at the three participating school systems. Interviews at each school site included the site coordinator, school administrator and participating teachers. Interview questions were open-ended and frequently led to lengthy descriptions of project activities and to detailed perceptions of services, effects and needs. We are especially grateful to those school principals, teachers, superintendents and other district staff who so generously shared with us their experiences and practices related to microcomputer use in the schools.

The purposes of this case study are to provide descriptive documentation of project activities and services, as well as a formative assessment, based chiefly on descriptive data, of implementation during the first project year. The issues addressed in the first year of the project are fully described in this report showing how the project was planned and implemented by Merrimack Education Center with the three school sites in Burlington, Lunenburg and Tewksbury. Project documentation focused on the relationships of linkage, structure, and capability of schools to perform with the new technologies and the transfer of technology into school settings. This assessment resulted in recommendations for strategies and services, including preparation of the evaluation design and research activities for 1984-1985 school year.

This project is exploratory in nature in that it has attempted to determine an effective means of instituting curriculum reform in appropriate use of microcomputers to enhance basic skills. The needed shift in curriculum emphasis and the introduction of computers and other forms of interactive technology (e.g., videodisc) have begun to occur. During the first year, we collected data on innovative technology applications and classroom practices within the three participating districts. This "transfer of knowledge" and informed practice and experience, among teachers and resource staff and consultants of Merrimack Education Center, is supplementary to the workshops and academic courses (two graduate courses) provided during the first year of the project. The case study and documentation will help to establish a replicable model for the instructional use of microcomputer technologies.

Findings from the First Year.

Based upon activities and accomplishments to date, we have realized several preliminary findings that are validated by research and experience:

1. The power of the computer can be more fully realized when used as a tool rather than as a teaching device, although the distinctions between the two modes are blurred in some applications.

2. The curriculum review time required is often underestimated in schools when integrating interactive technology. Wholesale adoption of existing NDN projects was not possible because of inappropriate matches, or time and resource constraints.

3. The amount of required staff development time, to develop a level of comfort with technology, may be underestimated by schools. Teachers require considerable support in order to prepare instructional units that incorporate technology applications.

4. Technology is a stimulus to rethink what are truly the "basic" skills in education for the 1980's and 1990's. Basic skills include learning to <u>use</u> the computer: e.g., data bases, editing text, and the like.

5. Preparatory training for students on technical skills is essential. For this reason, all project sites prepared a program of 15 hours of classroom instruction in preliminary computer activities using the <u>COMPUTER CONCEPTS</u>* software with groups of students and for <u>individual practice</u>. This software was also used to give students computer time in another subject area or in a general literacy program so that the project might continue with more sophisticated applications. Major recommendations in the areas of keyboarding and introductory concepts were made that have affected the entire student population at each of the schools.

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*TM-- Continuous Learning Corporation, Cambridge, MA.

6. In instances where there are limited computer stations, scheduling problems may be encountered in implementing a comprehensive project. Two of the three schools doubled their available equipment for the implementation phase to overcome this constraint. In all three sites advanced scheduling by the administration gave priority to meeting the needs of the project.

7. In the early phase of installation, computer utilization favors a laboratory setting rather than classrooms for several reasons, not the least of which, are the instructional management demands placed on the classroom teacher. Labs promote equal access in the initial stages when numbers of available microcomputers are small (e.g., four per school, ten per school, etc.) and a centralized location facilitates inservice education for teachers. For management, upkeep and maintenance, the centralization of microcomputers in a lab setting is also more easily accommodated.

8. The first year of the project met some initial needs; the second year of the project will need to focus on how best to coordinate and integrate microcomputer-based instruction with ongoing instructional programs. Instructional management and grouping modes are two factors that have a great impact on classroom settings and program success and will need to be explored in more depth.

9. Content and process skills need definition and integration in the curriculum. Our operational definition of problem solving, was selected using the OISE* framework and specific items selected with the evaluator for the research design. Generally, those teachers already "process-oriented" tend to accept the process approach more readily and to proceed further in implementation of problem solving or other higher order skills.

10 Internal factors of structure and organization of the school have varying consequences on the diffusion of technologies in their different settings; thus, the internal capability of the resource system of the school districts contributes to the implementation effort. The site coordinators facilitate linkage between MEC technology lighthouse resources and the school a factor that is positively related to diffusion of technology and impacts on the internal capability of the school district.

We have found that technology can serve as a powerful lever to revitalize what we teach as well as how we teach it. We have found that many times the simple technology tools that are available -- often those without all the glamour of more complex software -- can be used effectively to help students extend their learning capacities and be more productive.

*OISE--Ontario Institute for Studies in Education

As the transitional structures are put in place, narrowly construed training is inadequate to the requirements of this major undertaking for technology applications that are integrated within the curriculum framework. The "appropriate" use of technology must be defined in terms of the curriculum, learning processes and the students, not in terms of hardware and software. Criteria for determining what is appropriate are derived from a reference to the curriculum defined here as the facts, concepts, and procedural knowledge that teachers need to impart to students (cf. NCES definition).

> Knowledge of computer applications and the ability to operate a microcomputer for learning purposes, including an awareness of computer languages.

An important learning from the first-year activities is that the existing basic skills curriculum often is not appropriate or is not configured to make maximum utilization of technology. Additionally, staff uncertainty about the new technologies leads to initial confusion in roles, lack of focus in the curriculum target area, and negative perceptions about lack of incentives and burdens of "time". Teachers need to broaden their view and perspective of technology with regards to the curriculum. They need to create a new or enlarged context for the skills development that is necessary to make appropriate and meaningful uses of technology in the schools.

As we have participated with these school districts, we have noted three distinct stages in their development and implementation of computer literacy applications: stand alone, linkages and incorporation. While districts may start at any stage, by far the most typical progression is from first to last. Some of the indicators of teacher development through these stages include:

- As better software has been found, it has replaced other software previously tried.
- We have observed teachers progress through three stages of readiness and development as the project has become refined and institutionalized.

- Teachers and administrators have analyed the curriculum for appropriate uses of technology and have revitalized the curriculum to sustain intensive implementation activities. At first concerned with equipment issues, the sophistication of staff has developed to include more abstract applications about instruction and instructional systems design.

- School building staff were trained to make appropriate uses of technology in their daily lesson plans for the instructional program and have developed more than thirty instructional modules that blend applications of technology with a restructured curriculum.

- Project staff have investigated and are prepared to make recommendations about classroom organizational models that make optimum use of available technology including lab or classroom settings, in a typically organized and scheduled middle school program. The framework for each of the teacher-prepared modules requires information on both instructional management and instructional grouping modes.

The impact and outcomes of the project appear to be related to these stages and "stage of development" (cf. Hall) varies from school to school. The concept and definition of computer literacy, prior use of technology, the presence of a supporting structure ("breathing mechanism", as described by one principal), all affect our computer-using capabilities. We believe that in integration efforts, we have reached the "early adopters" who often come from a strong background of innovation. We need to define those strategies to encourage other more reluctant participants in new school sites to examine potential applications of computers and other technologies in the classroom.

In this project, an organizational model has been tested that would enhance this development of trained staff members and produce a nucleus of trained faculty -- a cadre of "computer-aware" educators who can help to carry the burden of implementation K-12. Another important factor is a high-level of leadership (superintendent, principal, computer directors, etc.) regarding curriculum reform and the modeling of computer-based practices by these individuals in their selection and application. These leadership personnel are supportive of technology in all three districts and are able to leverage the local school board and community for additional local resources. Managing the technology implementation in three different school sites is a task of great scope and is dependent upon a setting and organizational structure conducive to change, including administrative support from central office and, capabilities and expertise in both technology/technical skills and curriculum design. Furthermore, there is a lack of knowledge base or informed practice about how best to use microcomputers for instructional purposes.

Major elements of this project in the first year included: (1) incorporating new teacher role expectations; (2) selecting qualitative measures of student performance as detailed in the evaluation and research design; and, (3) refining and verifying the focused curriculum objectives so that technology could be applied once the equipment and software were in place. Thus, the instructional systems design was important to the technology implementation and was composed of a number of related factors that are reviewed here. This project reviewed many such factors that would help to integrate the process within a school. In doing so, we have considered (a) the technical cost and capacities of hardware and software; and, (b) the staffing and organizational issues for successful integration to take place in the typical school.

I. Project Background and Setting

Computers are beginning to have a vital role in the educational arena. It is inevitable that that role will continue to grow at an ever increasing rate. To stimulate the project applications in basic skills, the U.S. Department of Education funded demonstration projects by awarding over two million dollars. This funding allows schools to identify learning objectives and devise uses of technology to achieve those objectives. While working on these applications, it is expected that the schools will host visitors and provide material on their adaptations of technology for school uses. It is further expected that the project sites will provide outstanding examples and new uses of technology that can benefit all schools. Participating schools have the opportunity to share information about technology and use better equipment and software to improve education. These classroom sites are expected to build programs that can currently operate in local schools and that show potential for students to be able to access information and to apply knowledge.

The Technology Assistance in Basic Skills project began January 1, 1984 in the three communities of Burlington, Lunenburg and Tewksbury, Massachusetts. Each of these districts agreed to examine the integration of technology within the curriculum of a typical middle school. These three school sites were selected for the development and implementation of the technology project for writing, study skills, and for problem solving, respectively. While all schools address a target population of grades six, seven, and eight, districts vary and these differences have an effect on program implementation.

A. Burlington

The town of Burlington has a population of 23,457 and is located on Route 128 (I-95), ten miles north of Boston. School population is 5,000 with 300 enrolled at the Marshall Simonds Middle School where the project is being implemented in the language arts classes using a process approach to writing and word processing as the technology.

Burlington has been ably represented in the fertile technology ring of Greater Boston. It is considered an upper middle income community whose population is deeply involved in the electronics and technology industries. Many software and electronic firms have located here as spin-offs from the larger R&D firms and the major colleges and institutions of Boston. Burlington supports education very well.

In 1983, MEC prepared a three-year plan for the expansion of computer technology in the Burlington School Department, following the Computer Applications Planning guidebook published by the Center's Technology Lighthouse. Several additional efforts dealing with the use of microcomputers are now underway and approximately $400,000 was budgeted locally to expand the instructional use of microcomputers. The use of computers is clearly a high priority for Burlington and extensive resources have been, and continue to be, allocated for this purpose. A full-time coordinator of technology, who also serves as site coordinator for this project, is employed by the Burlington Public Schools.

B. Lunenburg

Lunenburg is located in Central Massachusetts, Worcester County, in the Fitchburg/Leominster area. It has a population of approximately 8,500 and a student population of 1,650. Primarily rural in orientation, Lunenburg serves as a residential community for persons who work in this tri-city region enjoying the cultural diversity of the urban area of Worcester, the second largest city in Massachusetts, yet comprised of rolling hills and pasture land typical of towns in Central Massachusetts. Recreational facilities and lakes dot this outer ring, 50 miles west of Boston, beyond the Interstate 128 and 495 technology rings. Worcester is well-known for Robert Goddard's early work, as well as that of other technological giants. A history of publishing books is significant to this area and thus the application of reference sources and study/research skills in the curriculum.

The school uses a variety of groupings depending upon the grade level. In grade 6, five teachers team for some areas of the curriculum and two of these are participating in the project. At the seventh grade, there are two teams of students and teachers, while grade eight is departmentalized. The four participating teachers have agreed to focus on study and research skills in applying technology to the curricula areas of social studies, science, language arts. Fifty grade six students are participating, twenty-seven students at grade seven, and twenty-four at grade eight. These grades will be combined in order to have a large population.

As with other Massachusetts school districts, Lunenburg School Department was severely affected by budget cuts caused by Proposition 2-1/2. A significant "reduction in force" has occurred and resources are stretched. A full-time teacher employed by the school district serves as project site coordinator and the principal of the Turkey Hill Middle School is also deeply committed to the project.

C. Tewksbury

The town of Tewksbury is a suburban community of 24,000 located 25 miles North of Boston. School population is 4,500 with 400 students in Tewksbury Junior High School. Tewksbury has over 25,000 residents and continues to grow in population even while the inner ring closer to Boston is diminishing in population. There are 400 students at the Junior High School and Tewksbury has many parents who work in the technology firms that have major headquarters in the Lowell/Tewksbury area. The University of Lowell, a division of the University of Massachusetts, is nearby with a specialization in science and engineering, including robotics, and a computer technology focus. Wang has its home office in this Greater Lowell area and Digital and Apollo, both high technology firms, have offices within six miles of the school.

An excellent modern high school and a modern junior high, equipped with two computer labs, make up the secondary facilities. As in Lunenburg, Tewksbury schools were also heavily affected by cuts due to Proposition 2-1/2. Staffing limitations, increased class size and reduced material resources fostered many changes including reductions in laboratory equipment in the science department and increased emphasis on textbook lessons. Staff members of the Science Department have shown interest and expertise in the use of computers in science instruction, and the principal, who is also the project site coordinator, has provided active leadership in revitalizing the science curriculum and in increasing the use of microcomputer technology.

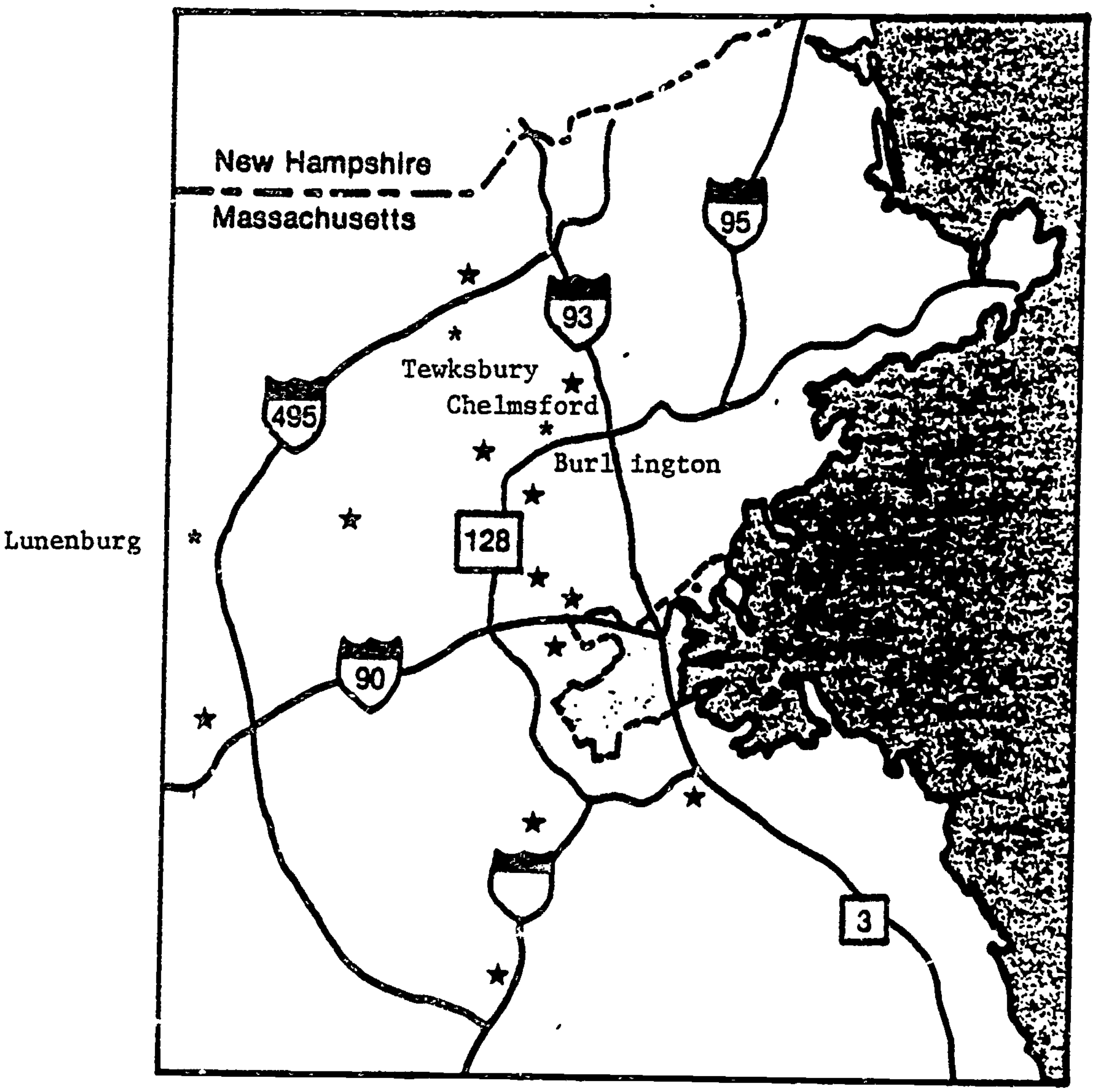
The three participating communities are geographically dispersed throughout northeastern Massachusetts and affiliated with MEC, in Chelmsford, Massachusetts, a suburban community north of Boston in the Merrimack Valley. MEC's Technology Lighthouse facility is located at a special center a few minutes drive from the central research office. The service area contains a diversity of community types. Both Burlington and Tewksbury are suburban communities; Lunenburg is a rural community. These three communities are located in the high technology belt of Massachusetts as shown in Figure 2.

Project Background.

When the project began, curriculum within the schools existed in the form of textbooks (the product actually becoming the curriculum) and was heavily oriented to a content focused approach. Discussions with staff, project site coordinators and consultants favored a curriculum that was more directly correlated to some of the process and procedural skills that could be represented by technology tools. Each of the schools then focused on establishing descriptions of what these process and procedural skills would be in the respective areas of written language, study skills

FIGURE 2

MAP OF GEOGRAPHIC LOCATIONS



★ —Location of some of the high-technology firms in the area.

and problem-solving. Using this approach the curriculum was modified to include a balanced approach emphasizing both process and content in the instructional systems design effort. We have asked school staffs to balance the teaching of procedural and factual knowledge in the curriculum. A strategy for doing this is to use current technology with the more traditional textbooks available in schools while reforming and updating the curriculum frameworks.

The proposal called for the identification of successfully-validated National Diffusion Network (NDN) programs that would lend themselves for use within the schools. Teachers would then add an appropriate software component through the development of specific lessons in the skills area. The investigation and search for validated programs in the basic skill areas of writing, problem-solving and study skills did not lead to total "adoption" of NDN existing curriculum. Many of the NDN programs, however, did serve as a basis for curriculum "revitalization" and adaptation/review of existing curriculum within the schools indicated that there was a need for modification before technology application or integration could occur. The NDN project Andover Airs curriculum and the New Jersey and Ferguson Florissant, Missouri writing projects were highly suitable to the needs of the students in two of the participating districts-- Lunenburg and Burlington, respectively. The Hawaii FAST Science Curriculum was also deemed highly suitable for the Tewksbury students. Additionally, we found the NDN Project Recipe to be an excellent example of the application of instructional systems design that would assist in preparing curriculum units. (Figure 3 illustrates a listing of some of the NDN projects reviewed for incorporation into this project.)

FIGURE 3

VALIDATED PROJECTS REVIEWED FOR ADOPTION

PROJECT TABS

March 1984

New Jersey Writing Project -- New Jersey

Ferguson Florissant Writing Program -- Missouri

Andover AIRS Reading Project (Study Skills Portion)

Independent Skills Development -- Bakersfield, California

Critical Analysis and Thinking Skills -- Salt Lake City, Utah

Computer Literacy Project -- Alma, Arkansas

Project Impact -- Critical Thinking -- Costa Mesa, California

Foundational Approaches in Science -- Honolulu, Hawaii

Marine Science Program -- Washington

Sci-Math -- Connecticut

Project READS -- C'oeur d'Alene, Idaho

Progress in the First Year

As the project progressed, each district attended program development sessions where the general theme of integrating technology with the curriculum was presented by project staff and outside resource personnel. Earlier studies had identified knowledge gaps that "still exist and that thwart the potential contribution of technology to improving and reshaping education." (Rand report, March, 1984) This study, one of twelve, was funded to assist the U.S. Department of Education in describing the patterns of microcomputer-based utilization in basic skill areas of the curriculum.

The staff development program focused upon areas of orientation, technological literacy, instructional design and development and practicum experiences. The training sessions to accomplish purposes related to the development of process skills for any one of the school districts (writing, study skills and problem-solving) and computer applications to assist in developing these skills, were conducted for the project staff of that school district. From these initial presentations, districts were then assigned the task of developing a set of lessons, or modules, that would integrate the use of technology software with a corresponding area of the curriculum. The purpose in these initial efforts was to determine what basically makes up a good application of technology in the curriculum and to pilot these activities in the spring of 1984.

Staff within school districts not only selected technology software for use in the integration but, at the same time, restructured their curriculum around the procedural skills. This resulted in an added time burden, but an important step in the preparation of lessons as the curriculum was revised or modified for application with the technology. The scope and sequence of the curriculum began to take on new dimensions, in an evolutionary sense, as the demonstration lessons and activities were created and utilized to test out how best to apply the software technology at each of the school sites. A module design was developed for application in the three districts across the different curriculum areas. Demonstration modules on problem solving and process skills were reviewed for adoption as a standard for all classroom or computer lab instruction (see Appendix A). Modules were prepared for full-scale implementation in the fall, 1984, based on the proposed design.

