DOCUMENT RESUME

ED 281 021 CE 046 874

AUTHOR	Roth, Gene; Tesolowski, Dennis
TITLE	Developing a Personal Plan for Microcomputer Competency. Microcomputer Applications for Vocational Teachers: A Competency-Based Approach--Book A.
INSTITUTION	Idaho State Univ., Pocatello.; Illinois State Board of Education, Springfield. Dept. of Adult, Vocational and Technical Education.
PUB DATE	Jun 86
NOTE	137p.; For related handbooks, see CE 046 875-878.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC06 Plus Postage.
DESCRIPTORS	Behavioral Objectives; Competency Based Teacher Education; *Computer Literacy; Computer Oriented Programs; *Computer Uses in Education; Inservice Teacher Education; *Microcomputers; *Planning; Resource Materials; Secondary Education; *Teacher Improvement; Units of Study; Vocational Education; *Vocational Education Teachers

ABSTRACT

This handbook is the first in a series of five competency-based resource guides on microcomputer applications for vocational teachers. The five units of instruction in this handbook are concerned with the content of the eight competencies included in the category, "Developing a Personal Plan for Microcomputer Competency." Units are designed to prepare the teacher to do the following: (1) define the elements of a local education agency (LEA) plan for computer-based instruction (CBI), (2) define the vocational instructor's role in the LEA plan for CBI, (3) conduct a personal assessment of microcomputer competency, (4) set personal goals and construct and implement a personal plan for microcomputer competency, and (5) evaluate and modify a personal plan for microcomputer competency. Components of each unit include unit and specific objectives, informative material, sample forms and evaluation measures, examples, a summary, achievement indicators, and a list of references. A prose glossary and glossary of terms are appended. (YLB)

Developing a Personal Plan for Microcomputer Competency

Illinois State Board of Education

Adult, Vocational and Technical Education

Developing a Personal Plan for Microcomputer Competency

Illinois State Board of Education

Department of Adult, Vocational and Technical Education

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in cooperation with

Illinois State Board of Education, Department of Adult, Vocational, and Technical Education

Research and Development Section

June, 1986

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CURRICULUM PUBLICATIONS CLEARINGHOUSE
Western Illinois University
Horrabin Hall 46
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ACKNOWLEDGEMENTS

This handbook evolved from the efforts and creative thought of a very special research team. Harold Blackman, Roger Rankin, and Dennis Tesolowski were the stalwarts of this research endeavor. They comprised the team which nurtured this project from its inception to its completion.

The foundation for this handbook was laid by a panel of Illinois vocational educators. Individuals were selected to serve on this panel on the basis of demonstrated leadership in the use of microcomputers. Utilizing a structured process known as DACUM (Develop A Curriculum), this group developed the initial competency list for the handbook and field tested the product. The DACUM participants included:

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INTRODUCTION

Microcomputer Applications For Vocational Teacher: A Competency-Based Approach

BY

DR. GENE L. ROTH

DR. DENNIS G. TESOLOWSKI

Historically, vocational educators have had to cope with the problem of keeping pace with technology. Preparing students for a workplace that is continually changing is a constant reminder to vocational instructors that they do not have the luxury of resting on previously learned work skills and knowledge. Vocational educators must keep abreast of contemporary developments within their vocational area of expertise.

This concern for technical updating is not limited to industrial or business applications of technology. In addition to concerns about preparing students for a changing world of work, vocational teachers must contend with applications of new instructional technologies. Many vocational teachers are currently struggling with how to integrate computer-based instruction into their classrooms and laboratories.

The rapid influx of microcomputers into vocational classrooms and laboratories has caught many vocational educators unprepared to effectively utilize this contemporary instructional technology. As educational systems continue to acquire computer technology, many vocational instructors are saying, or at least thinking, "Where do we start with these machines?" Microcomputers are often purchased for vocational programs which are staffed by personnel that have not been appropriately trained in the technology. Their knowledge of hardware and software may be quite limited. A resulting danger is that microcomputers will be misused or not used at all because vocational teachers have been inadequately acquainted with educational computing (Pratscher, 1983).