Because teachers' plans are a central focus of instruction, we attempted to offer inservice and a modular design that would integrate technology objectives with ongoing classroom lessons and activities. The modules included instructional goals for procedural skills, content of the particular subject area, and skills that could be measured in regards to use of technology (e.g., keyboarding, running pre-programmed software, etc.) Additionally, the study identified instructional planning and instructional programming (as opposed to microcomputer programming) as the main focus. As a result, the project accomplished several steps in this procedure:

1. development of a process for analyzing and strengthening the curriculum through the use of technology;
2. teachers trained to make appropriate uses of technology for instruction and skill development;
3. development of over 30 instructional modules that blend appropriate applications of technology within the curriculum;
4. classroom organizational models that make optimum use of available technology.
5. individual modules and course work in the preparation of teachers have already been incorporated in the Fitchburg State College graduate program through the off-campus masters degree requirements.
6. a program evaluation design that will yield substantial information on benefits to students and teachers.

Informal teacher-to-teacher exchange was encouraged through meetings and on-site practice with technology applications and specific software packages and consultants also met with small groups of two and three teachers to practice specific applications. Over the project's first year, we: (a) initiated teacher-to-teacher interchanges to discuss technology applications; (b) examined the knowledge and experience emerging from these teacher-shared experiences; and, (c) provided opportunities for students to apply skills while they learn a new technology. In all cases, the project encourages teachers and site coordinators as primary knowledge sources after they have some familiarity with microcomputers (or videodisc, etc.) and specific software applications. Consultants on specific technology (e.g. word processing, data bases, or particular software such as DATAPLOT) were available as coordinators or presenters to demonstrate the new technology and to assist in implementation at the three sites.

Teacher inventiveness and creativity were encouraged in the lesson adaptation and providing instruction in a lab or classroom setting. In most cases, teachers tried these lessons with their classes as part of a practicum before beginning full implementation. We asked teachers to report on instructional grouping modes and patterns of microcomputer use with their different classes and subject areas. The practicum reporting format asked about instructional decisions and practices that worked as the modules were used in the school settings. Software purchased as part of this project and for these goals created a rich, varied and extensive materials collection that were referenced to each of the lessons taught in the three schools.

The involvement of principals and, in one district, a computer technology director, has heightened the adaptability of this in-school project. The assignment of "site coordinators" and doctoral interns has also facilitated this leadership, as did the identification of key resource personnel. The superintendents have been most supportive and, indeed, have shown extraordinary leadership in many instances. This has greatly aided problem solving and identification of resource availability locally as superintendents have considered how they could bring interactive technologies into their districts and expand resource availability.

Given that the K-12 curriculum is in need of technology-based initiatives, and that technology is a useful tool for all students, schools have selected those priority areas of the basic curriculum for their next level of effort. An exchange of ideas among these three schools has occurred and we have begun to disseminate those successful practices beyond the immediate schools participating in the research design.

We have prepared several training agendas based upon the amount and types of staff development that are required to prepare faculty to implement a computer literacy program. Staff development, including skills development and ongoing support for classroom implementation, are detailed in our planning and agendas available for dissemination to adopting school sites. These agendas are now being used in the Fitchburg State College graduate programs that we offer, as well as in Commonwealth Inservice courses planned by MEC staff.

One of the immediate impacts from this project, indeed one that took a considerable amount of the inservice time, was to focus on the curriculum areas that needed reshaping. For example, study skills was not systematically taught in the middle school curriculum and, when the pretest was given to students, teachers realized how much their students really needed these skills. Additional time for inservice was spent on reshaping the curriculum to include a process and procedural focus in addition to the subject content already being taught. A preliminary survey of teachers provided information on their background with respect to technology and their ability to use the microcomputer for instructional purposes.

II. PROJECT DESIGN

A. Rationale for the Project

The rationale for this project was that the most appropriate and meaningful uses of technology will be realized when technology is used as a tool to support a revitalized curriculum across all or most content areas. This rationale was based on our observations and assessment of the state of the art with respect to technology applications in education and our experience in helping over fifty school districts to implement technology. By and large we found that applications were fragmented, uncoordinated and separated from the total school curriculum. Concurrently, we observed that, as a documented by the many national reports and studies, curriculum revitalization and educational reform in general were very much needed. We viewed these two sets of observations as mutually compatible and reinforcing. The Technology Applications Project was designed to address both at once.

From the first year of training activities, and as the project began full-scale implementation in the schools, our original rationale for the project appears to be substantiated. We are more convinced than ever that technology can improve the delivery of the total school curriculum, but more importantly we know that appropriate and optimum uses of technology <u>require</u> a strong curriculum. To use even the best technology to deliver an outmoded curriculum will impede the realization of our most important educational goals.

B. Needs to Which the Project is Addressed

The broad need to which the project is addressed is to increase productivity and effectiveness in learning basic skills. Whether it be the instructional time on task research or related studies of classroom learning, our knowledge and experience indicate that learning is far from a productive and efficient enterprise. This project is an attempt to discover and demonstrate those uses of technology that are most appropriate to increase productivity and effectiveness in learning.

Whether it be in the reports of national study groups or from the professional associations themselves, the need for increased attention to developing higher order process skills in both reasoning and problem solving is being proposed for major initiative in the schools today. This is not a new movement, but a rekindling of one that has recurred, Phoenix-like, over the last thirty years in education. With interactive technology, we may be able to put into place some of these ideals and goals using the tools now available to us that were not heretofore available to schools for direct applications. A pattern that we see emerging is renewed and increased emphasis on procedural skills -- skills for "learning to learn"--where the computer is seen as a tool through which new and higher order process skills may be developed and used.

As a project designed to adapt or modify programs that use technology to increase student competencies in the basic skills areas, we addressed the issues associated with a demonstration that would introduce computers into the instructional program. Typical of school district needs identified in the project proposal submitted to U.S.D.E. are:

- Computer hardware is often purchased without adequate curriculum planning, sometimes without adequate analysis of hardware needs.
- Plans for the introduction of microcomputers, and scope and sequence outlines for computer literacy are often developed without attention to the curriculum.
- Staff Development is focused primarily, if not exclusively, on training to use the technology; little attention is given to how the microcomputer can be used within the context of the existing curriculum or how the curriculum might be changed because of the availability of computers.
- Courseware is evaluated and selected without attention to principles of instructional systems design. As a result, most courseware used is inadequate and fails to advance the state-of-the-art of teaching.
- Classroom microcomputer applications are ad hoc and fragmented, often representing piecemeal "tinkering" with the technology.

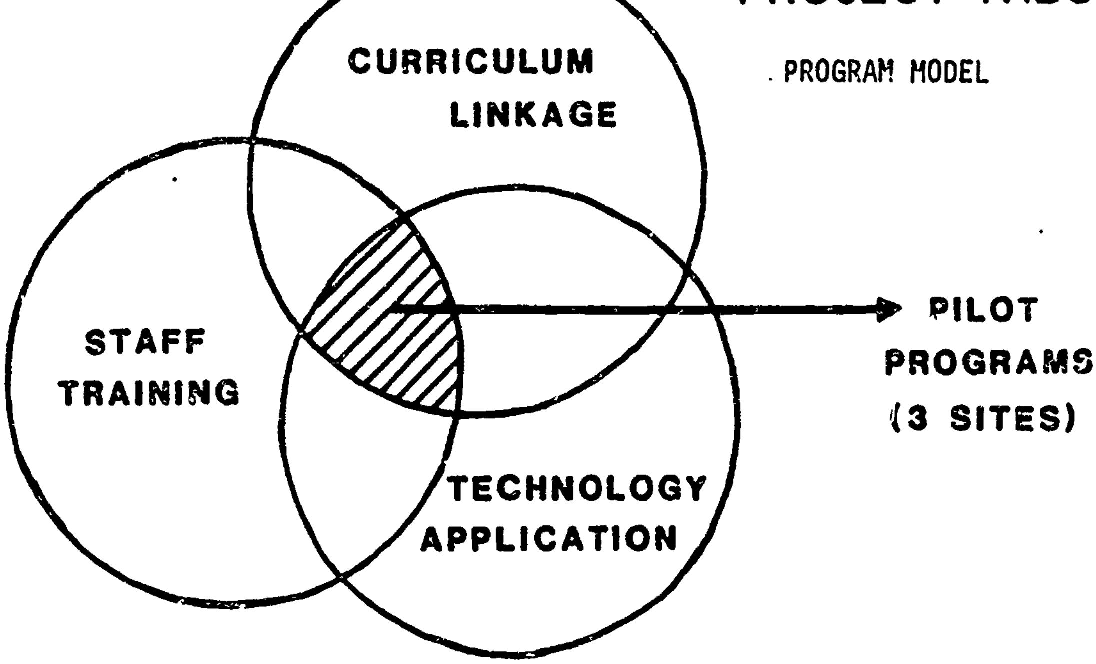
A primary need we have identified is that most curriculum existing in the schools presently is not designed to accommodate and make maximum use of technology, particularly microcomputer and minicomputer-based education. Also, we need to use the computer as a motivation and catalyst to revitalize existing curricula across all basic skills areas. Third, we need to discover what configurations of hardware and software are most appropriate to carry out instructional tasks. Fourth, we need to investigate a variety of instructional delivery systems and instructional strategies that make maximum use of technology. Fifth, we need to investigate staff development and support models that are most appropriate for local school implementation.

C. Program Development Model.

The technology applications model was derived from the Computer Applications Planning (CAPS) process designed by the Merrimack Education Center Lighthouse. Building on our process for Computer Applications Planning (CAPS), the project was able to assist schools in the integration of technology within the ongoing curriculum and in revitalizing that curriculum even as the integration process was taking place. Indeed, we found that bringing the technology into the curriculum served as a motivation and lever for making changes in the teaching of basic skills.

The program development model employed in this project is a relatively traditional one with certain components being emphasized. It is essentially a curriculum-driven model, as distinct from a technology-driven one. In addition, a heavy emphasis is placed on staff development so that faculty can understand and practice the uses of technology. Implementation support is provided throughout this process.

PROGRAM MODEL



Using the program model, the project teachers developed instructional lessons and modules that employ computer tools to support the delivery of a curriculum and that gave increased attention to procedural skills and knowledge related to each of the basic skills areas. A sample module is provided in Appendix B. These learning modules were presented to students near the end of the school year to determine their effectiveness in a teaching situation. The intent of this trial period was to accomplish the following:

- To determine, in the opinion of the teacher, if the module was effective in helping students reach the specified objectives.
- To determine if modifications should be made in the module to increase its effectiveness.

A Practicum report was completed for each module that was field tested (Appendix C) and modifications were made in each module as needed. The instructional modules used an eight-step process that will be completed by the end of year two and documented in our final reports and Implementation Handbook. This process includes these seven steps:

(a) Identify generic process skills and content
(b) Develop a module framework
(c) Develop skills and activities -- scope and sequence
(d) Prepare modules for pilot testing
(e) Pilot test modules
(f) Implement refinements
(g) Publish modules

During year one staff at each site created a series of instructional units or modules to serve as guides for the individual lessor plans. These instructional units range in length from five to thirty school days and cover the three basic skill areas identified. For example, in writing the modules address various steps in the writing process and blend appropriate applications of word processing and support software. In problem solving the modules address steps or components of the problem solving process and seek to link specific technological capabilities to the teaching of those problem solving processes using the science content lessons.

While these units have been used in the schools since September, we realize that they will need to undergo revision and expansion. The implementation and refinement process will be monitored and teachers will help us to identify areas where improvements are needed. We intend to document revisions made and the rationale for changes. In addition, we expect to prepare these modules for wider dissemination in published formats.

D. Conceptual Approach.

Our conceptual approach to the design of the project is based on several assumptions gleaned from research and experience:

- The most powerful applications of the technology will occur when it is used to support a revitalized curriculum, to help teachers and students be more productive and effective learners, and to extend their own capabilities through the use of new technological tools.
- Our conceptualization of what constitutes a "basic skills" curriculum is changing, both as a result of the national reports and studies and as a result of our increased accessibility to technological tools that can perform lower order computational and communication tasks.
- The scope and content of training and support for teachers and administrators in making appropriate uses of the technology has been vastly underestimated and has overemphasized the technical skills at the expense of instructional management skills.

- At present, the most useful software appears to be the generic tool software, such as word processing, spreadsheets, and database management programs. High quality CAI software can play an important supplementary role.

- As tool software becomes more sophisticated, the usually discrete and distinct modes of tool, tutor and tutee are becoming merged, offering opportunities for powerful instructional as well as productive capabilities.

- The orginal premise that educational applications of technology are primarily pedagogical tasks, not just technical skills, has been substantially validated in this first year of the project.

E. Instructional Program

Our implementation of the model has been undertaken in a middle school (grades 6 through 8) in three school districts, in each of three different area of the basic skills curriculum. In all three sites the major effort began with examining the basic skills curriculum so that it could fully and appropriately exploit the capabilities of technology. This curriculum revitalization has both resulted from, and stimulated extensive staff development for the teachers, including graduate level coursework, to bring their technological skills up to a level sufficient to work with their students in this demonstration project.

Our model and our implementation process were designed to be generalizable to a wide range of school districts. We recognize that hardware and software is in relatively limited supply and have based our designs on realistic settings. Therefore, while we in some cases assume that a computer lab exists, some of our approaches can accommodate as few as one computer per classroom.

Computer Literacy Curriculum.

The computer literacy curriculum needs to be viewed from two perspectives: (1) the set of competencies that constitute what students need to know and be able to do with the computer; and, (2) the way the computer is used as a tool to deliver or support the existing curriculum. Although the latter was originally the focus of this project, we found that we had to also direct attention to the former because schools were not totally geared up to provide these competencies.

Three categories have been defined for this project in terms of computer concepts and competencies. Only the first two have concentrated attention in this project and computer science is thought to be important after the middle school years.

1. Computer awareness and literacy -- all students need to become familiar with the computer, how it uses "languages" and operating systems, and how to use it in a variety of decision-making activities. In addition, all must have the opportunity to experience the computer as an instructional tool that supports the curriculum and enhances learning.

2. Computer tool competencies -- this was the major focus of our project and we believe <u>most</u> students in the middle school will need the opportunity to develo substantial competencies in using the computer as a tool in all areas of the curriculum. The project concentrated on three areas of the curriculum, one area for each school, with plans to share the learning among the schools during the second year.

3. Computer science education -- comparatively <u>fewer</u> students at the high school level, may need experience in focusing on the computer specialties of programming or data processing functions that pertain to future employement or postsecondary studies. This third area was not viewed as part of this project and is included here merely for illustrative purposes.

Scope and Sequence

Figure 4 illustrates a taxonomy of computer competencies that serve as the basis of computer applications or tool programs. This taxonomy focuses on what is clearly essential for all students, across the three school sites, with optional uses of tool programs selected according to the chosen curriculum area (science, language arts, social studies, etc.) The project sites were encouraged to all use Computer Concepts to accomplish level one in the previous taxonomy listing of skills. Then, we could as a project move ahead into the second component -- computer tool competencies. In the case of Lunenburg, this was telescoped into the spring of 1984 and much of the computer awareness and literacy

FIGURE 4

A Taxonomy of Computer Competencies

I. Foundation Skills

A. Required

1. keyboard/touch typing
2. operation and care of hardware/software/peripherals
3. using programmed software

B. Optional

1. history of the computer
2. career opportunities
3. social impact of the computer
4. misuses of the computer

II. Computing Skills

A. Required

1. flow charts, algorithms
2. basic computer operating system functions
3. computer languages (awareness level)

B. Optional

1. programming aids (authoring tools)
2. computer languages

III. Application Skills

A. Required

1. word processing 2. data bases 3. graphics 4. communications 5. spreadsheets	introductory level, with applications in subject areas as required

B. Optional

1. specialization in one or more applications as stand alone skills

continued into the fall of 1984. Also, Lunenburg required a great deal of time getting the study skills listing in order for the curriculum so that they could then concentrate on the computer tool competencies.

In preparing a scope and sequence for computer competencies, we found that we needed to establish priorities based on student need and availability of equipment and software. Computer and application skills (level 2) requires more equipment than is likely to be available initially and each of the schools attended to this problem. In our preparation of scope and sequence for the middle school, we found the following information from the Houston Texas basic skills project very helpful in thinking through the task:

> Technology is changing so fast that realistic projections are difficult to make beyond two years. The skills needed to be computer literate in 1985 are far less demanding thatn those that will be needed by the year 2000. Although experts have attempted to define a literacy continuum that is analogous to reading or math skills hierarchy, because of differences in learning ability and access to home computers, the concept of grade level expectations has become increasingly less realistic.

Curriculum Integration

Ideally, as soon as students begin to develop competencies in the use of computers as tools, they should begin to use these comptencies to learn more productively the material in the curriculum. Thus, for example, students would use their new work processing skills to prepare essays in the language arts classroom and their new database or spreadsheet skills in math, science or social studies. In keeping with the suggested outline of skills (taxonomy), using word processing in language arts would begin at the junior high school and other tools would be used in curriculum areas as well depending upon availability of resources.

Such integration requires that software and hardware be available to the teachers and they be trained to use it. More importantly, integration requires that teachers adapt their subject matter curriculum to make appropriate uses of the technology. For example, in the Burlington site described below, the English teachers employed a process approach to writing that makes optimum use of the word processor's ability to restructure and resequence sentences and paragraphs. Our experience indicates that the tool competencies can be integrated with subject areas if there is adequate attention to teaching the discipline-specific procedural skills that will be part of the revitalized curriculum. Three examples are provided in Figure 5.

Our approach to the work of the second year will be to maintain the staff development and curriculum revision activities throughout year two, although modified and on a somewhat reduced scale from the first year. In addition, we will continue to bring new technology products into the project and work for their integration into the revised curricula. Finally, we will focus on implementation support and monitoring to insure that the project is being implemented as planned and problems are identified and addressed as soon as possible. We hope to be able to bring other teachers within the district into the project as well as invite the other sites to adopt the project from the participating sites. Expansion beyond the existing sites will be initiated in the spring and fall of 1985 through the Technology Lighthouse.

We did not anticipate in developing this project that the curriculum would require so much revision in order to make maximum use of the computer as a high performing learning tool. Nevertheless, we have learned and accomplished a great deal and are ready to capitalize on those accomplishments in preparing the Implementation Handbook.

Expected Outcomes

- Teachers and students directly participating in the project will develop new skills and competencies in computer use; students will improve their basic skills in writing, problem-solving and study skills.

FIGURE 5

Computer Curriculum Objectives

English/Language Arts

Students will be able to use a word processing program to prepare a research report, including footnotes and a bibliography.

Students will be able to use spelling checker software to identify and correct spelling errors in their written work.

Science

Students will be able to use courseware to observe and analyze chemical and physical changes in various substances.

Students will be able to plot data from experiments and develop graphs and other visual representations.

Social Studies

Students will be able to use graphics software to prepare charts and graphs illustrating various characteristics of society.

Students will be able to access online databases (e.g., newspapers, encyclopedias, etc.) to conduct research on selected topics.

- All district staff will have a model to use in developing a district-wide computer instruction plan.
- The introduction of computer instruction into the total curriculum will support school improvement efforts in basic skills development.
- Curriculum will be reviewed for possible revision/ modification (process skills)

In each of the th.. e districts described below, the teachers reviewed the phases of computer program development in light of their existing curriculum and considered:

1. The relationship of computer literacy to the existing curriculum
2. How the school would plan for such issues as equity, staff deployment, creation of site coordinator's role
3. What general goals would be set for the students at grades 6, 7 and 8.

The development of the pilots in writing, science and language arts/research skills, proceeded through several stages as described in this report. In the first stage, the teams of teachers participated in general presentations and staff development sessions to acquaint them with the project goals. In the summer, 1984, teachers participated in a week-long institute with an option for graduate credits. The purpose of this summer institute was to allow teachers to develop instructional modules that blend the work of the curriculum areas with appropriate computer tool and support software. In the fall, we asked teachers to refine the modules and objectives and activities and prepare a checklist of student competencies to make optimum use of technology. The teachers implemented their modules in spring of 1984 and then monitored implementation in the fall of 1984 with new students participating in the experimental design.

III. Instructional Programs -- Three School Sites

A. Project Implementation in Burlington.

In Burlington Public Schools, the writing curriculum has been revised and strengthened, incorporating the principles and practices established in the NDN New Jersey Writing project and in the literature of Graves, Murray and Applebee. Working in both classroom and writing lab settings, students use a variety of word processing software (e.g., Bank Street Writer, Write Stuff and Milliken's word processor), as a tool to prepare their written work. Teachers use classroom instruction and effective teaching strategies to promote written language. The broad goals are as follows:

a. To improve student writing, both in quality and in quantity, through technology and through a specific writing process. Technology is the means to insure writing processes.

b. To develop peripheral language arts activities in grammar and sentence structure.

c. To adapt characteristics of existing, validated writing programs such as the New Jersey Writing Project, adding the use of the microcomputer technology and software to see if word processing will improve the results of established models.

The Burlington Public Schools had a commitment to develop technology applications prior to this project initiation. Therefore, when MEC approached the Burlington Superintendent, staff and school committee about the possibility of assistance through this project, all were enthusiastic. In fact, Burlington is merely expanding its improvement tasks, now assisted by resources from the project. The primary driving force remains local initiative and local direction and this project is seen as part of a comprehensive curriculum improvement effort for the district.

Technology and the Curriculum

Until now, these grade levels in Burlington have had no intensive writing curriculum universally implemented. Focus is on establishing writing process, melded with the word processing software and technology. Initial work concentrated on preparing module outlines. Existing curriculum from validated programs in New Jersey, California and Missouri were reviewed, as well as materials developed by recognized leaders in the field such as Applebee, Graves and Murray. Staff decided to take elements from all of these sources and to prepare their own "adaptation".

The site coordinator, and six participating teachers explored word processing software programs, writing programs and general use of computers as a learning tool. Inservice and curriculum preparation were carried out on the spring timeline. By fall, 1984, six written lessons were produced, piloted and reviewed by the MEC staff and consultants. Because Burlington has a strong full-time Director of Computer Technology for the District, who also serves as project site coordinator, leadership is clear and direct.

Instruction is delivered in both a laboratory setting and in an open classroom setting with an integrated language arts curriculum. After instructional teams and classroom assignments were scheduled, the teams of teachers set up time blocks for the written language instruction as part of the language arts, time with some classes being taught in the computer lab. In addition, non-computer writing time is included in the lessons as pre-writing activities, including planning and organizing, before access to the computer by each student. Five of the six participating teachers are scheduled into the computer lab with their classes for 50-minute blocks each week. Computer labs will help students to work on writing assignments at various times, individually scheduled by classroom. Figure 6 illustrates how computer applications are integrated with the writing process over time.

FIGURE 6

TABS PROJECT: BURLINGTON

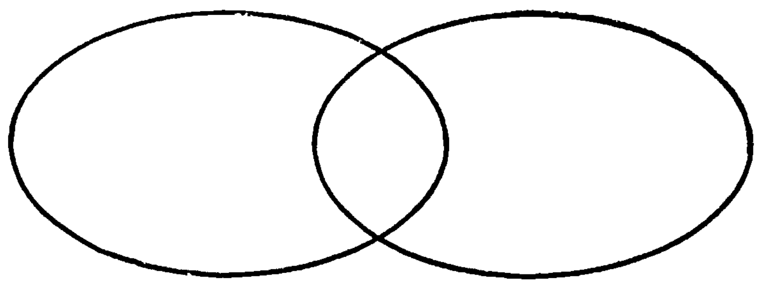
WRITING SKILLS

INITIAL STEPS

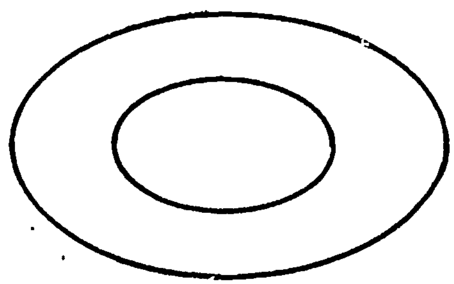
Writing Skills/Reference & Research Skills **Computer Applications**

STEP 1

STEP 2



STEP 3



Hardware, Software and Materials

Computer hardware has been, and continues to be increased yearly. Earlier, in 1981, there was one microcomputer in the school. Now there are 27. Relatively speaking, Burlington is well equipped for the task at hand. Two computer labs are operating in the Middle School in addition to computers available for classroom use. The sixth participating teacher has set up a hardware cluster of three microcomputers and one printer in an open classroom. Students are scheduled into the learning center in the classroom to use the computer equipment. which is on portable computer wagons. This cluster provides a different perspective on the use of hardware to contrast with the fifteen-computer lab setting.*

Burlington teachers have reviewed and studied word processing programs and language arts programs. Nearly all available word processing programs were reviewed and Milliken materials were selected for word processing. The total software collection has been growing with a firm local financial commitment; yet, budget constraints are still real problems. The word processing program developed by Milliken was selected after review of about a half dozen different software programs. This software is used for revising and editing activities; the Milliken word processor was chosen because it requires very little explanation time for technical skills to learn to operate the equipment. (See Figure 7.) Supportive materials in the project for keyboarding have been presented to teachers for use in their prepared lesson plans. These materials include Typing Tutor Program III and a sequential text on developing keyboarding skills entitled Keying in on Keyboarding. Students were able to learn the software package in about three lab sessions. Other language process skills related to writing will take longer to implement.

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* A summary of hardware inventories for all three sites is found in Appendix D.

FIGURE /

CRITERIA FOR SELECTION OF WORDPROCESSING SOFTWARE

1. EASE OF IMPLEMENTATION

2. FEATURES IN PACKAGE

3. COST

4. SUPPORT MATERIALS FOR
   FOR TEACHER USE

5. TIME TO TEACH STUDENTS TO USE

6. EASY TO USE IN A SYSTEMWIDE
   IMPLEMENTATION.

The process approach for teaching writing was presented to the teachers in a series of inservice workshops. The teachers created a series of modules and listed these under topic development. The remaining columns in Figure 8 illustrate the types of cognitive skills and technical skills to be developed in these lessons as each module was prepared by the staff.

Constraints identified included equipment, scheduling of limited time, varying levels of teacher competence within a lesson, teaching "styles" (e.g., content oriented vs. process oriented), and team schedules for language arts blocks. None of these was seen as insurmountable. The financial commitment of the Burlington School District to the over-all goals of this project is extensive. Specific planned allocations to hardware, software, coordinator's time, inservice training in summer workshops, and other resources were ideal to establish this type of project. A second computer lab with adequate equipment and a new staff member opened in fall of 1984 so that students could learn technical skills and keyboarding skills prior to their English classroom instruction on composition and word processing.

Staff Development and Training

Three kinds of staff development were utilized: (1) dissemination of printed materials by the site coordinator and MEC staff; (2) inservice training at MEC (24 hours) on technological applications for basic skills; (3) individual, on-site training by the site coordinator; and, (4) two-week summer institute including opportunities for teachers to take a computer with word processing home for use and practice. Two week-long workshops during the summer, one paid for by the district, provided time for lesson preparation and materials development for full-scale implementation and expansion to follow.

FIGURE 8

I. TOPIC DEVELOPMENT

	Learning	Cognitive Skills	Written Content	Tech.
A. Halloween	Notetaking Adjectives & Adverbs	Brainstorming	Halloween poems Filmstrip on Poe Scholastic Mag. Story Starter	Word Process. Vocab.
B. Fable	Adages, & Idioms Quotation Marks	Brainstorming Categorizing	Aesop's Fables "Writing for Results" 3,4 Comic Strip I,II 5,6	Milliken i,ii "Red" Category
C. Holiday	Mapping Verbals Adj. & Adverbs	Brainstorming Sensory Awareness	"Christmas Carol" Collage Books on Holidays "Writing for Results" detailed description 11-13	Milliken "Looking Back" "Writing About Memory"
D. Debate	Interviewing	Brainstorming Forming Opinions	"Free To Be You and Me" Books on Role of Women Speakers Mts. Are For Climbing-Opinions "Writing for Results" 18-20 Pet Peeves	Writing & Thinking #6, p.61-71
E. Research	Interviewing Research Skills	Generalization Inferencing	Books on Cultures Film "Angel Joe" Field Trip, Chinatown and Libraries Lit. textbook stories on other cultures	
F. Letter Writing	Format of Letters Correct Use of Pronouns	Oral Presentation on Letters Received	Famous Letters Letters to Editor Dear Abby "Writing for Results" 21-23 Writing for Complaint	

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F. Letter Writing	Format of Letters Correct Use of Pronouns	Oral Presentation on Letters Received	Famous Letters Letters to Editor Dear Abby "Writing for Results" 21-23 Writing for Complaint	

Some initial findings from this school site are the following:

1. Students need formal keyboarding training; when provided this training, they make fewer typographical errors.

2. The peer process of revising and editing leads to more productivity in writing.

3. Some features of the word processor tend to lead to output errors not related to the student's grammar or syntax.

4. Prewriting activities such as topic selection, preparing outlines and other skills are time-consuming.

5. Teachers are integrating writing with other language arts activities to secure adequate time for use of microcomputer.

6. Modules were modified in the implementation phase to respond to organizational issues, specific grade level curriculum and scheduling.

7. It is projected that teachers will utilize the maximum amount of computer time available. (Projected time totals include 1,035 minutes of computer time per student and a maximum of 2,070 minutes planned for project activities including prewriting.)

Classroom management and organization are important issues still to be addressed. Early observations indicate that students are improving their editing skills and concentrating on the "publishing" phase of the project to make the essays and work samples more visually pleasing when they are printed out. Writing appears to be more focused.

B. Program Implementation-- Lunenburg

Staff members of the Lunenburg Public Schools view the project as an opportunity to do a better job teaching the essential study skills in basic skill areas, using microcomputers as the instructional tool. The school district recognized a need for help in preparing curriculum for the subject areas that would support the use of microcomputers, and the school was pleased to receive funding to address this need. The Superintendent enthusiastically participated in the project as an opportunity to increase the resource assistance for students. The Lunenburg school is addressing the complex task of using technology to support the teaching of study/research skills in several content areas. Based on a range of available study skills programs and materials, the project uses database management and communications software tools to support comprehensive instructional units. Related support software is used as appropriate.

The project is responsive to the Massachusetts Commissioner of Education's efforts to raise standards in the basic skills areas. The Principal at Turkey Hill Middle School is also the basic skills coordinator for the district and plays an active role in support of this project. The site coordinator is a full-time teacher and has an additional assignment of responsibilities for this project. The scope of the tasks is broad because it encompasses three subject areas. Although study skills are usually the responsibility of a language arts teacher, the teaching teams decided to share responsibility for these skills in social studies and science as well. Many hours of teacher time were devoted to the task, including preparation of a listing of study skills and assignments to particular grade levels.

Students have access to the computer during regular classes, with their teachers. Comparison groups were identified, and teachers scheduled activities keeping the groups separate in their exposure to project resources and lessons and in their use of computers. It is expected that all students in the school will be exposed to general types of literacy in the fall.

Curriculum and Technology

Participants and the principal agree that the existing curriculum, eventually for all subject areas, will be modified so that the organizing concept in this project will be "study skills". New approaches to study skills, because of availability of microcomputer technology, will change the focus curriculum in these areas, integrating the use of the computer. Because the content area for this activity is seen as several basic skills areas (e.g., reading and mathematics) and ultimately all content areas, the task ahead is formidable and a workable scope was carved out for this beginning project.

A scope and sequence of curriculum was prepared, and participating teachers in grades 6, 7, and 8 included study skills in their daily lesson plans. The initial work emphasized study skills while teaching the content areas of reading/language arts, social studies and science. Participating teachers reviewed extensive collections of software and identified programs for part of their regular curriculum during the implementation of this project.

In the fall, 1984 semester, eighth grade students completed an introductory unit in their year-long study of energy conservation. The first lessons used the software program, Geology Search (McGraw Hill), and emphasized study skills. Students in grade six social studies used prepared materials with the National Geographic videodisc on Whales and applied study skills in note-taking, comparing and contrasting information, and categorizing and compiling files of information. The Voyage of the MIMI created by the Bank Street College Science and

Mathematics Education Program, was used with students to master study skills in applying the scientific method. Another grade six class used the Archeology Search software (McGraw-Hill) to apply their study skills. In the seventh grade, students in communiations class explored library skills and locating reference sources through the Britannica Library Skills software and the Elementary Library Media Skills software distributed by Combase.

ERIC literature searches and review of NDN and other research explored similar programs. The National Diffusion Network had many programs and program evaluations that support the Lunenburg approach of applying microcomputers to the improvement of basic skills (e.g., Andover Airs).

At the initial inservice sessions, the teachers examined a listing of study skills from the NDN validated project Andover AIRS. A listing was prepared of the essential research and study skills (see Figure 9.) Additional inquiry skills that could be applied to school subjects were listed such as using reference materials, interpreting and processing information, reading tabular data, and classifying information and drawing inferences. It was not until summer, however, that these skills were fully fleshed out and prepared in a scope and sequence for grades 6 through 8. This took a considerable amount of time to bring clarity to the focus of the skills listing -- time that might have been better spent practicing with particular software programs.

6. Hardware, Software and Materials

In the fall semester, 1984, eighth grade students completed an introductory unit in their year long study of energy conservation. The first lessons used the software program, Geology Search (McGraw Hill) and emphasized study skills. Students in grade six social studies used prepared materials from the National Geographic videodisc on Whales and applied study skills in notetaking, comparing and contrasting information, and categorizing and compiling files on information. The Voyage of the Mimi, created by Bank Street College science and

FIGURE 9

RESEARCH/STUDY SKILLS
EXAMPLES

- MAP SKILLS — 5 SKILLS
- GRAPHS & TABLES — 3 SKILLS
- REFERENCE SKILLS — 11 SKILLS
  - LOCATING INFORMATION
- INDEPENDENT CLASSROOM & RESEARCH (WORK HABITS)
- ORGANIZES & EVALUATES MATERIALS (FOR REPORTS OR CLASS PRESENTATION)
- CRITICAL THINKING ABOUT INFORMATION

mathematics education program was used with students to master study skills for applying the scientific method. Another grade six class used the Archeology Search software (McGraw Hill) to apply their study skills.

In the seventh grade, students in communications class explored library skills and locating reference sources through the Britannica Library Skills software and the Elementary Library Media Skills software distributed by Combase.

Constraints centered on lack of material resources and equipment. First, one computer room was seen as inadequate (housing 12 microcomputers) and competition for access to limited equipment was a major constraint. There are twelve microcomputers in the lab with two printers and a 19" monitor. A separate phone line was installed for database hook-ups. Until April, 1984, the school had just two microcomputers purchased from block grant funds. Therefore, this project was timely and a good deal of start-up and initial installation was telescoped along with the early teacher inservice. Ten microcomputers were added for the lab set up because of the support of the superintendent and members of the community who donated funds to purchase nearly $20,000 worth of hardware.

The local community also paid for all substitutes and teacher salaries during released time for inservice. Local funds paid for telephone hook-up and additional hardware as needed. Funds are very limited; there is no computer coordinator in the school district, and both hardware and software are in demand. The resources from this project have about tripled the software collection in the building which began with a very small inventory.

Respondents indicated that some of the unanticipated benefits were access to quantities of software, inexpensive blank disks and an enormous interest among the teachers in technology. A short term benefit was that students were amazed to see the activities that were interesting and also taught them study skills. They were also impressed with the massive data bases available to them through the microcomputer, or as slides from the National Art Gallery on videodisc. Long term, students begin to recognize that all aspects of education are related and the teachers believe that these study skills are enormously important. Technology is related to all content areas and the teachers state that these students really need to be taught the study skills.

Staff Development

One of the major tasks was to sort out issues involving which study skills to focus upon and which curricula areas to highlight. Five study skill areas were finally decided upon, after a review of Andover AIRS study skill listing, the Wisconsin Design, and textbooks by Santeusanio (Addison Wesley) and Devine (University of Lowell.) These study skills were assigned a major grade level where they would be introduced with mastery and reinforcement coming at later times in the grade level sequence. Software was selected that would teach these skills and some drill and practice CAI was found that would teach library skills of locating references (LearnCo, Britannica, etc.). For the more advanced skills of organizing information and preparing lab reports or research reports, tool skills were found in software packages.

Staff development activities identified included: (a) MEC sessions with the project team; (b) sessions specific to and offered at Turkey Hill Middle School (e.g., PFS, on-line databases, etc.); (c) an inservice course conducted in the local school district and funded by the Commonwealth Inservice Institute entitled Microcomputers in the Classroom; and, (d) distribution of numerous articles and printed materials, including NDN validated project materials from the Andover AIRS Project and materials for social studies and science that reinforce study skills (e.g., USMES social studies and mathematics lessons on reading graphs, tables and charts), and a wealth of ERIC documents and published materials such as Hunter's textbook. Teachers in all three schools were provided with Bev Hunter's book My Students Use Computers.

Initial levels of staff knowledge were claimed to be identical because all had taken only the one course (identified above) taught in the district. Sessions offered under project auspices were fully documented and described with agendas and these courses had an extensive impact on the curriculum and on prepared classroom lessons for students. It is believed that these sessions will form the basis for total curriculum "revitalization" as future years and subject areas are addressed.

Early stages of staff development examined the technical issues and in a later phase, the teachers examined specific applications at their building and classroom management issues. The sessions held at the Middle School, addressing the specific needs of the staff in developing study skills lessons, proved useful in listing the skills that students would be expected to master.

Each teacher piloted a lesson with students in May, 1984. An example of a module for science is contained in Appendix E and features the study skills that are part of a science lesson. During implementation, several issues surfaced including the number of class sessions/ class hours necessary for each student to have enough computer time when there is only one computer lab.* Priority was given to students in this project and the faculty want to assure equity for all students. The software available is often expensive and schools have limited funds to purchase duplicate copies of expensive software for each machine in the lab. Thus, instructional management issues are paramount in organizing the scheduled lesson during the lab time. Individualizing instruction, with different pieces of software within a large class, also poses record keeping problems. Figure 10 lists some modules that were developed by the teachers for study skills.

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* As noted by the Rand study, teacher incentives were the most pressing organizational issue in the Lunenburg site.

FIGURE 10

MATRIX OF SKILLS AND TECHNOLOGY APPLICATIONS

STUDY SKILLS	LESSON/MODULE	CONTENT	TECHNOLOGY TOOL
Locate Information Use reference skills Draw conclusions	Special Interests (facts/trivia)	Grade 7	Answering Questions Library Style
Draw conclusions & generalize Summarize Produce written report	Art Appreciation	Art Grade 6	National Art Gallery Videodisc
Use reference sources Prepare notes and bibliography Locate information and take notes Organize info	Whales	Science & Social Stud. Grade 6	Whales videodisc Whales game software from NDN project Voyage of the Mimi
Draw conclusions draw inference Summarize info Prepare bibliog. Prepare written report	Astronomy	Science Grade 6	URSA (MECC) SOLDIST (MECC) Bank Street Writer
Locate info using references	Library Research	Grade 7	Britannica Library Skills ELMS
Use reference sources Categorize data Summarize	Food Chain	Grade 6 Science & Social Stud.	PFS File Odell Woods (MECC) and Odell Lake Bank Street Writer

SAMPLE

C. Program Implementation-- Tewksbury

The science curriculum in Tewksbury has been restructured to focus on problem solving processes and on related procedural knowledge and skills, using microcomputers as learning tools. The restructuring was accomplished by the participating teachers and incorporates all or most of the subject matter previously covered in the eighth grade physical science course. This new approach is consistent with the recommendations of recent studies of math and science curricula, and uses as an instructional framework the generic process steps of the problem-solving process. (Cf. Figure 11.)

In 1983, students in grades 4, 5 and 6, received computer literacy instruction so that students entering the Tewksbury Junior High School in 1984 had essential prerequisite skills. The Junior High School has established goals; first, to teach keyboarding skills in grades 7 and 8, using manual typewriters and, then, to begin programming in computer science education. Instructional modules will be developed in all areas of the curriculum eventually but, first, through this project, attention will be given to integrate the computer into the science program. This is seen as a way to "revitalize" the science program at the middle school level. Tewksbury students use spreadsheet and database software, as well as laboratory simulations and probes, tutorials and demonstrations to support the teaching of problem solving concepts in science.

Historically, budget cuts resulting from Proposition 2-1/2, preceded by 4% tax caps, have reduced staff, increased class size, and reduced resources for lab work, particularly lab equipment. The science program has just changed from SCIS and IPS materials, which feature highly inductive lab approaches, to a text-centered and non-lab program. While some science teachers were pleased with this change, administrative leadership believes that the program needs to be "revitalized" at this point. Science teachers had existing expertise in computer use, thus this content area was logical for a project choice. Administrators participated in Computer Applications Planning seminars and developed plans for introducing microcomputer technology into the schools working with MEC in the fall of 1983.

FIGURE 11

THE PROBLEM SOLVING PROCESS

- DEFINE A PROBLEM

  Identify elements of problem to be solved or question(s) to be answered. Establish a framework for the inquiry.

- COLLECT DATA

  Determine sources of data and obtain data at sources.

- ORGANIZE DATA

  Judge the adequacy of data, reduce data to summary form, and put data into a framework.

- INTERPRET DATA

  Observe relationships in data and express the relationship accurately.

- DRAW CONCLUSIONS

  Generalize from one context to another or apply the conclusions reached with one set of cases to a different set of cases. Recognize that there may be more than one solution to a problem.

- REPORT THE RESULTS

  Report the results and, when relevant, the process of an investigation. Describe the conclusions and questions to be answered by further investigation.

Research was identified to be inadequate in that there is little relating to the middle school grades; there was little concerning technology in problem solving; and, there were few validated science programs using the computer. (See for example: Robert Tinker's report to Massachusetts Governor's Committee.) The Tewksbury project is viewed by administrators as an exciting instructional approach and a needed research study.

The site coordinator is also the Principal of the Tewksbury Junior High School which provides an effective and efficient leadership style for this project. Program leadership is clear and precise. Participating teachers are all science department staff. The MEC project staff member, newly assigned to Tewksbury, has provided printed materials as resources, and also serves as the main communication linkage between MEC and Tewskbury Junior High School. It is recognized by all that the teachers have the major task in preparing lessons.

Instructional service delivery of this newly developed implementation and application project is within regularly assigned science classes. Entire science classes go into the computer lab together, although some students may not participate in all of these assignments. It was reported that the "slower" students frequently take to the computers best since they appear to be motivated by the change. Some activities, such as use of measuring probes as accessories to the microcomputer, will necessarily be used for demonstration in the science classroom. While different teachers have different levels of proficiency and comfort with computers, all eighth grade science classes are participating.