This concern about providing vocational educators with pertinent information related to microcomputer applications has brought about a collaborative effort between two state offices of vocational education. The Illinois State Board of Vocational Education, Department of Adult, Vocational, and Technical Education and the Idaho State Board of Education, Division of Vocational Education are jointly supporting this research and development project entitled "Microcomputer Applications for Vocational Teachers: A Competency Based Approach." This project, which has been conducted at Idaho State University, features a systematic approach to the identification of microcomputer competencies for vocational instructors (Roth & Tesolowski, in press).

This is a shortened version of an article that appeared in *The Computing Teacher*, 12 (3), November 1984. Reprinted with permission.

The DACUM Process: A Method for Identifying Microcomputer Competencies

The DACUM (Developing A Curriculum) process (Adams, 1975) was utilized by this project as a foundation in the development of competency-based materials on microcomputer applications for vocational instructors (Roth, Tesolowski, Rankin, & Blackman, 1984). This procedure is based on three assumptions: (a) expert workers can define and describe their job more accurately than anyone else; (b) any job can be effectively described in terms of the tasks that successful workers in that occupation perform; and (c) all tasks, in order to be performed correctly, demand certain knowledge and attitudes from workers (Miller-Beach, 1980).

Utilization of the DACUM process required the project to assemble a panel of 12 vocational educators. The 12 members, all from Illinois, included 4 secondary vocational instructors, 4 postsecondary vocational instructors, 3 secondary vocational administrators, and 1 representative of the Department of Adult, Vocational, and Technical Education. In addition to being practitioners in the field of vocational education, these individuals have been recognized as leaders in the State of Illinois at applying microcomputers in their work. The challenge for the DACUM panel was to identify competencies specific to the application of microcomputers in vocational education. This was accomplished through a process of competency identification and consensus decision-making. The activity involved the panelists and the facilitators in two days of difficult work. However, the panelists were rewarded for their efforts as competencies were established for each category and the final profile of microcomputer applications for vocational educators unfolded. Furthermore, the panelists began to realize that they had increased their own personal level of knowledge about the application of microcomputers in vocational education.

RESULTS OF THE DACUM PROCEDURE

Most vocational teachers recognize the vast potential of microcomputers in vocational education. However, many professionals have had difficulty identifying the precise role of the machine in their professional lives. The DACUM profile provides teachers with a graphic portrayal of how the microcomputer integrates with the overall schema of vocational instruction and curricula. The profile consists of 47 competencies clustered within the following 5 categories (Table 1):

A. Developing a personal plan for microcomputer competency.

B. Integrating computer-based instruction (CBI) into vocational curricula.

C. Planning, executing, and evaluating CBI.

D. Planning and organizing vocational education learning environments for CBI.

E. Performing classroom management functions with CBI.

The content of these 47 competency statements was refined and validated through a formative process. After the DACUM panel had generated the core of this profile, the competency statements were scrutinized and revised by: (a) members of the project team at Idaho State University; (b) a group of vocational educators in Idaho; (c) consultants of the Illinois Department of Adult, Vocational, and Technical Education; and (d) supervisors and staff members of the Idaho Division of Vocational Education.

A survey was conducted by this project's research team to ascertain the relative importance of each of the 47 microcomputer competencies. The survey population consisted of a national sample of 134 vocational educators. These instructors were identified by their respective state supervisors as leaders in their states at applying microcomputers to the roles and responsibilities of their teaching jobs. Ninety-seven vocational teachers (72%) responded to the survey.

Ratings for each competency are listed on the *Vocational Teacher Competency Profile for Microcomputer Applications* (Table 1). Mean ($\bar{x}$) competency ratings were derived from respondents' atings on the following scale: (1) no importance, (2) minimal importance, (3) average importance, (4) high importance, and (5) extreme importance. Vocational teachers can consider these ratings as benchmarks as to how their peers view microcomputers in vocational teaching.