Constraints identified included lack of sufficient equipment (another lab set-up was requested in the Town appropriations for the FY 1985 budget and equipment was subsequently ordered for the school budget); lack of time for teachers to write and prepare lessons; competition among departments for time allocation for access to limited computer equipment, and material shortages because of budget cuts. Local financial support includes substitute teachers for the Science Department when teachers attend training sessions at MEC, the teacher salaries, plus hardware and software purchases. (See study by Tinker in the bibliography.)

Technology and the Curriculum

Several NDN programs, as well as other recognized programs, were studied in curriculum planning and they proved helpful in efforts to define "problem solving". Of particular help to the research was the Ontario Institute for Studies in Education (OISE) publication on problem-solving. This project will refocus the present curriculum to emphasize problem solving for all of the science curriculum. Staff see a major program modification, using the computer to teach the scientific method as a comprehensive thinking and problem solving process. Topics were selected in the science content areas where: (1) problem solving can be emphasized and is important to the topic; and, (2) software can help and is available. Implementation is occuring in three groups: (a) taught traditionally with supplementary material in the past; (b) traditional content with emphasis on problem solving skills, without computer use; and, (c) full lesson content, with focus on problem solving and use of computers.

In 1983, students in grade 6 received computer literacy instruction so that students entering the Tewksbury Junior High School in 1984 already had the essential prerequisite computer skills. The Junior High School has established goals to teach keyboarding skills in grades 7 and 8 using manual typewriters and, to begin programming in computer science education. Instructional modules will eventually be developed in all aeas of the curriculum, but through this project, attention was given first to integrating the computer competencies into the science program. This is seen as a way to revitalize the science program at the middle school level. Tewksbury students use spreadsheet and database software, as well as laboratory simulations and probes, tutorials and demonstrations to support the teaching of problem-solving concepts in science.

Instructional delivery is within regularly assigned science classes. Entire science classes go into the computer lab together, although some students may not participate in all of these assignments. Some activities such as using measuring probes as accessories to the microcomputer, are employed for demonstration in the science classroom

While different teachers have different levels of proficiency and comfort with computers, all eighth grade science classes are participating. Figure 12 illustrates the problem-solving skills on a matrix showing how technological support can be provided to maintain these skills. In the appendix is the full module containing further descriptions of this approach.

Hardware, Software and Materials

The computer software tool selected for initial focus is the spreadsheet. The "what if" capabilities of the spreadsheet produce possibilities for classroom discussion. Data correction and manipulation of data were taught in early lessons on Visicalc and Data Plot (MUSE) for interpreting observations and writing lab reports.

The addition of a keyboarding course using manual typewriters was chosen to enhance skills for computer usage within the project and a second computer lab was requested to allow for scheduling these extra course units in keyboarding and computer concepts for all seventh and eighth grade students. Seventh graders (not participating in this project) are using LOGO and the comparison group at grade eight uses computers for word processing, for graphics, and for data base management.

The hardware consists of 12 microcomputers, primarily kept in one computer lab; computers are sometimes used in the regular classroom. One set of measuring probes, attached to a computer, is available and these are used in a science lab setting. The budget for FY '85 passed Tewksbury Town meeting and the approval of purchase of ten more computers funded a second computer lab, but delivery of Apple was delayed because of company back-orders.

Teachers reviewed software from various sources including loans and software on 30 day approval. Tewksbury and Burlington both subscribe to the Minnesota Educational Computing Consortium (MECC) collection.

Staff Development.

Pre-training levels of expertise were described with three teachers having great deal of knowledge, two with a medium level and two with a very limited skill level. The principal serves as an excellent role model in his use of applications software including Apple Works, spreadsheets and data bases.

Staff development activities were described included: (1) common meetings held at MEC; (2) materials provided for teachers*; (3) exploration of available technologies (lab probes, videodisc, terminal for data base searching, etc.); and, (4) instruction from the site coordinator and from consultants on topics specific to the Tewksbury science curriculum.

Benefits identified by respondents included improved motivation for average students, attendance improved for some students, and teachers in other disciplines saw more uses for the computers by way of example.

Figure 12 presents a representative sampling of some inservice topics for all three communities.

Appendix F presents a detailed example of staff development as planned for Burlington.

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* Loaning computers to teachers over weekends encouraged them to increase their computer knowledge.

FIGURE 12

Learning Modules and Time Segments

February - August 1984

	Burlington	Lunenburg	Tewksbury
Feb 6		Orientation	
Feb 13			Orientation
Feb 14	Orientation		Microcomputer Program for Science Teachers
March 2			Overview of Project Literature Research Related to Problem Solving
March 13			An Approach to Developing Instructional Units
March 22		Common Meeting The Computer as a Tool	
	Bank Street Writer	Study Skills	Data Handler
April 5	Word Processing		
April 6		Creating Databases and Files	
April 10		Common Meeting Integrating Computers into the Curriculum	
	Revitalizing the Teaching of Writing	Instructional Applications for Large Scale Databases	Problem Solving Model Being Developed at Digita
May 7		Videodisc for Science Lessons	
May 9			Problem Solving in Science
May 15		Common Meeting Curriculum and Computer Technology	
Aug 6		Common Meeting Overview of Project Evaluation The Module Development Process	
Aug 6-10	Instructional Module Development	Instructional Module Development	Instructional Module Development

IV. Project Assistance

1. Staff Development and Support.

While considerable effort was made during year one to prepare teachers and administrators to design and implement the program, actual implementation requires an ongoing staff development and support system. Staff development focused upon the areas of orientation, technological literacy, instructional design and development. Earl, in the first year of this project, all participating teachers were surveyed to determine their training needs. (Cf. Appendix H for a copy of the competency inventory.)

The training program included a number of sessions dealing with analyzing and revitalizing the curriculum as well as sessions dealing with reviewing software and developing instructional applications and classroom lessons. Participating teachers were also instructed in the use of the tools that they would be using in the classroom (e.g., Interpreting Graphs, Data Plot, etc.) The training sessions related to the development of process skills for writing, study skills and problem-solving through computer applications. Staff during the summer conducted "lesson planning" workshops in which curriculum delineation for the purpose of computer based technology interface is available. This modularized delivery for teacher training is in practicum format accredited by Fitchburg State College.

Site coordinator meetings, held on a regular basis, allow staff to discuss the way the implementation is going, how it might be improved, and what resources they will need to improve it. These meetings will continue throughout the second project year. Additionally, we expect to undertake review of the instructional units and the configuration and application of hardware and software.

During year two, the project will continue to provide staff development to participating teachers. The focus will be on delivery and evaluation of the modules as planned. We anticipate providing approximately at least five formal training sessions to be scheduled at appropriate times throughout the spring with a second wave of training initiated during the summer of 1985 to help additional teachers learn about the project and begin to implement the instructional modules in their classrooms. Formal training based on problems, issues and topics that the teachers identify as they implement this program, will be the focus for year two.

We anticipate that these project activities will be conducted on the second year implementation timeline:

- Regularly scheduled meetings with planned agendas for the principals and site coordinators. Three doctoral interns will assist in preparation of these agendas and topics.
- Teacher inservice provided through the year to prepare applications, lessons and instructional management plans as well as practice with new software or equipment.
- Ongoing classroom observations conducted by site coordinators, doctoral interns, and MEC staff to assess the degree of implementation.

Implementation Support for Technology Applications

Each project developed an appropriate configuration of hardware and software matched to the curriculum framework. The MEC project staff provided training and support in evaluating and selecting appropriate software. In general, the software selected and tool programs in all three sites were for the Apple microcomputer. The technology employed in all three sites is readily available for instructional purposes and is the most common hardware and software available in schools across the country. This is important in attempting to make the process and the outcomes of the project generalizable to other schools.

Project staff and the individual site coordinators provide ongoing support to the teachers as they implement the instructional modules. Regular meetings of the teachers with the site coordinators, project staff and consultants are held to provide monitoring information and to obtain information from the teachers about the implementation. This information is used to guide the development of agendas for the formal meetings and training sessions.

In order to guide our activities with respect to the research areas, an implementation monitoring system is being used so that we can assure that the project at all three sites is being implemented as planned. (See preliminary monitoring forms in the Appendix I.) The implementation checklist for each school will be used in reviewing local classroom implementation. We have prepared standardized data generation procedures that assist with the monitoring of activities and provide a timely database for determining the extent of relevant student learning impact in the pilot school settings. The implementation checklists are completed by teachers as they conduct lessons or units and are filled out by the project staff and school principals as they visit and observe classrooms or lab settings where technology applications are being implemented.

- We will use the information gained in the monitoring system to identify training needs, or areas in the curriculum where technology is not being applied adequately. The implementation monitoring system will also need to feed into our documentation efforts on the implementation of the program during year two.

- Project staff and the individual site coordinators provide ongoing support to the teachers as they implement the instructional modules. The implementation checklists will be completed by teachers as they conduct lessons or units and will be filled out by the project staff and school principals as they visit and observe classrooms or lab settings where technology applications are being implemented.

Our focus during the second project year is more on "how to" intervene within the standard instructional classroom process with various instructional components of a computer based module. Staff at MEC and project consultants conduct instructional methods workshops in which the various approaches to incorporating computer based technology within specific curriculum sequences can be explored; and, specific classroom-oriented instructional strategies developed.

The classroom teacher may have software that has been field-tested by the publishers and intend to incorporate instructional methods within the learning process. However, the training and support for this to actually occur have been largely underestimated and without the appropriate knowledge as to how to apply such techniques and when, (what lessons for which students), for introduction, refinement and mastery, for tutorial, testing, enrichment or review, a teacher may apply the materials in the wrong methods for invalid purposes. This takes supportive assistance and guidance and the MEC staff will provide the research orientation to assist the schools in determining how they wish to incorporate technology within the ongoing classroom process.

School staffs are neither research trained nor experimentally oriented in terms of collecting data on student learning for the validation of instructional programs. Thus, such questions as to whether an instructional technology is working as proposed, how well it is working, and whether it is any better than the "standard" former program of instruction it replaced (or supplements) are unanswerable without a research design. MEC staff and consultants assist school administrators with the tasks of "how to" implement, monitor and analyze the impact of technology programs in an instructional pilot to determine a degree of validation toward project goals. The project performs this function in a standardized mode for comparison purposes, and thereby uses such information to define comparable practice, which is both valid and reliable, for the accountable instruction of the student.

As a result of the intensive involvement in this demonstration project, the school districts have benefited directly from the new process strategies in place:

1. Participating districts conduct various computer instruction activities as they undertake this incremental and long-range planning task during the adaptation.

2. Planning and techical assistance encourage the district to pilot efforts while promoting an integration within the curriculum that offers valuable experience.

3. Because of the rapid burgeoning technological environment, the applications of technology on the classroom will evolve during this time frame.

4. Participants develop generic skills of curriculum planning, managing change and innovation, and implementation of technology applications.

Principals and teachers attend meetings and receive follow-on assistance in selecting appropriate software for students, in measuring and interpreting achievement gains. Inservice training assists staff with the "how to" restate a curriculum in terms of a framework, goals and sequenced activities for the identification of benchmarks for computer based instructional integration.

None of these steps can be skipped in the design and adaptation of a complex and sophisticated innovation such as technology. However, we have seen some of these steps telescoped as school district staffs go through the implementation stages. Many classroom teachers are not curriculum specialists and they rely upon textbooks to define what instructional objectives should be covered, how and when. This is why so much time was spent wor'ing with staff to integrate technology within the standard instructional classroom process with components of a computer based module. The project staff conduct specific workshops, study and research issues, and make recommendations for where technology might intervene within the learning process; then the teachers can define the curriculum framework for each learning subject or concept and illustrate its use with computer technology or other interactive learning device. The training and support for this to occur have been largely underestimated and without the appropriate knowledge as to <u>how</u> to apply such techniques and <u>when</u> materials may be applied in the wrong method for invalid purposes.

Planning for Year Two

The project was planned as a two-year effort to begin on or about September, 1983 with full-scale implementation scheduled for January, 1984. Funding was delayed and start-up for project timelines collapsed by four or five months resulting in a six-month project that was telescoped into 1984 while school was still in session until June, and then a summer planning period with full implementation in September, 1984. Despite the many modifications and adjustments that were made in our original plans for year one and the relatively late start-up date (January, 1984), the project made substantial gains across all areas.

There is some evidence that expenditures on computers and computer software may be diverting funds from purchase of more traditional instructional materials; however, the project resources greatly supplemented the purchase of software in the three schools and this may not be the case in this instance. To meet this recommendation, about two percent of a school district's total educational budget (about $50 per student/ per year) would need to be allocated to software and related materials. The cost of software may be running over $1,000 per machine, depending upon the applications selected.* One of the most significant costs, then, for implementing any computer program is <u>software</u>, not hardware, and the costs of introducing new technology to each additional new classroom can be high.

Just as with differential purchasing of equipment, careful selection of software for each purpose also is strongly recommended. Despite the low cost of equipment, the software and supplies needed for each machine can significantly increase the total cost. This has implications for instructional management, grouping modes and for individualized instruction and independent learning (e.g., when software copies are too expensive to purchase in quantity for all-class activities.) Furthermore, these are not one time expenditures when it comes to equipment and software; the rapid developments in computer technology and the continuing need for new computer software mean that the expenses are ongoing. According to most studies, half an hour a day of computer time should be available to students. In this project, we have been able to meet this requirement only two or three days in a given week.

During the summer and fall of 1985, we intend to synthesize all documentation about the implementation into a guidebook that can be used as a companion to the instructional modules. The guidebook will promote a uniform and comprehensive dissemination of the project.

*The expenditures on all instructional supplies used in education typically amounts to only 2.5 percent of the total school district budget. Houston Public Schools projected a 30% increase in software costs,per year, beginning in 1984.

V. PROJECT ORGANIZATION and MANAGEMENT

Organization Project activites are coordinated by the management team composed of the MEC project director, the program development specialists, and a site coordinator (or principal) from each site. In two schools, the principals are directly involved in this management plan and in the third the computer director for the system. Three doctoral interns have provided substantial assistance in program coordination and in establishing the research design for this project.

The site coordinators are responsible for managing day-to-day activities of the school development team. In all three school sites, the site coordinator serves as liaison to other computer instruction activities in the districts, thus comprehensive planning can occur that will help the district implement a K-12 framework for computer literacy.

Project Management. Dr. Richard J. Lavin is project director. Lavin pioneered the brokering and linking concepts in New England as Executive Director of one of its largest educational service centers. Lavin is also director of MEC's Lighthouse for Technology. He has been instrumental in providing technollogy training programs for educators in the New England states as well as major initiatives for training and technology applications throughout the NDN network. Lavin's comprehensive management system for CAI was validated by JDRP as one of the first technology projects to be so recognized and achieved Lighthouse status over three years ago.

Dr. Charles Mojkowski, senior consultant to MEC, has been instrumental in the design of CAPS planning seminars, the CAPS guidebook, and similar publications in New York at the State Department's Center for TEchnologies in Learning. Mojkowski conducts many of the training of traiers semianrs that MEC offers and he has designed computer liteacy seminars that are offered for Lighthouse partitcipants. He taught the first field-based graduate program for Technology Applications in Basic Skills offered as a practicum course with this project. Mojkowski's doctoral work and publications are in the languge arts area and he is overseeing the Burlingon project implementation using a process model of writing skills and text editing/revising methodologies.

Mr. John Phillipo works with Lavin as assistant project director and works with school site teams in programatic issues and inservice. John recently joined the MEC staff from the Oxford, Massachusetts Lighthouse project, one of the first four funded by NDN in 1981. He is also a doctoral candidate and intern at the Harvard University Educational Technology Center. His credentials in science and technology are well-known in Massachusetts because he directed Project COFFEE's Lighthouse for four years. John has graduate level concentration in policy and technology implementation and extensive experience in the design and application of technology in educational settings. He will help to identify resources that will be used by schools as they develop increased sophistication with interactive technologies such as the use of the videodisc.

Dr. Jean E. Sanders received a doctoral degree from NOVA University in educational administration. Sanders conducted practicum experiences in data bases and evaluation as part of that program and she has continued to assist NOVA in development of resource manuals for doctoral students in their technology programs. Sanders has been director of research and evaluation at MEC for over ten years. Working with Educational Testing Service's New England office, an implementation manual for holistic scoring and basic skills assessment was published and used by over 25 school districts to institute major policy mandates of the Massachusetts Board of Education. Sanders will offer the holistic scoring training during this project for evaluation in Burlington. MEC continues to supervise basic skills assessment, testing analysis and data reporting for the Merrimack Valley school districts as well as inservice education for basic skills improvement. Dr. Sanders conducts many of the evaluation programs for Chapter I, basic skills, including comprehensive assessment and program audit published by the Center's research division. Dr. Sanders serves as adjunct faculty for Fitchburg State College in special education as well as the MEC technology graduate programs.

Special consultants assisted the TABS project with technology training and graduate coursework in the first project year including Robert Milley, director of computer training for MEC and George Hanify. Bob and George plan technology courses for inservice programs, oversee the CAI validated component for inservice and delivery of CAI to 16 schools, and provided field services and technical assistance tc school districts. The site coordinators for the first project year were as follows:

Arthur Fallon, Computer Director	Burlington
Richard Griffin, Principal	Tewksbury
Judith Harper, Teacher	Lunenburg
Carol Eaton, Principal and doctoral candidate	
John Sweeney, Audiovisual Director and doctoral candidate.	

Each of these individuals is a content area specialist or supervisor with the management of the local school and participates in the governing body for the project. In addition, ech has basic computer competencies and skills in integrating technology into curriculum areas. All three towns have participated in Computer Applications Planning and software leadership institutes offered by MEC. The coordinators are responsible for day-to-day program operation at each site, including scheduling the lab, identifying topics for inservice edcatuion, and implementation monitoring. They help to arrange program and staff development activities and serve as liaison with the MEC staff for this project to plan agendas and program initiatives.

Decisions related to the operation of the program were made at meetings of MEC personnel and the three site coordinators. At these meetings, plans were formulated, policies related to all phases of the program were established, analyses of the success or failure of procedures in effect were made, and changes in direction established when deemed necessary. Figure 13, Organizational Chart, displays how the Project Administrators, the Resource Coordinators, the Advisory Group and the Site Coordinators with their staff relate to each other. (Cf. role for site coordinator in Figure 14.)

FIGURE 13

PROJECT MANAGEMENT TEAM

TECHNOLOGY APPLICATIONS IN BASIC SKILLS

THREE CURRICULUM MODELS

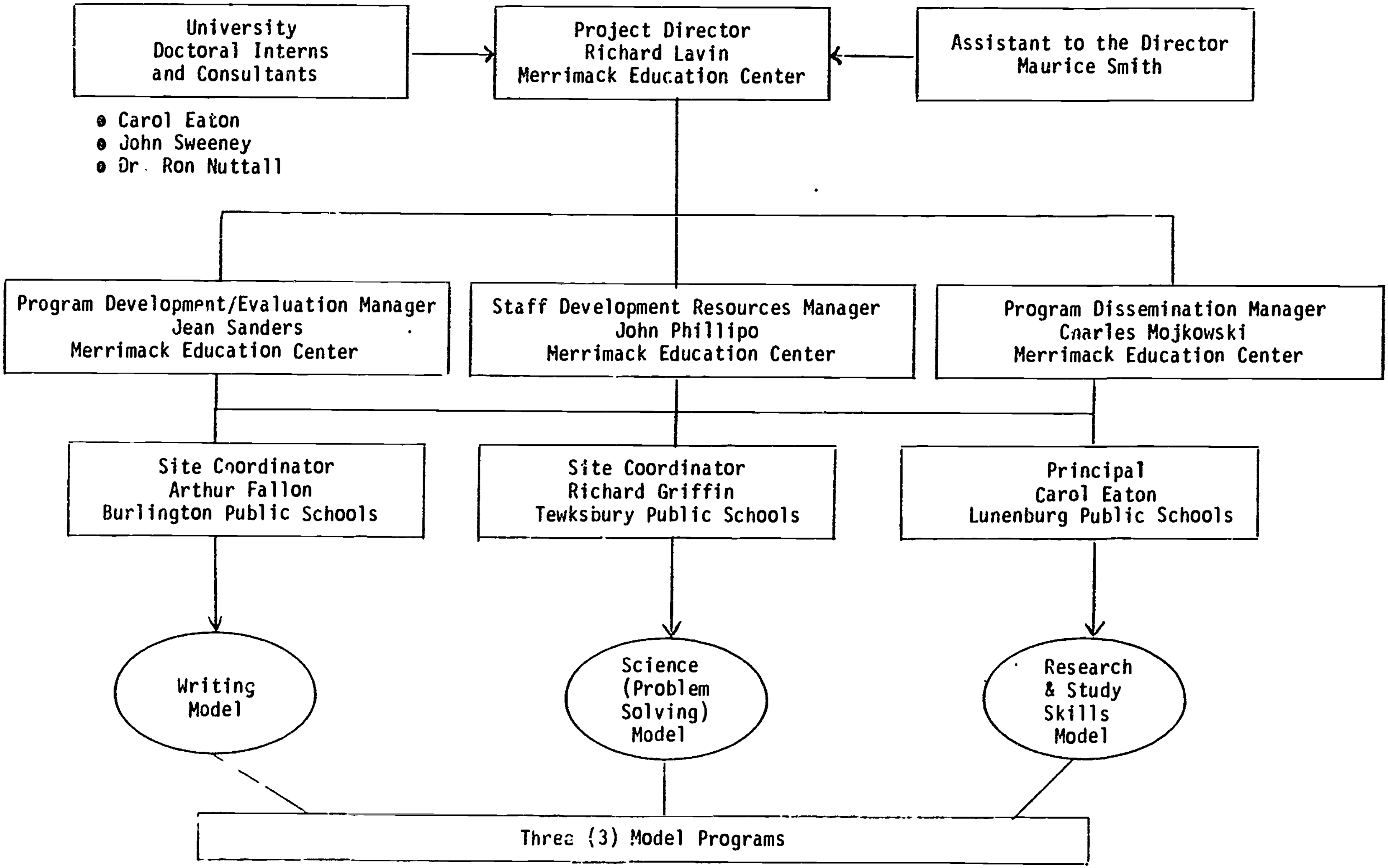

FIGURE 14

ROLE OF THE SITE COORDINATOR

March, 1984

Maintains relationship and communications about the project with staff and MEC consultants.

Hosts on-site meetings and workshops in the school.

Schedules program activities to keep teachers informed as to applications of new technologies and new developments.

Plans activities for on-site teams of teachers working on practicum.

Maintains adequate records as to programs, procedures and schedules for documentation.

Recommends appropriate program materials for teachers to use with students.

Previews, evaluates and selects software for inclusion in building collection.

Provides teachers with appropriate guides and printed materials pertaining to the subject area and use of technology.

Helps students and teachers locate appropriate instructional materials to be used in the technology application.

Maintains a LAB center schedule, working with the Principal to have adequate time for the project.

Identifies equipment needs, including need for maintenance and routine repairs, upkeep of facility, etc.

Operates equipment on request from teachers for a demonstration of technology.

Helps inform teachers of acquisition of new materials and resources available for the project.

Prepares documentation and reports with MEC personnel.

Attends project meetings with MEC staff.

Assists teachers in locating reference and resource materials or other instructional technology.

VI. EVALUATION DESIGN

Documentation and Evaluation

A principal goal of the project is to produce exemplary technology applications in basic skills instruction. Because the intent of the project is to prepare three programs that can be submitted through the Department of Education's JDRP process, an extensive documentation and evaluation effort has begun to describe the process and its application in the three schools.

Our documentation and evaluation efforts fall into four areas: (a) documenting the process model; (b) collecting, analyzing and reporting student performance information; (c) preparing three JDRP applications; and, (d) preparing the instructional units and the handbook for dissemination.

The evaluation design specifies the program implementation and student performance gains in the three subject areas and the appropriate standardized tests that will be employed to assess impact in the content areas. To determine student performance impact, a pre-post control group design is being employed in the 1984-1985 school year. Student performance measures include an assessment of writing proficiency, test items taken from the NAEP on science, and a test of study skills. In addition, student competencies in using the specific technology requirements are identified on checklists of student performance. Competencies relating to the technical skills for computing literacy and to the curriculum subject areas have been identified.

Pretest information was gathered on the participating students in September, 1984 and a control group of comparable students was identified in each school for assessing the performance gains of program participants. Statistical procedures will include ANCOVA to produce valid and reliable performance assessment. The evaluation of the project is being supported in part by the conduct of two doctoral dissertations, each focused on a specific set of variables and questions related to the project. Figure 15 indicates the number of teachers participating and

FIGURE 15

STUDENT GRADE LEVELS
AND
NUMBER OF TEACHERS PARTICIPATING IN THE PROJECT

	Burlington	Lunenburg	Tewksbury
Curriculum Area:	Writing Skills	Study Skills	Problem Solving Skills in Physical Science
Number of Teachers	6 teachers	5 teachers	4 teachers *
Grade Levels and Number of Classes	Grade 6 - 2 classes 49, 56 students Grade 7 - 1 class 64 students Grade 8 - 3 classes 47, 42, 40 students Control Group 50 students	Grade 6 - 2 classes 46, 46 students Grade 6 & 7 - 1 class 26 students Grade 7 - 1 class 28 students Grade 8 - 1 class 56 students Control Group 22 students	Level 1 (high ability) 2 classes 22, 31 students Level 2 - 4 classes 31, 31, 31, 30 students Level 3 - 2 classes 25, 25 students Level 4 - 2 classes 17, 18 classes Level 5 - 2 classes 13, 21 students
Site Coordinators	Computer Coordinator for the School District	Language Arts and Reading Teacher (included above)	Principal of the Junior High School

* Three Grade 7 teachers (Life Science) are participating in the Project and are assisting the Grade 8 teachers. Their students will not participate in the Project at this time.

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the grade levels of students involved in the project in the three school district settings and the areas of basic skills chosen as focus.

Evaluation Questions

The final report produced will be guided by questions used by the JDRP for project validation:

1. Has a positive change occurred and what is the evidence?

2. Can the change be attributed to the program?

3. Is the change large enough and observed often enough to be statistically significant?

4. Is the change educationally significant? What is the size of the change and what is the importance of the area in which change has occurred? Is the cost reasonable, considering the magnitude and area of the change?

The major evaluation questions for the second year (school year 1984-1985) are as follows:

- Have the students participating in the project developed basic skills better than non-participants?
- Does the application of technology in basic skills subject areas result in achievement gains for participating students?
- Are the student achievement gains recorded sufficient to meet all JDRP requirements (efficiency, cost effectiveness, etc.)?
- Does the in-service teacher training have effects on classroom instruction and application of technology in curriculum subject areas?

5. Can the program be used in other locations with comparable impact?

6. Has the evidence supporting the program's claims been gathered and interpreted correctly?

Figure 16 illustrates the various audiences for this evaluation and documentation through a case study and research design during year two of the project.

DATA SOURCES	LEVEL OF ANALYSIS	REPORT(S)	PRIMARY AUDIENCE
• Site Visits	School Level Study (Outcomes)	Report of Special Study of Outcomes	
• Telephone Interviews		Report to Practitioners	Managers
• In-person Interviews		Special Report on Selected Findings	Researchers
• Project Documents		Curriculum Products	Teachers/Principals/ Curriculum Directors
• Case Studies	Training Component Study	Report on Support and Training	Managers
		Manual for Training	Managers/Schools
		Credentials/Certification	Colleges/Studies
	Project Level Study "Brokering"	Report on Project Management Issues and Practices	Managers
		Special Report on Executive Summary	Policy Makers/ TEC Centers/ Education Service Centers

Instrumentation

In selecting a test to be used in the respective areas of problem-solving (Tewksbury) and study skills (Lunenburg), it is important that the treatment as represented by the lesson plans and modules contain enough of those concepts and items in the instructional area that will ultimately be tested. Teachers reviewed sample test items before selecting a test to determine that skills and sub-skills that will be found in the test are addressed in the instructional activities being considered. The evaluation of the project is being supported in part by the conduct of two doctoral dissertations, each focused on a specific set of variables and questions related to the project.

1. Evaluation of Research/Study Skills Project--Lunenburg

The Research/Study Skills project is being conducted in the Lunenburg school district. The following is a listing of skills and sub-skills in the area of study/research skills:

Lunenburg School District

Research/Study Skills

1. Map Skills
2. Graphs & Tables
3. Reference Skills
4. Locating Information
5. Independent Classroom & Research Habits
6. Organizes & Evaluates Materials (For Reports or Class Presentation)
7. Critical Thinking about Information

Instrumentation

Pre testing was done in September with the Wichita Reading Inventory -- Study Skills Level G. Post-testing will be done in April, using the Wichita Reading Inventory -- Study Skills Level J. These tests are being used because they are reasonably well developed tests and well oriented to the goals of the Research/Study Skills project.

Samples of Students in Lunenburg

Pre and post testing are being conducted at Grades 6, 7, and 8. However, only Grade 6 has the complete evaluation design. Three groups are being used: Experimental Group I (Revitalized Curriculum and Use of Technology), Experimental Group II (Revitalized Curriculum without Use of Technology) and Control Group (Regular Curriculum).

	Experimental I	Experimental II	Controls
Grade 6	44 students	23 students	47 students
Grade 7	28 students	-	27 students
Grade 8	24 students	-	32 students

The Wichita Reading Inventory-Study Skills Level G test has 18 behavioral objectives. (Cf. Appendix J.)

2. Evaluation of Writing Skills Project

The writing skills project is being conducted in Burlington among Grade 8 students. The evaluation process will involve pre and post production of written essays. About 85 experimental and about 85 control students will each produce two essays in October and two essays in April. The listing of skills in the writing process is as follows:

Burlington School District

The Writing Process

1. Formulating an idea: topic development (link to reading)
2. Planning the communication
   a. audience
   b. purpose
   c. form, style, voice
3. drafting/organizing
4. revising, rethinking ("re-visioning")
5. editing
6. publication

- The Writing Exercises

The writing exercises call for the students to produce two pieces of work: a descriptive and an expository essay. Particular exercises were prepared for this project based upon those that are routinely used as part of statewide assessments. All essays will be typed professionally (leaving in spelling and grammatical errors) so that it will not be possible for the raters to know which essays were produced on a word-processor and which written by hand.

- Administration of the Writing Exercises

The student essays are to be written in the classroom without aids such as a dictionary allowing thirty to forty minutes for each of the two exercises. The students write on any type of 8 1/2 by 11" paper. Both sides of the paper may be used, though it is important that each student use no more than one piece of paper for each exercise. A separate piece of paper should be used for each of the two exercises. On the post-test, students in the project will produce their essays on an Apple with attached printer. (The pupils in the control groups will have hand-written essays that will be typed by the project secretary.)

A seven digit number code is used to assure anonymity of essays during the essay reading workshop. After the essay writing, the two essays are collected by the teacher. The two student essays are batched separately with a cover sheet indicating school, teacher, grade and class for each notebook of papers. Each student record shows his or her name, teacher, class, and group on a card for data entry.

- Selection of Readers

The readers are teachers of writing or staff familiar with student writing at several levels who have participated in essay scoring in the previous three years as part of the statewide basic skills assessment. All readers were trained by Educational Testing Service in 1981 and have MEC has continued to train additional readers each year since then. For the one day scoring workshop, one teacher (scorer) should be available for every 150 sets of student papers submitted.

- Scoring of Essays

Standardized procedures taught to us by Education Testing Service were followed. In the scoring session, each participant indicated his or her score for an essay by using a letter code. That is, instead of recording the score of 4, 3, 2, or 1 on the essay paper, each recorder indicates the appropriate score by an assigned letter. Each reader always has a unique code; however, in all codes assigned, a particular letter always represents the same value. For example, whenever B was assigned it represented the value of 1-- Low; whenever G was assigned, it represented the value of 3, a higher value.

The basic code follows, indicating the letter equivalents for the four scores:

(Low)	1.	R B A L S
	2.	M J D K U
	3.	W Q G Z P
(High)	4.	H C N F V

Each paper was read at least twice. The scores given by both readers were accepted if: 1) the same value was assigned by both readers to the essay (i.e. 4-4, 3-3, 2-2, 1-1) or, 2) or the two values assigned by the readers were within one point of each other (i.e. 4-3, 3-2, 2-1). On the other hand, papers with a discrepancy of more than one point between readers (i.e. 4-2, 4-1, 3-1) necessitated a third reading.

By noting the above code, it was possible to determine the values assigned to each essay written in the class(es). The scores for each student are computed on a scale from 2 to 8 by adding together the two ratings (score from each reading.) A score of 8 does not necessarily represent the ideal paper; it does indicate that the paper was among the best of the essays scored. In those cases where three readers read the essay, the two highest scores can be used (e.g., 3, 2, 1 choose the two and three for a total of 5).

Using the student code cards prepared for each student at the time of the writing exercise, report the scores for each student for data processing. These coded cards show each student's total score for each essay. This listing of scores was then submitted by the local project facilitator for data entry. On the data entry form, the student essay scores will be matched with covariate information that has been collected locally. Appendix K contains the summary directed to readers of the papers at the training session.

Samples of Students in Burlington

	Experimental	Control	Outside Control
Grade 6	52	53	--
Grade 7	27	27	--
Grade 8	64	65	50

3. Evaluation of Problem Solving in Science Skills

The problem solving in science skills lessons took place in Tewksbury. The skills outline follows the listing presented earlier in the report and summarized here:

Tewksbury School District

1. Define a Problem
   a. Establishing a Focus for the Inquiry
   b. Establishing a Framework for the Inquiry

2. Collect Information
   a. Determining Sources of Data
   b. Obtaining Data at Source

3. Organize the Information into a Logical Pattern
   a. Judging the Adequacy of Data
   b. Putting Data into a Framework

4. Interpret the Information
   a. Reducing Data to Summary Form

5. Draw Conclusions
   a. Observing Relationships in Data
   b. Interpreting Data

6. Report the Findings
   a. Communicating an Inquiry

The following tests were administered on a pre-test basis to all Grade 8 Physical Science students during the week of September 17th. Post-testing on the same test will be conducted the first of June, 1985. One 46-minute period was used for each test.

1) Physical Science Test (materials taken from the National Assessment of Educational Progress, The Third Assessment of Science, 1976-1977.

2) Attitudes on Science Test (materials taken from National Assessment of Educational Progress, The Third Assessment of Science, 1976-1977.

Sample of Students

	Experimental	Control
Grade 8	147 students (6 classes)	156 students (6 classes)

Project Dissemination

We will prepare a dissemination program and products for use within and across the participating school districts, K-12, as well as regionally and nationally. The MEC Technology Lighthouse will serve as the principal dissemination vehicle for the project, once it is approved by JDRP.

To support the future replication of the three programs in other schools, a case study data will be available with sub-parts devoted to each of the three sites. The case study will be prepared as part of the guidelines for new school sites to implement technology. In the case study we will identify the kind of information and resource exchanges that take place among the participating districts. We will develop print and other media materials that describe our project and what the schools have accomplished. Our dissemination model includes materials, demonstrations, training and consultation. In addition to the descriptive case study, guidelines and manuals for undertaking the program planning process and implementation will be made available.

We anticipate extending the program to a new group of teachers and students in 1985-1986. The documentation of training agendas and course outlines for teachers will identify those topics needed for developing student competency statements, curriculum objectives using technology, and intructional strategies and applications. Each of the school teams has been trained to use specific hardware and software systems to manage instruction and the guidelines will include the specific lesson plans, instructional activities, logistical arrangements and student performance assessment as implemented. Demonstration classrooms will be available for those who attend training events to learn more about the computer applications.

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LIST OF FIGURES

APPENDICES

APPENDIX A

MODULE FORMAT RECOMMENDED

Problem Solving, Science, and Technology

J. R. Cole

Confidential Draft

Table of Contents

DRAFT - J.R.C.
June 26, 1984

Forward

(These notes are for MEC personnel only and this version will not be included in the final package.)

The focus of these modules is on the process of problem solving. It is assumed that the teachers involved in the project know their subject content and do not require assistance in that area. The modules are generic in nature and as such can be applied to any set of content concepts. However, teachers must themselves be problem solvers in order to teach problem solving. The teachers should be exposed to the concepts in the modules, helped to recognize them in diverse content contexts, assisted in developing comprehension of the concepts, and supervised in the productive use of them in terms of writing their own modules. The vector application module is included for demonstration purposes only and is not designed for dissemination. Even the most creative unit easily becomes a workbook-style exercise when implemented by teachers who were not part of the creation process.

Problem Solving, Science, and Technology

(This section to be included in the final version of the package. This topical outline is for overview purposes only.)

Science as Problem Solving:

Problem solving as a process applied to more content specific concepts.

Top-down as opposed to bottom-up instruction.

Rationale and reasons for spending time on the problem solving process rather than the science content per se.

Problem solving as representation.

Problem solving as choice among alternatives.

Creating an attitude and perspective for problem solving.

Technology as a Tool for Cultivating Problem Solving:

Technology as support for attitudes and objectives and as impetus for change.

The need for alternatives without excessive time and effort is met through technology.

Tools for organization, representation, and communication - all part of the problem solving process.

Tool for accessing and storing information.

Creating a Problem Solving Environment:

Development of student and teacher attitudes and philosophy.

Organizing for problem solving.

Fostering the interactive nature of problem solving.

Module Chart

	Acquisition		Transformation	Evaluation
Process	Exposure	Recognition	Comprehension	Production
Representing the Question	1	2	3	4
Collecting Information	2	3	4	5
Representing the Data	3	4	5	6
Representing Relationships	4	5	6	7
Representing Conclusions	5	6	7	8

(Note: Module 4 is the demonstration module.)

Topic: Representing Relationships :

Information	Concepts	Process Skills & Concepts	Study Skills & Concepts	Cognitive Skills & Concepts	Science Content Concepts	Technological Support
Exercises						
	Exposure	Representing relationships Communicating results	using notes - within and between subjects	inference and generalization		spread sheets & graphing programs
Acquisition						
	Recognition	Representing the data Communicating results	organization	abstraction implication		spread sheet
Transformation						
	Comprehension	Collecting information	note taking organization information sources	abstraction inference		word processing
	Production	Representing the question		abstraction analysis conceptualization argumentation		word processing
Evaluation						
Problems		all (see text)		generalization inference		

OISE reference

Module 4: Representing Relationships

This module introduces the concepts involved in determining and representing the relationships within a set of data. The objective is to expose the students to the process of choosing a focus, choosing between an eyeball or computational examination, determining the direction, nature, and size of the relationship, and the criteria for each. To accomplish this objective, word processors and spread sheets are used to manipulate the data set in a 'what if ..' manner ("What if this variable was the focus. Would there be a clearer relationship?") and graphing programs are used to display the results for further discussion of how to describe relationships. As with all of the modules, this module relies upon the previous sequence in terms of those concepts, skills, and processes which the students are expected to produce independently, comprehend but require some guidance in using, and those which they are expected to recognize when the teacher leads the discussion.

Production:

(It is assumed that the students have been exposed to and had practice in recognizing the different types of "problems" and that there is a fair degree of comprehension exhibited by them. It is similarly assumed that the students are prepared, by modules 1 - 3, to actively use analysis, abstraction, and argumentation.)

The students are expected to actively determine the type of problem representation they are dealing with, to develop a plan for satisfying it, and to communicate this plan in writing and in oral discussion. They should be able to use the previously developed analysis techniques and present to the teacher a written plan for completing the exercise. This could be written using stored forms in a word processor file (eg. the 'planner' mode of "Quill" or a form stored as a separate file within any word processor)

BEST COPY AVAILABLE

or composed by the students themselves using what they have learned about appropriate styles for different types of problem representation (see module 1). This plan is then presented by the investigating group to the teacher and a peer review board for critique. The investigators are expected to present and defend their rationale as if they were applying to NSF for a research grant. Problems (Note: **not** 'errors') or potential problems should be pointed out, ideally by the peer board and the plan taken back for revision and resubmission (ok. so it really isn't exactly like NSF!). Once the plan has been accepted (keep in mind the caveat about the importance of plans and experiments that do not produce the expected results!) the entire team, researchers, peers, and teacher (whose role is mainly that of catalyst or suggestion resource) review the means of collecting the data and determine the form of representation.

Comprehension:

(In modules 2 and 3, the students were exposed to and had practice in collecting information for the various types of problem representation (interviews, questionnaires, tests, scaled or physical measurement), on note taking and organization, and on the various types of information resources (primary, secondary). It is further assumed that the students have had practice with abstracting relevant information and in drawing inferences from it.)

The students at this level are expected, with some guidance, to be able to take the lecture and demonstration material and determine what additional factual information they want and where to begin looking for it. They are expected to search out that information, take notes on it, and include a distilled, conceptual version of it in their plan outline and/or oral presentation (see module 2).

The students are also expected to take the lecture and demonstration information, their previous exposure and practice with various forms of experimental apparatus and the directions of the teacher and be able to explain how the current set of manipulatives (experimental apparatus, data tables, charts, computer simulation, or other sources of data) relate to the current question. They should also be able to develop, with some guidance to ensure that the relevant variables are included in some form, a plan for recording the data.

Note that many of these issues are involved in developing the plan for representing the question in the production level. These concepts and skills are not independent but rather interactive and should not be viewed as separate "skills". However, at this stage, module 4, the students are not expected to have the background experience to 'intuitively' know what information will be relevant and how to find it.

Much of the work in this stage is in effect a writing exercise and as such lends itself to word processing where revisions can be done relatively efficiently and painlessly. The focus is on representing **information**, ie. am I communicating these concepts and procedures effectively, are they organized logically and coherently. The content determines the form of the representation and the organization within it. Students at this level should be encouraged to interact with the content in terms if its concepts and implications. Reorganization of a particular section may lead to a different perspective and the resultant implications, if sought, may lead to a reevaluation of the plan or the goals. When this occurs, we can be fairly confident that the students are becoming problem solvers.

Recognition:

(It is assumed that through module 3, the students were exposed to different forms of data representation (text, maps, charts, tables, diagrams, lists, graphs), and the implications for each. It is not expected, with the exception of text representation, that they will be able to independently develop and manipulate them. It is further expected that they have been exposed to and had practice in organizing their notes and other materials in an orderly manner.)

Once the data has been collected, the students and the teacher collaborate on different ways of representing it. To get different forms of representation, the students are divided into teams, each responsible for representing their data set in a particular form (list, graph, text, table,etc.). Each team presents its version to the class for comparison and critique. The critique focuses on what that particular form communicates and on what it implies (for example, a chart may communicate more about how the various phases of an experiment were related whereas a table may communicate more about how an aspect of the data changed. Both are appropriate but for different intents.) At this stage, there is no attempt to delete extraneous data. That is an issue for the next stage. Rather the focus is on why a particular form is or is not appropriate for the given intent. The students need to develop the concepts related to each form (eg. When is a list used, why, what can one infer from it, ...) and as is true for any concept, both positive and negative examples are needed. The current intent, ie the current plan, provides the criteria for evaluating each form. However, in keeping with the problem solving perspective, it may be that the students and teacher decide to change the plan rather than the form of representation. If a rationale can be presented to show that the original plan was inappropriate or that the original problem was not the most interesting one in view of the current data, then the problem solving 'skills' are being actively used. It is this type of questioning, inferring, and organization that are at the heart of scientific problem solving.

When an appropriate form has been decided upon, here it is up to the teacher to manipulate the discussion so that the students understand why it is the appropriate one, each team is given a different focus for organizing the data within that form. At this point, the concepts of classifying data by variables, sequencing the data in one variable, and organizing more than two variables (if appropriate) are discussed and reinforced. Again, group presentation and discussion should focus on developing the concepts involved in determining the appropriate representation for the current plan.

Regardless of the type of representation, text, diagram, graph, table, etc., the students will need to be able to revise their particular form. Word processing, graphics (drawing), graphing, or spread sheet programs make this a relatively painless process and allow for a more rapid generation of alternatives.

Exposure:

In this stage, the teacher has a more direct role. The goal is to expose the students to the concepts involved in looking for relationships within the data. The data representations of the previous stage provide the focus for the discussion.

Concepts –

Choosing a focus: The important understanding is to examine the data for those variables which are most appropriate for the current plan. Each variable is examined for its contribution, either directly or inferentially depending upon the level of discussion, to answering the initial question and irrelevant data is, depending upon its future supportive or contrastive usefulness, eliminated or moved to less prominent positions within the representation. In comparative problem types, the focus is on the data sets which are most relevant. The teacher should take each team's representation and guide the students towards giving reasons for its appropriateness or lack thereof. Similarly in decision-making problems the discussion focus is on those variables which give the maximum information for making a choice. However, for the students to be able to develop and use this concept, they have to understand why a particular data set and representation is important. Hence, the representations which focus on extraneous variables are as important a discussion topic as those that focus on the critical variables. An experimental or correlational problem may not have such a clear focus. Rather it is in the nature of the problem type that the focus, from the point of view of the data, may not be the same as the focus from the perspective of the plan. In particular, a scientific experiment may set out to prove a particular relationship but when the data is analyzed, the investigator realizes that a different relationship is the critical one (of such serendipity and the ability to recognize it are famous scientists made). Hence, for these two problem types, the teacher needs to help the students see different possible focii and move on to the other concepts before eliminating any particular focus.

Eyeballing vs computational examination: The choice of teaching either or both of these depends upon the ability and experiential level of the students as well as the type of problem. The first factor must be determined by the teacher and the curricular goals for the particular class. To develop these concepts, students should first be exposed to data that can be resolved by simply eyeballing. This implies that the exercise itself was chosen with this in mind. At the next stage, resolution of the data should require simple averaging. On the next set of exposures, the students will need to use more sophisticated measures of central tendency and spread. Within each of these, exercises should be chosen that deal with an increasing number of cases and amount of information per case (number of variables and samplings). The suggested progression is as follows:

number of cases	number of variables	type
one	2	eyeball
limited with two extreme cases	2	eyeball
limited with arbitrary choice	2	eyeball
all cases	2	eyeball
all cases	2	calculates average
all cases	3	eyeball
all cases	3	calculates average
all cases	3 or more	standardizes scores, uses statistical analysis, and/or trend analysis

It should be kept in mind that not all of these have to be covered at this stage. This stage is designed to expose the students to the concepts while later stages refine the

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concepts in terms of the different levels and permutations. Comparative and decision-making problems will most likely, at this level, be amenable to eyeballing. However, to help move to the next stage, data which require simple averaging could be included for these types. Experimental and correlational types can also be setup for eyeballing and indeed in previous modules where the goal was to deal with other issues, eyeballing is the simplest and therefore the least distracting for the students to deal with. Depending, though, on their level of exposure and competence with the other issues, one would expect, at this level, that the students should be confronting the concepts involved in computational examination. Spreadsheet programs are highly effective for this especially if the students have already used them for representing the data they collected. Simple averages, statistical tests (ANOVA's, etc.), and various measures of trends (linear regression, etc) can be presented. The students do not necessarily need to understand the statistical or trend device itself, but with an introduction to the basic concept and some instruction in plugging in the values (this implies that the teacher has already setup the formula and any necessary cells within the spread sheet, eg. subtotals or standard deviations) they can be exposed to the results of such complex analyses and use them in their report.

Direction (+ / -), nature (linear / nonlinear), and size of relationship (ratio / nonratio): Determining the direction, nature, and size of the relationship requires the ability to hold things in tension. One set of data must be treated as a constant while another is compared against it. Depending upon the number of cases, variables, samples, and whether eyeballing or computation is appropriate, the students may be able to work directly from the data. However, relationships within the data, especially its nature, are more easily derived from a visual representation. Most spread sheet programs offer the capability to display data graphically either within the program or by linking with a separate graphing package. By displaying the data in graph form and comparing it to other, contrasting data sets, the concepts of direction and linearity can be introduced. This provides an opportunity to team with the math teacher and introduce concepts such as slope and y-intercept. It also provides an opportunity to introduce the concept of representing lines and curves with equations and using them to predict various datum, the concepts of interpolation and extrapolation (see module 6, Comprehension of Representing Relationships, for a discussion of the use of programs such as TK!-Solver and Sem-Calc to further develop these concepts). The presentation of math concepts by the math teacher within a science class aids in the generalization and application of cross-subject concepts, processes, and skills. Additionally, or alternatively if the concepts are taught within the math curriculum only, the student's notes from other courses become resources.

Once the students have begun to understand the basic concepts involved, some of the alternative data representations that were previously suggested can be plotted to further reinforce the concepts relating to data representation. Discussion should focus on whether a particular representation, either by itself or in graph form, makes the desired relationships obvious and more importantly, why or why not.

The students are expected, with some guidance from the teacher, to add a section to their written report showing the derived relationship representation and discussing its relationship to the original question. They are not expected at this point to make any generalizations or conclusions other than any reached in the general discussion (these topics are introduced in module 5). They are expected to discuss, both in class discussion and in their report, anything that they would do differently if they were to repeat the exercise and any new questions which were raised. The reports should then be 'bound' and included in the class resource library and/or added to the on-line data base under the appropriate key headings. This creates a resource for the students to refer to in making comparisons with similar problem types and as a means of widening their knowledge base.

Problem:

As in previous modules, the above has been conducted within the framework of an exercise. A problem, for the students, must require the use of their knowledge within what they perceive as a novel context, ideally one of their own creation, alternatively one 'planted' by the teacher. The context, however, must be carefully contrived, or manipulated by 'creative discussion' on the part of the teacher, to force the independent use of the concepts which the students are expected to produce and comprehend, to require them to recognize other concepts, and to provide an opportunity for further reinforcement of the current set of new concepts. In the current module, the students are expected to devise and evaluate a plan for solving the 'problem' and to collect the data for it. With some input from the teacher, they are expected to recognize alternative ways of representing the data and to engage in 'critical' discussion to choose the most representative. The data representation then provides an opportunity for further development of the concepts involved in representing relationships within the data. The students are then expected to independently devise a means of communicating the definition of the problem and the plan for solving it (the traditional rationale and methods sections). Communication of the data representation (results section) may or may not need teacher guidance especially if it is simply a matter of printing a computer file. Again, at this point the new concepts can be reinforced. It is sufficient, at this stage, to simply state the relationships within the data. Later modules will be concerned with deriving conclusions and generalizations from the results and expanding this section (discussion section). However, the students are also expected to include discussion of how the results addressed the problem and what they would do differently if they repeated the task. This report should also be added to the resource library.

Topic: Representing Relationships :

Information	Concepts	Process Skills & Concepts	Study Skills & Concepts	Cognitive Skills & Concepts	Science Content Concepts	Technological Support
Exercises						
	Exposure	Representing relationships Communicating results	using notes - within and between subjects	inference and generalization	vectors: direction resultant magnitude equilibrium	spread sheets & graphing programs
Acquisition						
	Recognition	Representing the data Communicating results	organization	abstraction implication	vector diagrams scales resultant data tables diagrams	spread sheet
Transformation	Comprehension	Collecting information	note taking organization information sources	abstraction inference	measurement science texts & references	word processing
	Production	Representing the question		abstraction analysis conceptualization argumentation	How is the size of the force related to the the size of the angle?	word processing
Evaluation	Problems	al' (see text)		generalization inference	Trajectory problems	Artillary or America's Cup programs writing a program to draw vector diagrams given different inputs and showing the resutant

Merrimack Education Center
Chelmsford, Massachusetts

Technological Applications in Basic Skills
Module Outline

School: Tewksbury Jr. High School Date: June 22, 1984

Subject: Problem Solving

Subject Area: Physical Science - Grade 8

Content: Motion - Vectors

I. Instructional Rationale:

To expose the students to the concepts involved in representing relationships within data, to reinforce concepts involved in representing data, collecting information, and representing the question.

To introduce the concepts of vectors and vector analysis and the understanding that motions can be analysed in terms of vectors and their resultant.

II. Prerequisites:

1. Independent ability to represent questions, involving the abstraction of main ideas or concepts, problem analysis, and the ability to give a reasonable supporting argument (modules 1 - 3).
2. Comprehension of the concepts involved in collecting information, including the use of primary and secondary sources, use and implications of different data recording forms, and record keeping (modules 2 - 3).
3. Recognition of the different forms used to represent data and an awareness of some of the implications of their use, including maps, diagrams, lists, charts, tables, graphs (module 3).
4. Knowledge of the basic concepts of motion, including mass, weight, force, gravity,speed, acceleration, and deceleration.
5. Basic familiarity with a word processing package and a spread sheet package.

III. Instructional Design:

A. Objectives

1. Science Content
   - a. motion can be analyzed and represented in terms of vectors
   - b. vectors have both a direction and a magnitude
   - c. a given motion is the resultant of several forces
   - d. equilibrium is a state of balance between opposing forces
   - e. vector diagrams are used to represent the forces on an object
   - f. scales are used to represent very large or very small magnitudes
2. Process Content
   - a. sets of data can be represented in terms of relationships among the data items
   - b. choosing different focii, variables, within the data set may make different relationships obvious or make it appear that there is no apparent relationship
   - c. investigating different focii and their relationships can help in choosing the appropriate one for the given question or may lead to an answer to a totally different question
   - d. some relationships can be inferred through a simple eyeballing of the data, but others can only be discovered through computation
   - e. graphs are an efficient way to represent the results visually and, through determining the slope and y-intercept, aid in determining the direction, nature, and size of the relationship
   - f. mathematical representations and manipulations allow interpolation, the filling in of intermediary data points, and extrapolation, the generation of data points beyond the testable range
   - g. to reinforce the concepts involved in choosing from the different forms of data representation (module 3)
   - h. to reinforce the concepts involved in collecting data (module 2)
   - i. to give the students a situation in which they can practice determining the type of question and representing it and in communicating their plan for resolving the question, their data, and the relationship within the data
3. computer competencies
   - a. to reinforce the use of a word processor and spread sheet as organizational and communication tools
   - b. to introduce the use of a spread sheet as a means of

manipulating data and in determining relationships

c. to introduce the use of graphing programs as a means of representing data and as a tool for determining relationships

B. Instructional Strategy:

1. Lecture / demonstration to introduce vector concepts
2. Presentation of exercise: using spring scales and weights on a vector board to determine the relationship between the size of the force and the size of the angle. This should follow from the demonstration and be presented as an 'interesting question', "Gee I wonder what ..."
3. The students are given the task of working in small groups to determine the type of problem and entering into the word processor a rough draft of a plan for answering it. Depending upon the extent of the lecture and demonstration, they may need to request additional information regarding the vector board from the teacher, but such germane questions are part of the information collection task and should be encouraged. The rough drafts are then submitted for review and acceptance or revision (see overview). Depending upon the abilities of the class and any serious time constraints, the teacher may want to allow more than one definition and plan for comparison, now and in each of the subsequent stages, rather than manipulate the acceptance of a single plan. It is necessary, however, to ensure that alternative plans and conceptualizations are **not** regarded as <u>wrong</u>, but rather as <u>departure points for discussion</u>.
4. The teams of students collect the data. As part of the plan discussion, the issues in measuring and recording the data should have been raised, if not by the students then surreptitiously by the teacher.
5. When the data has been collected and recorded, the class should discuss the different ways of representing the data. Each form should be discussed in terms of its assumptions and implications. The various teams should each choose one form of representation and arrange their data accordingly using the word processor or spread sheet. Each team then presents their data, in their chosen form, to the class for critique. The discussion should center on why a particular representation is or is not appropriate.
6. When a form has been decided upon, with 'a little help from the teacher', the teams return to their work area to re-organize their

data or enter it into a spread sheet. To reinforce the concepts of data representation, the different organizational choices are discussed in terms of the implications and assumptions surrounding the choice of a particular variable. The concepts of classifying data by variables and sequencing the data in one variable provide a focus for the discussion.

7. One of the data tables is then selected for examination by the class or each team's data is examined individually and the concepts involved in determining a relationship are presented. The teacher leads a discussion on determining a relationship through eyeballing vs calculation and on using averages. The effect of different focii, using the data tables from different groups, is presented in terms of the relationship to the original question. Instruction is given in the formulas and procedures used to determine averages within the spread sheet and the students allowed to construct similar cells within their team's data files. (More advanced formulas may be used with more advanced groups.)
8. The teacher then demonstrates the use of a graphing package to plot a data table. Discussion is invited on the visual representation of the relationship conclusions from the previous section. The concepts of slope and y-intercept are introduced.
9. The students return to their work areas to complete writing a report of the experiment. Upon completion, the class should discuss the experiment in terms of how well it answered the initial question, whether it raised any new questions, and how the information could be used.
10. The students are then presented with a 'problem'. If the preceeding discussion raised a similar area for application then it should be used, otherwise the discussion should be 'steered' toward one, or more, of the following areas: trajectories or sailing. The students are then given the task of applying their knowledge to either the Artillary or America's Cup programs or to writing their own program to display vectors and the resultant in a context of their choosing.

C. Scheduling

Classes	Activities
1-2	Lecture / Demonstration
3	Representing the Question
4	Collecting Data
5-6	Representing the Data
7-9	Representing Relationships

D. Instructional Materials

Lab materials, computers, monitors, and printers.
Software: word processing, apread sheet, and graphing packages.
Optional: Artillary - a 'game' involving two opposing artillary pieces and an intervening mountain. The object is to calculate the angle and force needed to project your shell over the mountain and into the enemie's gun. The program generates a variable wind velocity and direction which must be considered.

America's Cup - a sailing simulation in which players try to calculate headings to sail their entry and win (re-win?) the America's Cup.

BASIC, Pascal, or some familiar programming language for the students to write their own vector simulator.

E. Teacher Preparation Activities

1. Prepare lecture and demonstration
2. Collect materials (spring scales, weights, screw eyes, board, string) for each team.
3. Set up computer and monitor for each team and at least one printer.
4. Enter blank data table and configure calculation cells. This table will be filled in later using sample data from the students to demonstrate the calculations.
5. Familiarity with graphing package, especially if it requires file transfer from the spread sheet.

F. Classroom Organization and Management

1. Traditional seating for lecture and demonstration
2. Discussion group seating for all student presentations
3. Data collection - small groups of students assigned to a workstation.

Data recording and presentation duties should be shared and rotated among the members.

4. Small group discussion - as the groups are working, the teacher engages them individually in a discussion of their progress as a means of directing and as a means of reinforcing an understanding of the concepts

G. Student Activities

1. Listen and take notes during the lecture / demonstration
2. Prepare a representation of the question and a plan for resolving it
3. Present thier representation orally for a critique
4. Collect and organize data with some teacher guidance and give an oral presentation
5. Participate in a discussion of representing the relationships within the data and use the spread sheet and/or graphing capabilities to develop a representation of their data
6. Write a report including all of the above and include the report in the resource library and/or the on-line data base of similar reports under the appropriate keys for future reference by this and other classes
7. Apply these concepts to a 'problem' raised by the class discussions.

H. References

Heimler, Charles H. and Price, Jack. Focus on Physical Science. Ohio: Charles E. Merrill, 1977.

APPENDIX B

SAMPLE MODULE

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

TECHNOLOGICAL APPLICATIONS IN BASIC SKILLS

MODULE OUTLINE

SCHOOL: Tewksbury Jr. High School DATE: July 2, 1984

SUBJECT AREA: Physical Science

TOPIC: How to Use a Problem-Solving Approach to Learning

I. Instructional Rationale

To enhance the cognitive domain of logical thinking and develop the ability to discover relationships, formulate hypothesis and arrive at solutions through a series of trial and error experiences.

II. Prerequisites

General working knowledge of an Apple computer.

III. Instructional Design

A. Student Objectives

1. Content Area Objective

o to develop the understanding that there should be a systematic approach to problem solving

2. Process Skills

Collect Some Information

Obtaining Data at Source

- to gain experience scanning over lists of data several times, each time gathering more data -- or eliminating possibilities -- in order to draw conclusions (scan for clues and hints)

- to learn to seek information through research or experimentation

- to learn to use the experimentation process to formulate a hypothesis

Organize the Information Into a Logical Pattern

Judging the Adequacy of Data

- to learn to break down the problem, solve it in parts, if possible, and identify necessary and unnecessary information

Putting Data into Framework

- to gain experience in note (data) recording and making organized lists
- to find order and discover patterns, relationships and improve perception
- to gain experience in understanding the importance of sequence
- to recognize there may be more than one solution (pattern) to a problem

Drawing Conclusions

Observing Relationships in Data

- to learn to vary only one aspect (variable) at a time to eliminate errors in conclusions
- to gain experience in using the cognitive strategy of working backwards

3. Computer Competencies

To develop the ability to:

- use the computer keyboard to follow menued instructions

B. Length of Time for Module

Approximately 12 46-minute class periods

Scheduling details:

Computer Classroom - 6 periods
Regular Classroom - 6 periods

C. Teacher Preparation Activities

Become acquainted with the computer operation of the following software:

The Factory
The Incredible Laboratory
The Pond

Collection of practice worksheets related to the above.

D. Instructional Materials

Transparencies
Worksheets
Software:

Factory

Uses several strategies used in problem solving: working backwards, analyzing a process, determining a sequence and applying creativity.

The first level of the program allows students to experiment with three machines.

The second level, the students' creativity can be expressed where they can design products, try to produce them using combinations of the three machines, and then challenge other students to produce them.

The third level, students look at a final product and then work backwards and determine what process took place to construct the product. In order to perform the task, students must know the function of each machine and devise a sequence which will produce a final product.

The Incredible Laboratory

Made up of three main sections: Novice, Apprentice, Scientists.

Designed to teach strategies. It places each student in the role of a scientist creating monsters in a laboratory. By selecting from a list of chemicals, a monster is created with features such as a green head, cowboy boots, or a scaly body. The student must determine which chemical was used to create each part.

Altogether there are five different body parts with six possible variations each.

Particular emphasis is placed on successive scanning (process of scanning over lists of data several times, each time gathering more data -- trial and error).

Note taking and making organized lists -- from this they can devise hypothesis and test those in the next experiment.

The Pond

Designed to teach strategies. It focuses on gathering information to formulate a hypothesis or pattern. After the relationship is discovered, the hypothesis or pattern is tested.

The objective of the program is for the student to help a frog jump along a maze of lily pads arranged in a pattern. Students can discover the pattern by moving the frog one lily pad at a time. In order to reach the magic lily pad at the end of the pattern, the student must be able to identify and type in a pattern that will make the frog jump through the pond without falling into the water. The pattern entered must repeat at least once for the frog to jump onto the magic lily pad.

E. Instructional Strategies

This module should be presented at the beginning of the year as a "Problem-Solving" topic. All other topics during the year will be "spin-offs" of a problem we have to solve.

Students will be asked to apply what they have learned from this module with other problems they will encounter throughout the year.

The computer, as a tool, will better demonstrate a problem situation rather than just paper and pencil patterns. Hence, closer to a real life situation.

F. Classroom Organization and Management

All students will have experience with each piece of software. The number of students who will work on each program at one time will be as many as the physical limitations of numbers of students, computers and discs will allow.

G. Student Activities

Students will participate in worksheet exercises to reinforce the computer program used. Students will be asked to summarize what they have learned about problem solving after using each piece of software.

H. Evaluation

Whether problem solving skills have been attained by students and used, where appropriate, in problem solving situations, can be determined in future reports handed in by students as basic scientific.

APPENDIX C

PRACTICUM REPORTING FORMAT

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

TECHNOLOGICAL APPLICATIONS IN BASIC SKILLS

PRACTICUM REPORTING FORMAT

1. SUBJECT AREA

2. MODULE TOPIC

3. CURRICULUM OBJECTIVES

   Were the student objectives for the module appropriate for this audience? If not, please explain.

   a. Content area objectives
   b. Process skills objectives
   c. Computer competencies

4. STUDENT ACTIVITIES

   a. Describe the student activities and how they were scheduled.

   b. Was the software chosen for this module effective in helping students reach the specified objectives?

   ☐ ☐ ☐ ☐ ☐

   Very Effective Effective Not Effective

5. RESULTS/OUTCOMES

   a. What was the overall effectiveness of this module (i.e., to what extent did the target audience achieve the stated objectives).

   ☐ ☐ ☐ ☐ ☐

   Very Effective Effective Not Effective

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APPENDIX D

SUMMARY OF HARDWARE AND SOFTWARE

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

TECHNOLOGICAL APPLICATIONS IN BASIC SKILLS
SUMMARY OF HARDWARE INVENTORIES
January 1984

BURLINGTON			LUNENBURG			TEWKSBURY		
Type	Computer Number	School (Room)	Type	Computer Number	School (Room)	Type	Computer Number	School (Room)
Apple II Plus	4	Marshall Simonds Middle School (Computer Lab)	Apple II E	8	Turkey Hill Middle School (Lab Area 213)	Apple II Plus (64 RAM)	10	Jr. High (214)
Apple II E	23	"				Apple II E * Terminals - DEC (LA 36 & VT101 with modem & switch) * Used with Tech DEC System 20 Computer	2 2	Jr. High (214) Computer Room

Computer Peripherals			Computer Peripherals			Computer Peripherals		
Type	Computer Number	School (Room)	Type	Computer Number	School (Room)	Type	Computer Number	School (Room)
Disk Drives Apple II	26	Marshall Simonds Middle School	Disk Drives Apple	8	Turkey Hill Middle School	Disk Drives - Apple II	6	Jr. High (214)
Printer, Apple Dot Matrix	3	"	Printer - Image Writer	1	"	Printers - Epsom MX	2	"
Printer, MX-80 Epsom	1	"	Printer - Epsom	1	"	Koala Pad	1	"
Printer, RX-80 Epsom	2	"				Joystick - Apple	1	"
Green Screens (for Word Processing)	15	"				Board - Apple IIE (80 col)	1	"
Paddles, Apple II Plus	1 set	"						

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TECHNOLOGY APPLICATIONS IN BASIC SKILLS

SOFTWARE INVENTORY
MARSHALL SIMONDS MIDDLE SCHOOL
BURLINGTON, MA

Carson-Dellosa Publishing Company
Key on Keyboarding (Text)

Centre for Applied Researcn
Nyack, New York

Basic Composition Kit (Text)

Christopher Lee
Houghton Lake, MN 48629

Find It Fixit (Transparencies and Masters)

Kirya Systems

Typing Tutor III

MECC
2520 Broadway Drive
St. Paul, MN 55113

MECC LA Arts Disc - Elementary

Milliken
1100 Research Blvd.
St. Louis, MO 63132

Milliken Word Processor

Ontario Institute for Studies in Education
Toronto, Canada

Writing for Results

Scholastic
904 Sylvan Avenue
Englewood Cliffs, NJ 07602

Story Tree
Bank St. Writer

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CHELMSFORD, MASSACHUSETTS

TECHNOLOGY APPLICATIONS IN BASIC SKILLS

SOFTWARE INVENTORY
TURKEY HILL MIDDLE SCHOOL
LUNENBURG, MA

Apple
20525 Mariania Avenue
Cupertino, CA 95014

Apple Presents Apple
Applewriter

Britannica
425 N. Michigan Avenue
Chicago, IL 60611

Britannica Library Skills

ComBase
St. Paul, Minnesota

Elementary Library Media Skills

Conduit
P. O. Box C
Oakdale, Iowa 52319

Computer Concepts
Interpreting Graphs

Learnco
Greenland, NH

Answering Questions Library-Style

McGraw Hill
1221 Avenue of the Americas
New York City, New York 10020

Archeology Search
Geology Survey

Milliken
1100 Research Blvd.
St. Louis, MO 63132

Milliken Writing Workshop

MECC
2520 Broadway Drive
St. Paul, MN 55113

Classification
Heat Loss
Odell Lake, Odell Woods
Sumer
Soldist
Ursa

Muse Software
347 N. Charles Street
Baltimore, MD

Data Plot

National Science Teachers Assoc.
1742 Conn Avenue, NW
Washington, D.C.

Personal Energy Survey
Temperature Graph

Scholastic
904 Sylvan Avenue
Englewood Cliffs, NJ 07602

Bank St. Writer

Southwestern Publishing Company
5101 Madison Road
Cincinnati, OH 45227

Alphabet Keyboarding
PFS File

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

TECHNOLOGY APPLICATIONS IN BASIC SKILLS

SOFTWARE INVENTORY
TEWKSBURY JUNIOR HIGH SCHOOL
TEWKSBURY, MA

Apple
20525 Mariania Avenue
Cupertino, CA 95014

Appleworks

Compress
P.O. Box 102
Wentworth, NH 03282

Molecular Animator
Test Generator
The Elements

Focus Media, Inc.
135 Nassau Blvd.
Garden City, NJ 11530

Physical Science Keyboard Package
Energy Keyboard Package
Matter Keyboard Package
Matter & Energy Series
Energy Series
Discovering the Scientific Method

HRM Software

175 Tompkins Avenue
Pleasantville, NY 10570

Experiments in Science
Optics: Mirrors and Beams

Great Plains National Company

Science Lesson #2 - Physics

Ideatech Company
P.O. Box 62451
Sunnyvale, CA

Basic Electricity

Sunburst Communications, Inc.
39 Washington Avenue
Pleasantville, NY

Fun House Maze
Incredible Lab
Semi-calc
Think Tank
Pond
Code Quest
The Factory
Color Keys
Explorer Metros
Discover a Science Experiment

Krell Software
320 Stoney Brook Road
Stoney Brook, NY 11790

Connections

MUSE Software
347 N. Charles Street
Baltimore, MD

Data Plot

MECC
2520 Broadway Drive
St. Paul, MN 55113

Energy Conservation Manager
Electronic Spreadsheet

Visicorp Inc.
2895 Zanka Road
San Jose, CA 95134

Visicalc

APPENDIX E

SCIENCE MODULE (SAMPLE)

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

PROJECT: TECHNOLOGICAL APPLICATIONS IN BASIC SKILLS
(A Project of the Division of Educational Technology,
U. S. Office of Education, Washington, D.C.)

MODULE OUTLINE

SCHOOL: Lunenburg Middle Schools DATE: August 9, 1984

SUBJECT AREA: Science

TOPIC: Energy Conservation

I. Instructional Rationale

To stress conservation of energy as a means of saving non-renewable resources until technology can find efficient, workable ways to use alternative energy sources.

II. Prerequisites

The student should be able --

- to understand geologic time
- to understand geologic processes
- to understand fossil fuel formation

III. Instructional Design

A. Process Objectives

1. Representing the Question

a. to follow oral directions
b. to follow written directions

2. Collecting Information

a. to take accurate notes
b. to order collected information

3. Representing Data

a. to determine the purposes of the various kinds of graphs
b. to locate points on a grid
c. to read multi-column tables
d. to interpret graph pictures
e. to interpret tables

4. Representing Relationships

   a. to arrange ideas in sequence
   b. to compare/contrast information

5. Representing Conclusions

   a. to make judgments about data
   b. to summarize data
   c. to produce a conclusive written report

B. Content Objectives

1. Representing Data

   a. to diagram (by graph) the scientific information obtained by the experiment
   b. to distinguish the purpose of the various types of graphs and determine which is most appropriate for this lesson

2. Representing Relationships

   a. to classify materials according to their insulative properties
   b. to compare the relationships between different insulative materials and their abilities to retain or keep out heat energy
   c. to contrast the effectiveness of different insulative materials

3. Representing Conclusions

   a. to interpret the graphic information pertaining to heat loss

C. Computer Competencies

The student should be able --

- to load, boot and run disks
- to use the computer to generate graphs from scientific information

D. Length of Time for Module

2 weeks

Scheduling Details

- class will meet for one 45-minute period each day for 10 days

- six days will be spent in classroom and laboratory actually listening and gathering information

- four days will be spent in computer lab to enter data

E. Teacher Preparation Activities

1. Teacher must gather or purchase lab material.

2. Teacher must learn Data Plot.

F. Instructional Materials

- worksheets on understanding and interpreting various kinds of graphs
- lab sheet with instructions for doing and writing up the lab

Software Program Description:

- "Interpreting Graphs"
- "Data Plot"

G. Instructional Strategies

1. Large Group

Listen to lecture presentation of content methodology and goal. Use of Data Plot software.

2. Peer Group

Work in groups of two to do the lab and also to enter data into the software package called Data Plot.

3. Individual

Maintain records for lab activity and also generate conclusions at the conclusion of the exercise.

H. Classroom Organization and Management

- lab conducted by students in groups of two
- same grouping maintained in the computer lab
- while some students are on the computers, remainder does accompanying activity sheets on graphs
- once lab work and graphs have been completed, students prepare a formal lab report on their activities.

I. Student Activities

Day 1 Whole class begins unit with a discussion of how graphs can help us visualize scientific information.

Worksheets - Graph Interpretation

a. circle graphs
b. bar graphs
c. line graphs

Day 2 Computer Lab - Students in teams of two boot and run the software "Interpreting Graphs" and conclude the activity by doing the graph simulation game on the disk. The disk continues to expand the students' understanding of the grid and grid positions and the position locations as given by a set of coordinates.

Day 3 Application of graph information will be made to our scientific problem of energy conservation. Since this is first exposure in Science Lab for the students, adequate time must be spent on a pre-lab discussion to cover new areas: using °C, controlling variables (example, all cans receiving same light exposure; all cans same distance from heat source, etc.) and a rehash of written instructions with a practice run through lab.

Day 4 Students run lab and record data during the heating and cooling phase of the experiment. Data is recorded in a chart or data table that the students generate.

Day 5 Computer Lab - The whole class is introduced to software called "Data Plot" through the use of a large screen TV monitor. Discussion of advantages of computer doing graph generation. Students will observe how to enter data, how to plot data, how to save on disk, how to print single graph, how to print multiple graphs.

Day 6 Computer Lab - Groups will enter their information, plot and save it.

Day 7 Repeat of Day 6.

Day 8 Computer Lab - As printer becomes available, students print graphs for the heating and cooling curves.

Day 9 Cooperative group discussions on what lab data indicates about irrelative materials -- Is the data reliable? What conclusions can be drawn about which is the best insulative materials under given conditions?

Day 10 Classroom: Entire class meets to discuss and interpret data.

J. Evaluation Instruments

1. Written lab report - drawing conclusion about the insulative properties of various materials.

2. Teacher checklist of observable lab behaviors.

3. Teacher scale of evaluation of computer competencies.

4. Teacher scale of evaluation of study skills stressed by the module.

5. Worksheets on graph selection and interpretation to evaluate acquisition of skills.

K. References

1. "Data Plot" documentation

2. NSTA Science Study Skills Program - "People, Energy and Appropriate Technology"

3. EDC Intermediate "How To" Series on Graphing by Agro, Sally, et.al.

L. Suggestions for Module Implementation for the Gifted and Talented

Lab - How Can Insulation Help Save Energy?

Materials:
- 4 soda cans, same size and same color if possible (Why is this important?)
- 4 thermometers
- clock with second hand
- hot water
- 150 watt lamp (reflector and clamp)
- newspaper
- aluminum foil
- fiberglass
- clay
- tape
- funnel

Wrap can 1 with thick layer of newspaper. Be sure to cover the top of the can with paper also. Continue to do the remaining cans in the same manner usig Al foil, fiberglass and clay. Insert a thermometer into each can after you have used the funnel to fill each can with hot water. (Be sure you use the same volume of hot water with each can.) If necessary, secure the thermometers in the cans with the clay. Turn on the lamp. Be sure that the light shines equally on all the cans. Record the temperature in each can every two minutes for 20 minutes. Turn off the lamp. Record the temperatures every two minutes for another 20 minutes.

You will use the information to graph the information using Data Plot.

After the graphs have been constructed, you will draw conclusions on the effects that different insulation materials have on energy conservation.

Explain the following:

a. Which materials reached the highest temperature?

b. Which material stayed the coolest?

c. Which material dropped the fewest number of degrees after you removed the jars from the energy source?

Merrimack Education Center 101 Mill Road, Chelmsford, Ma 01824
617-256-3985

MEMORANDUM FOR:
Grade 8
Holistic Essay Scoring Project

Subject: Scoring Codes for the Workshop Essays

Date: Nov. 29, 1984

From: John Sweeney
Jean Sanders

In the scoring session, each participant indicates his or her score for an essay by using a letter code. That is, instead of recording the score 4, 3, 2, or 1 on the essay paper, each reader indicates the appropriate score by an assigned letter. Each reader has a unique code; however, in all codes assigned, a particular letter always represents the same value. For example, whenever B was assigned, it represented the value of one; whenever G was assigned, it represented the value of three. The basic code follows, indicating the letter equivalents for the four scores:

(Low)	1.	R B A L S
	2.	M J D K U
	3.	W Q G Z P
(High)	4.	H C N F V

Each paper was read at least twice. The scores given by both readers were accepted if: 1) the same value was assigned by both readers to the essay (i.e. 4-4, 3-3, 2-2, 1-1) or, 2) the two values assigned by the readers were within one point of each other (i.e. 4-3, 3-2, 2-1). On the other hand, papers with a discrepancy of more than one point between readers (i.e. 4-2, 4-1, 3-1) necessitated a third reading.

By noting the above code, you will be able to determine the values assigned to each essay written in the class(es).

The scores for each student are computed on a scale from 2 to 8 by adding together the two ratings. A score of 8 does not necessarily represent the ideal paper; it does indicate that the paper was among the best of the 150 essays scored.

BASIC SKILLS WRITING EXERCISES

APPLICATION TECHNOLOGY FOR BASIC SKILLS

DIRECTIONS FOR FACILITATORS TO ADMINISTER

The Writing Exercises. The writing exercises call for the students to produce two pieces of work, a descriptive and an expository essay. The particular exercises were prepared for this project.

The Administration of the Writing Exercises. The student essays are to be written in the classroom without aids such as a dictionary allowing thirty to fourty minutes for each of the two exercises. The students write on any type of 8½ by 11" paper. Both sides of the paper may be used, though it is important that each student use no more than one piece of paper for each exercise. A separate piece of paper should be used for each of the two exercises.

Each student record shows his or her name, teacher, class, and group on the card. A seven digit number code is used to assure anonymity of essays during the essay reading workshop.

After the essay writing, the two essays are collected by the teacher. The two student essays are batched separately with a cover sheet indicating school, teacher, grade, and class for each notebook of papers.

Selection of Readers. The readers are teachers of writing or staff familiar with student writing at several levels. For the one day scoring workshop, one teacher (scorer) should be available for every 150 sets of student papers submitted.

In those cases where three readers read the essay, the two highest scores can be used (e.g., 3,2,1 choose the two and the three for a total of 5).

Using the student code cards prepared for each student at the time of the writing exercise, report the scores for each student for data processing. These coded cards show each student's total score for each essay. This listing of scores will be submitted by your local project facilitator for data entry. On the data entry form, the student essay scores will be matched wi+ʰ covariate information that has been collected locally.

APPENDIX F

STAFF DEVELOPMENT BURLINGTON

MARSHALL SIMONDS MIDDLE SCHOOL

BURLINGTON, MASSACHUSETTS

OUTLINE AND SCHEDULE

OF

STAFF DEVELOPMENT MODULES

1. Basic Computer Literacy

2. Technology in Education: A Vision

3. Technology and Writing: An Overview

4. Revitalizing the Teaching of Writing

5. Technology Tools and Writing

6. Instructional Design: Principles and Practices

7. Instructional Applications Development

8. Practicum: Pilot-Testing Instructional Modules

Sequence

		Time	
1.	Basic Computer Literacy	6 hrs.	
2.	Technology in Education	ongoing, ad hoc	
3.	Technology and Writing: An Overview	2 hrs.	3/5-3/9
4.	Revitalizing the Teaching of Writing	8 hrs.	3/12-3/23
5.	Technology Tools and Writing	8 hrs.	3/19-4/6
6.	Instructional Design: Principles and Practices	2 hrs.	4/2-4/13
7.	Instructional Applications Development	4 hrs.	4/13-4/27
	Total	24 hrs.	
8.	Practicum	12 hrs.	4/27-6/1
	Grand Total	36 hrs.	

Note: Readings, self-study materials, activities

APPENDIX G

THREE CREDIT GRADUATE COURSE

FITCHBURG STATE COLLEGE

DIVISION OF GRADUATE AND CONTINUING EDUCATION

COURSE REQUEST FORM

SUMMER 1984

SUBJECT AREA (ACADEMIC DEPT.) EDUCATION TODAY'S DATE 6/26/84

COURSE NUMBER (IF KNOWN) ME 971 CREDITS 3

COURSE TITLE THE APPLICATION OF TECHNOLOGY TO PROCESS SKILLS IN CURRICULUM DEVELOPMENT

COURSE LEVEL: CIRCLE ONE
700 Undergraduate Credit ONLY
800 Graduate Credit (Undergraduates Admitted)
x900 Graduate Credit ONLY

COURSE DESCRIPTION: If course has never been offered, or if changes are to be made, please attach or write on reverse side.

If course is a repeat, please check course description in Room T108. SPECIFY ANY PREREQUISITES

INSTRUCTOR Jean E. Sanders, Ed.D. Rank Visiting Lecturer
(List name EXACTLY as it should appear in Bulletin)

HOME ADDRESS (Visiting Lecturer) 24 Charlemont Court, No. Chelmsford TELEPHONE 251-3502

WORK ADDRESS 101 Mill Road, Chelmsford, MA 01824 TELEPHONE 256-3985
(If not on-campus)

PLEASE CHECK PREFERRED CLASS MEETING DAY AND TIME:

____ MONDAY ____ TUESDAY ____ WEDNESDAY ____ THURSDAY

SPECIAL SCHEDULING (PLEASE DESCRIBE) ____

ROOM PREFERENCE AND/OR SPECIAL REQUIREMENTS 160 Turnpike Road, Chelmsford, MA 01824

IS THIS COURSE BEING OFFERED AS PART OF YOUR REGULAR (CONTRACTUAL) TEACHING LOAD?

x YES ____ NO

APPROVED BY: ____ Jean E. Sanders
(Dept. Head or Grad. Com. Chairperson) (Instructor's Signature)

FOR OFFICE USE ONLY

SEMESTER SUMMER 1984

COURSE #

TITLE

INSTRUCTOR CREDITS SEATS

ROOM COST

DAY TIME

BEST COPY AVAILABLE

FITCHBURG STATE COLLEGE

FITCHBURG, MASS. 01420

DIVISION OF GRADUATE
AND
CONTINUING EDUCATION

STANDARD COURSE DESCRIPTION FORM

CATALOG NUMBER ME 971
COURSE TITLE The Application of Tech. to Process Skills in Curriculum Dev.
INSTRUCTOR Dr. Jean E. Sanders

CATALOG DESCRIPTION: 2-4 sentences

Teachers learn to facilitate content mastery and this course will assist teachers in implementing strategies for classroom instruction in the procedural skills. Problem solving, procedural skills for studying and "learning to learn."

GRADE AND ATTENDANCE POLICY:

In 2 or 3 cr.courses,only one 3 hr. absence is allowed & work must be made up. Thereafter each session missed means a reduction in grade by .5 (4.0 to 3.5 etc.) In the event of extenuating circumstances,notify MEC's Director of Staff Dev. & special arrangements may be worked out for make-up in conjunction with instructor/director/student. In a 1 cr. course there are no abesences allowed.

COURSE REQUIREMENTS: Assignments,etc.

Preparation of a lesson plan with classroom activities (including description, materials and critique of each;) completion of problem solving, study skills or written language exercises; definition of instructional strategies.

REQUIRED AND SUGGESTED TEXTS: (GIVE TITLE, AUTHOR & PUBLISHER)

(R) "My Students Use Computers" Beverly Hunter, Reston Publishers

(R)

For science and problem solving, Ontario Institute for Studies in Education (OISE, Ontario) materials

Sample modules prepared by Dr. Charles Mojkowski.

MERRIMACK EDUCATION CENTER/FITCHBURG STATE COLLEGE

COURSE SYLLABUS FORM

COURSE TITLE: THE APPLICATION OF TECHNOLOGY TO PROCESS SKILLS IN CURRICULUM DEVELOPMENT

OVERALL GOAL: To stress the need and provide the practice for developing process skills in planning curriculum for middle school students and to utilize computer software to assist in the development of the process skills.

SESSION TOPICS:

August 6, 1984

Presentation and student participation in development of process skills for several subject areas.
Review hands-on experience with computer hardware to assist in development of process skills.
Student assignments of segments of subject matter for curriculum development.

August 7, 8, 9 Work Sessions

Development of segments of curriculum to include process skills supported, where possible, by computer software.

August 10

Analyze, review and refine segments of developed curriculum.
Identification of possible problems to be faced upon implementation of revitalized curriculum during the coming school year and planning to provide for these problems.

ME 971 THE APPLICATION OF TECHNOLOGY TO PROCESS SKILLS IN CURRICULUM DEVELOPMENT

GOALS

- Encourage teachers and students to use and create computer applications that are helpful in teaching, learning, managing information and solving problems in all subject areas.
- Help students and teachers to develop a sense of control over computers and to learn a variety of tools and techniques for exercising that control.
- Help students and teachers learn problem-solving procedures-procedures that people can use with and without the aid of computers.
- Help students and teachers to evaluate advantages, disadvantages, and limitations of particular computer applications.

The Project will focus on the following areas:

- Substantive concepts (concepts and principles integrated into "knowledge").
- Scientific Method and Problem Solving (skills for "learning to learn"; procedural skills).
- Specific skill strands; dependent upon content area chosen, teachers will list and identify the specific tools (.e.g., collect and summarize data, express concepts and ideas in pictorial or graphic form).
- Practice with the computer as a tool to assist with these skills: (a) numerical representation of physical phenomena; (b) graphical representation of numerical date; (c) relationships and variables.

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

PROJECT: TECHNOLOGICAL APPLICATIONS IN BASIC SKILLS

PROGRAM FOR SUMMER INSTITUTE

AGENDA - August 6, 1984

Common Meeting - MEC Computer Learning Center, 160 Turnpike Road

8:30 A.M. - 12:30 P.M.	-	Morning Session
		Project Evaluator's Presentation (Dr. Ronald Nuttal)
		Hypothetical Module to be Presented for discussion. (Dr. Charles Mojowski)
1:30 P.M. - 4:30 P.M.	-	Afternoon Session
		Work session at individual school buildings. Refinement of Modules completed.

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DIVISION OF GRADUATE AND CONTINUING EDUCATION

COURSE REQUEST FORM

WINTER/SPRING SEMESTER 1984

SUBJECT AREA (ACADEMIC DEPT.) EDUCATION TODAY'S DATE 4/11/83

COURSE NUMBER (IF KNOWN) ME 861 CREDITS 3

COURSE TITLE Technology Applications in Problem Solving (Science)

COURSE LEVEL: CIRCLE ONE
- 700 Undergraduate Credit ONLY
- x800 Graduate Credit (Undergraduates Admitted)
- 900 Graduate Credit ONLY

COURSE DESCRIPTION: If course has never been offered, or if changes are to be made, please attach or write on reverse side.

If course is a repeat, please check course description in Room T108. SPECIFY ANY PREREQUISITES

INSTRUCTOR George Hanify Rank Visiting Lecturer
(List name EXACTLY as it should appear in Bulletin)

HOME ADDRESS (Visiting Lecturer) 271 Washington Street, Belmont TELEPHONE 484-5451

WORK ADDRESS MEC Training Center, 160 Turnpike Road, Chelmsford, MA TELEPHONE 256-6254
(If not on-campus)

PLEASE CHECK PREFERRED CLASS MEETING DAY AND TIME:

___ MONDAY ___ TUESDAY ___ WEDNESDAY ___ THURSDAY

SPECIAL SCHEDULING (PLEASE DESCRIBE)

ROOM PREFERENCE AND/OR SPECIAL REQUIREMENTS 160 Turnpike Road, Chelmsford, MA

IS THIS COURSE BEING OFFERED AS PART OF YOUR REGULAR (CONTRACTUAL) TEACHING LOAD?

___ YES x NO

APPROVED BY: F. Q. [illegible] / [illegible] (Dept. Head or Grad. Com. Chairperson)

George Hanify (Instructor's Signature)

FOR OFFICE USE ONLY

SEMESTER WINTER/SPRING, 198[illegible]

COURSE #

TITLE

INSTRUCTOR CREDITS SEATS

ROOM COST

DAY TIME

FITCHBURG STATE COLLEGE
FITCHBURG, MASS. 01420

DIVISION OF GRADUATE
AND
CONTINUING EDUCATION

STANDARD COURSE DESCRIPTION FORM

CATALOG NUMBER ME 861

COURSE TITLE Technology Applications in Problem Solving (Science)

INSTRUCTOR George Hanify

CATALOG DESCRIPTION: 2-4 sentences

Through a combination of skills training, curriculum development. activities, and instructional applications in classroom settings, participants learn about new basic science skills, practices and programs, as well as about new technologies for supporting their teaching and learning.

GRADE AND ATTENDANCE POLICY:

In 2 or 3 cr.courses,only one 3 hr. absence is allowed & work must be made
Thereafter each session missed means a reduction in grade by .5 (4.0 to 3.5
In the event of extenuating circumstances,notify MEC's Director of Staff De
& special arrangements may be worked out for make-up in conjunction with in
structor/director/student. In a 1 cr. course there are no abesences allowed

COURSE REQUIREMENTS: Assignments,etc.

To examine nationally validated programs in the field of problem solving in Science.

To select a nationally validated program or parts of such programs that could strengthen the curriculum currently in effect.

To identify technological competencies that might relate to the adjusted curriculum. *

REQUIRED AND SUGGESTED TEXTS: (GIVE TITLE, AUTHOR & PUBLISHER)

(R)

(R)

* To develop instructional modules and pilot test them in the classroom.

To assess the usefulness of the instructional modules and identify needed modifications.

MERRIMACK EDUCATION CENTER/FITCHBURG STATE COLLEGE

COURSE SYLLABUS FORM

COURSE TITLE: TECHNOLOGY APPLICATIONS IN PROBLEM SOLVING (Science)

OVERALL GOAL: To develop or modify programs that use the microcomputer and related technologies to increase student competencies in the basic skill area of problem solving/sicence at the middle school level (grades 6-8). Although the focus of this demonstration program is on basic skills in a small part of the total curriculum, it is also designed to develop procedures and programs that are compatible with and can serve as a model for a district's total technology application endeavors.

SESSION TOPICS:

2	February 14	-	Planning Meeting/Software Review
3	March 13	-	Planning for Computer Integration Science Software
4	March 22	-	Computer as a Tool
4	April 10	-	Technological Futures
7½	April 26	-	Problem Solving in Science Applications Development
4	May 15	-	Instructional Design
13			Practicum
37½			

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

TECHNOLOGY APPLICATIONS IN BASIC SKILLS (PROJECT TABS)

PRACTICUM

The Practicum portion will address instructional applications in a LAB or classroom setting where the technology will be applied with groups of students. An organized plan of action will prepare a unit, course module, or topical lesson for students in the chosen curriculum or subject area.

This Practicum is one-third of the course sequence and will document implementation steps for the technology application. The resource person at MEC will assist in scheduling support from materials or consultants as needed to achieve the maximum benefits at the school district site (LAB or classroom). The MEC resource person will confer with the Site Coordinator to determine what materials or consultation help is required for each school.

TOPIC

The area to be focused on is a curriculum subject in which the teacher will work directly with students to develop a LAB or unit of study. Working individually or in teams, teachers will propose topical areas and develop the lesson plans and activities necessary to work with their students including a checklist or other means of keeping track of student progress on a skills continum.

The documentation of the LABS and units prepared at each school site will attempt to describe the following:

(a) A clearly identified topic and subject area.

(b) A listing of materials or references (software, etc.) that are to be used by the teacher or students.

(c) A clearly stated purpose for the LAB, lessons, or unit. This will include goals and specific skills (or objectives) to be mastered by students.

(d) Specific activities, strategies, and lessons presented by the teacher in working with students; (grouping modes, either individual student or small groups).

(e) A time line and schedule for the activities so that all students in the participating group have ample opportunity to work through the lesson.

(f) A means of measuring outcomes and pupil growth (i.e., gains in skills, attainment of objective in the curriculum area).

FITCHBURG STATE COLLEGE

DIVISION OF GRADUATE AND CONTINUING EDUCATION

COURSE REQUEST FORM

SUMMER 1984

SUBJECT AREA (ACADEMIC DEPT.) EDUCATION TODAY'S DATE 4/23/84

COURSE NUMBER (IF KNOWN) ME 867 CREDITS 3

COURSE TITLE STUDY SKILLS, STRATEGIES FOR LEARNING

COURSE LEVEL: CIRCLE ONE
700 Undergraduate Credit ONLY
x 800 Graduate Credit (Undergraduates Admitted)
900 Graduate Credit ONLY

COURSE DESCRIPTION: If course has never been offered, or if changes are to be made, please attach or write on reverse side.

If course is a repeat, please check course description in Room T108. SPECIFY ANY PREREQUISITES

INSTRUCTOR Elizabeth C. Keroack Rank Visiting Lecturer
(List name EXACTLY as it should appear in Bulletin)

HOME ADDRESS (Visiting Lecturer) 31 Apple Hill Road, Melrose, MA TELEPHONE 665-5981

WORK ADDRESS Shawsheen Valley Regional/Vocational/Technical H.S. TELEPHONE 667-2111
(If not on-campus)

PLEASE CHECK PREFERRED CLASS MEETING DAY AND TIME:

____ MONDAY ____ TUESDAY ____ WEDNESDAY ____ THURSDAY

SPECIAL SCHEDULING (PLEASE DESCRIBE) Week of August 13, 1984
8:00 A.M. - 4:30 P.M.
Abbot Middle School, Westford, MA

ROOM PREFERENCE AND/OR SPECIAL REQUIREMENTS

IS THIS COURSE BEING OFFERED AS PART OF YOUR REGULAR (CONTRACTUAL) TEACHING LOAD?

____ YES x NO

APPROVED BY:

(Dept. Head or Grad. Com. Chairperson) (Instructor's Signature)

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SEMESTER SUMMER 1984

COURSE #

TITLE

INSTRUCTOR CREDITS SEATS

ROOM COST

DAY TIME

APPENDIX H

COMPETENCY INVENTORY

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

TECHNOLOGICAL APPLICATIONS IN BASIC SKILLS
SUMMARY OF TEACHER COMPUTER COMPETENCY SURVEY

January 1984

	Have No Experience or Knowledge	Have Limited Experience but Not Enough to be Useful in Class	Can Now Deal With This Effectively in My Teaching	Sufficient Experience to Teach This to Other Teachers
Hardware: parts of a micro; Apple DOS; printers, general operation	Burlington - 1 Lunenburg - 0 Tewksbury - 1	Burlington - 5 Lunenburg - 2 Tewksbury - 1	Burlington - 0 Lunenburg - 2 Tewksbury - 1	Burlington - 0 Lunenburg - 0 Tewksbury - 3
Software: Familiarity with available software in your subject area	Burlington - 4 Lunenburg - 2 Tewksbury - 1	Burlington - 2 Lunenburg - 3 Tewksbury - 4	Burlington - 0 Lunenburg - 0 Tewksbury - 1	Burlington - 0 Lunenburg - 0 Tewksbury - 1
Software Evaluation: How to classify and critically review technical and instructional features	Burlington - 4 Lunenburg - 0 Tewksbury - 3	Burlington - 2 Lunenburg - 5 Tewksbury - 1	Burlington - 0 Lunenburg - 0 Tewksbury - 1	Burlington - 0 Lunenburg - 0 Tewksbury - 1
Utility Software: Software that provides new "tools" or media for learning or record keeping	Burlington - 5 Lunenburg - 2 Tewksbury - 3	Burlington - 2 Lunenburg - 3 Tewksbury - 2	Burlington - 0 Lunenburg - 0 Tewksbury - 0	Burlington - 0 Lunenburg - 0 Tewksbury - 1
Programming Languages: Logo Basic Pascal Other ( )	Burlington - 5 Lunenburg - 5 Tewksbury - 2	Burlington - 3 Lunenburg - 5 Tewksbury - 0	Burlington - 0 Lunenburg - 0 Tewksbury - 3	Burlington - 0 Lunenburg - 0 Tewksbury - 1

MERRIMACK EDUCATION CENTER

CHELMSFORD, MASSACHUSETTS

PROJECT TABS

COMPUTER COMPETENCY SURVEY

Name of Staff Member ________________________________

____

Postion ________________________________

School ____________________ Community ____________________

In an attempt to ascertain training needs for staff members participating in Project TABS in the area of microcomputer applications, it would be most helpful if you would respond thoughtfully to the following survey.

Check one block for each topic that most accurately describes your current state of ability.

	Have no Experience or Knowledge	Have Limited Experience But Not Enough To Be Useful in Class	Can Now Deal With This Effectively In My Teaching	Sufficient Experience Teach this Other Teac-
HARDWARE: parts of a micro; Apple DOS; printers; general operation.				
SOFTWARE: familiarity with available software in your subject area.				
SOFTWARE EVALUATION: How to classify and critically review technical and instructional features.				
UTILITY SOFTWARE: Software that provides new "tools" or media for learning or record keeping.				
PROGRAMMING LANGUAGES: Logo BASIC Pascal Other ( )				

APPENDIX I

IMPLEMENTATION CHECKLISTS

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

PROJECT: TECHNOLOGICAL APPLICATIONS IN BASIC SKILLS
(A Project of the Division of Educational Technology,
U. S. Office of Education, Washington, D. C.)

KEY COMPONENTS CHECKLIST
BURLINGTON WRITING PROGRAM

Date of Observation ________________ _________

Components	Degree of Implementation						Essentiality						Level of Difficulty in Implementation					
	Low			High			Low			High			Low			High		
The teaching of reading, writing and grammar are integrated.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
The teacher provides writing examples.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
The teacher coaches students in the writing process.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Students maintain a writing folder.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
The student produces more than one draft of his writing sample.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Peer writing and evaluation occurs.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Students choose the topics of their writing.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
The evaluative criteria for a writing assignment are shared with the students in advance.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Not all of the students' writing is graded.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A

Components	Degree of Implementation						Essentiality						Level of Difficulty in Implementation					
	Low			High			Low			High			Low			High		
The writing process is taught, particularly revision and editing.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Students' writing is "published" or communicated for an audience other than the teacher.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Students read their preliminary drafts aloud to themselves and to others.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Teacher conducts individual writing conference.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
The teaching of grammar, usage and mechanics is focused on students' current writing problems.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A

Comments:

Name of Person Completing Form

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

PROJECT: TECHNOLOGICAL APPLICATIONS IN BASIC SKILLS
(A Project of the Division of Educational Technology,
U. S. Office of Education, Washington, D. C.)

KEY COMPONENTS CHECKLIST
LUNENBURG STUDY SKILLS PROGRAM

Date of Observation ____________________

Components	Degree of Implementation (Low – High)	Essentiality (Low – High)	Level of Difficulty in Implementation (Low – High)
Teaching of study skills is integrated with content subject.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
Students print (and save) performance samples.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
Teacher has described the purpose of the lesson with students.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
Students gather information from a wide range of sources, media, technology, etc.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
Students demonstrate that they can organize information (data).	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
Students located information and used references/sources.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
Lesson is planned so that all students effectively use time available.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
Students appear to be motivated by the use of technology.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
Students do work independently on task.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
Students work in small groups on task.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A

Components	Degree of Implementation						Essentiality						Level of Difficulty in Implementation					
	Low				High		Low				High		Low				High	
EXAMINE AND COLLECT A SET OF CLASS PAPERS/REPORTS																		
On student work samples for this lesson:																		
(a) students use a range of resources/ sources	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
(b) students select appropriate information from sources	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
(c) students organize their presentation of information	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
(d) students' work samples demonstrate that they have successfully attained the process objectives for the lesson	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
(e) students prepare bibliography of learning materials	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A

Comments:

Name of Person Completing Form

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

PROJECT: TECHNOLOGICAL APPLICATIONS IN BASIC SKILLS
(A Project of the Division of Educational Technology,
U. S. Office of Education, Washington, D. C.)

KEY COMPONENTS CHECKLIST
TEWKSBURY JUNIOR HIGH SCHOOL SCIENCE DEPARTMENT

Date of Observation ______________________

Components	Degree of Implementation (Low — High)	Essentiality (Low — High)	Level of Difficulty in Implementation (Low — High)
1. The Problem Solving Process			
The problem chosen relates to the content area objectives of the module.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
The problem chosen requires the problem solving skills planned for the module in order to be solved.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
The problem solving sub-skills are presented to the students in a manner conducive to understanding.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
The problem solving sub-skills are presented to the students in a manner that their relationship to major skills and to the whole range of skills can be understood by the students.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
The students developed a plan for satisfying the problem and communicated that plan in writing and in oral discussion.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A
Factual information is located and collected.	1 2 3 4 5 N/A	1 2 3 4 5 N/A	1 2 3 4 5 N/A

Components	Degree of Implementation						Essentiality						Level of Difficulty in Implementation					
	Low				High		Low				High		Low				High	
Information gathered is organized logically and coherently.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Organized information is reorganized in an alternative manner.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Materials are presented and analyzed appropriately.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Relationships within data are recognized and communicated.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Conclusions and generalizations are derived from the results obtained.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
The objectives and instructional strategies of the module are clearly stated.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
2. The Technology Process																		
The software is appropriate to the development of specific problem solving skills identified in the module.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
The software is used as a tool for organization, representation and communication.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
The software is used as a tool for accessing and storing information.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
The software is judged to be efficient in allowing the examination of alternatives without having to expend excessive time and effort.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A
In scheduling for the use of hardware by students in the project, sufficient time has been allocated for implementation of the modules throughout the year.	1	2	3	4	5	N/A	1	2	3	4	5	N/A	1	2	3	4	5	N/A

The computer was used in the classroom. ___ yes ___ no

The computer was used in the following manner:

___ demonstration

___ individually

___ small groups

___ large groups (more than 4)

Estimate of percentage of students actually using the computers during the classroom period. ______%

Comments:

____

Name of Person Completing Form

APPENDIX J

LUNENBURG CRT OBJECTIVES

MERRIMACK EDUCATION CENTER
CHELMSFORD, MASSACHUSETTS

TECHNOLOGICAL APPLICATIONS IN BASIC SKILLS

SCHEDULE OF COMPUTER USE FOR PURPOSES OF THE PROJECT

Period of Time That Schedule will be Effective: October 22, 1984 to November 2, 1984

School: Tewksbury Junior High

Date: October 16, 1984

Date of Computer Use	Time of Computer Use	Location of Computer Use	Teacher	Proposed Use of Technology
10/22/84	Period 3	Room 214	Garceau	Use of simulation disk "The Incredible Laboratory"
	" 6	" "	Olsen	
	" 7	" "	Garceau	To introduce students to the problem solving techniques 1, 14, 15, 16, 17 and 21 from the list of problem solving skills.
10/23/84	Period 2	Room 214	Garceau	
	" 6	" "	Garceau	
10/24/84	Period 2	Room 214	Olsen	
	" 7	" "	Garceau	
10/25/84	Period 1	Room 214	White	
	" 7	" "	White	
10/26/84	Period 3	Room 214	Garceau	
	" 6	" "	White	
	" 7	" "	White	

NOTE: To be submitted on a bi-weekly basis beginning October 15th and every two weeks thereafter until post-tests are administered.

Alfred J. White
Person Submitting Schedule

WICHITA READING INVENTORY STUDY SKILLS LEVEL G

BEHAVORIAL OBJECTIVES

Level G CRT-1 Given verbal directions for a series of tasks of suitable difficulty and length, the learner will perform the tasks in correct sequence with 100% accuracy.

Level G CRT-2 Given a reading selection of suitable difficulty and length containing a series of written tasks, the learner will demonstrate his ability to follow written directions by answering questions with 100% accuracy.

Level G CRT-3 Given a series of questions on the SQ#R study method, the learner will demonstrate his understanding of this technique by answering the questions with 100% accuracy.

Level G CRT-4 Given a reasing selection of suitable length and difficulty, the learner will demonstrate his working knowledge of the SQ#R study method by answering the questions on the selection with 100% accuracy.

Level G. CRT-5 Given a series of statements concerning the adjustment of reading rate to the purpose for reading, the learner will demonstrate his understanding of this perceptual concept by differentiating between those statements which require a slow and careful rate and those which require skimming with 100% accuracy.

Level G CRT-6 Given a timed reading selection on his instructional level, the learner will demonstrate his ability to adjust his rate of reading to his purpose for reading by responding to a comprehension check with 100% accuracy.

Level G CRT-7 Same as Level G CRT-6

Level G CRT-8 Same as Level G CRT-6

Level G CRT-9 Same as Level G CRT-6

Level G CRT-10 Same as Level G CRT-6

Level G CRT-11 Given a series of questions on the various parts of a book, the learner will demonstrate his knowledge of their use with 100% accuracy.

Level G CRT-12 Given graphic material of appropriate complexity, the learner will interpret the information with 100% accuracy.

Level G CRT-13 Given graphic material of appropriate complexity, the learner will interpret the information with 100% accuracy.

Level G CRT-14 Given information of appropriate complexity, the learner will produce graphic representations with 80% accuracy.

Level G CRT-15 Given a specific topic, the learner will select the appropriate source for locating information on that topic with 100% accuracy.

Level G CRT-16 Given a list of questions based on sample source materials, the learner will demonstrate his ability to use source materials with 80% accuracy.

Level G CRT-17 Given reading material and an oral presentation of suitable difficulty and length, the learner will identify facts or figures, ideas or concepts, and main ideas as well as identify the best outline form for notetaking with 80% accuracy.

Level G CRT-18 Given reading material on an appropriate level and an incompleted outline of the reading selection, the learner will complete the outline (main and subordinate ideas) with 80% accuracy as determined by his instructor.

Given a reading selection of suitable difficulty and length on which he has completed an outline, the learner will utilize the outline to write a summary identifying main ideas, facts, and concepts with 100% accuracy as determined by his instructor.

The Wichita Reading Inventory-Study Skills Subtest-Level J used as the post-test measure has 17 behavioral objectives:

Level J CRT-1 to 12 Same as Level G CRT-1 to 12

Level J CRT-13 to 17 Sames as Level G CRT-14 to 18