VOCATIONAL TEACHER COMPETENCY PROFILE FOR MICROCOMPUTER APPLICATIONS

Illinois State Board of Education
Department of Adult, Vocational and Technical Education

Idaho State Board of Vocational Education
Division of Vocational Education

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Dr. Dennis G. Tesolowski
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Dr. Harold S. Blackman

← Competencies →

	Category								
A	Developing a Personal Plan for Microcomputer Competency	A.1 Define Elements of a Local Education Agency (LEA) Plan for Computer Based Instruction (CBI) 3.67	A.2 Define the Vocational Instructor's Role in the LEA Plan for CBI 4.00	A.3 Conduct a Personal Assessment of Microcomputer Competency 3.90	A.4 Set Personal Goals for Microcomputer Competency 4.11	A.5 Construct a Personal Plan for Microcomputer Competency 4.06	A.6 Implement a Personal Plan for Microcomputer Competency 4.16	A.7 Evaluate Personal Plan Based on Computer Innovations 3.87	A.8 Modify Personal Plan as Needed 3.97
B	Integrating CBI Into Vocational Curricula	B.1 Identify Job-Specific Applications of Microcomputers for Inclusion in Vocational Curricula 4.42	B.2 Identify Educational Applications of Microcomputers for Inclusion in Vocational Curricula 4.37	B.3 Develop a Plan to Apply CBI to Vocational Curricula 4.38	B.4 Demonstrate an Awareness of Microcomputer Software for Developing Computer Based Vocational Curricula 4.22	B.5 Write Specifications for Hardware/Software Based on Vocational Curricula Requirements 3.77	B.6 Implement a Plan to Apply CBI to Vocational Curricula 4.26	B.7 Evaluate Applications of CBI in Vocational Curricula Based on Innovation in Computer Technology & Work 3.95	B.8 Modify Applications of CBI in Vocational Curricula as Needed 4.04
C	Planning, Executing & Evaluating CBI	C.1 Differentiate Among Applications of CBI (Such as Drill & Practice, Tutorial, Simulation & Problem Solving) 3.84	C.2 Assess Students' Needs for Specific CBI Applications 4.15	C.3 Develop Lesson Plans Incorporating CBI 4.22	C.4 Select Appropriate Software for Specific Instructional Purposes 4.61	C.5 Modify Simple Software for Specific Instructional Purposes 3.71	C.6 Develop Software for Specific Instructional Purposes 3.38	C.7 Prepare Instructional Materials to Accompany Software 4.22	C.8 Modify Software Documentation for Specific Instructional Purposes 3.77
	Planning, Executing & Evaluating CBI (Con't)	C.9 Orient Students to CBI 4.43	C.10 Execute CBI 4.39	C.11 Individualize Instruction with CBI 4.17	C.12 Assess Student Microcomputer Skills 4.02	C.13 Evaluate Effectiveness of CBI Based on Student Achievement 4.21	C.14 Modify CBI as Needed 4.10		
D	Planning & Organizing the Vocational Education Learning Environment for CBI	D.1 Develop a Plan to Implement CBI in Vocational Education Learning Environments 4.11	D.2 Schedule CBI Activities 3.97	D.3 Project Resource Needs (Supplies, Materials, Equipment) for CBI 4.02	D.4 Provide Microcomputer Maintenance 3.69	D.5 Establish Microcomputer User Security 3.72	D.6 Establish Microcomputer Hardware/Software Security 3.84	D.7 Create Authorized Back-up Copies of Microcomputer Software 4.40	
E	Performing Classroom Management Functions with CBI	E.1 Determine Classroom Management Activities to be Performed with CBI 4.13	E.2 Select Software for Classroom Management Activities 4.28	E.3 Prepare Software for Classroom Management Activities 3.57	E.4 Maintain Classroom Rosters 3.44	E.5 Maintain Attendance Records 3.39	E.6 Generate Tests 3.83	E.7 Score Tests 3.53	E.8 Record Grades or Performance Progress 3.88
	Performing Classroom Management Functions with CBI (Con't)	E.9 Maintain Inventory of Teaching Supplies, Materials & Equipment 3.91	E.10 Manage Vocational Student Organizations 3.49						

Competency Rating Scale

The relative importance of these 47 competencies was determined by surveying a national sample of 134 vocational educators. Vocational instructors included in this sample were identified as experts at applying microcomputers in their program by their respective state supervisors. Ninety-seven (97) vocational teachers (72%) responded to this survey. The following vocational disciplines were represented in this sample: agriculture; business; home economics; marketing and distribution; trade and industrial; and health occupations education. Mean competency ratings were derived from respondents' ratings on the following scale:

1=No Importance 2=Minimal Importance 3=Average Importance 4=High Importance 5=Extreme Importance

Instructional units have been packaged in this competency-based resource guide on microcomputer applications for vocational teachers. This handbook is being disseminated by the Curriculum Publications Clearinghouse, Western Illinois University, Macomb, IL 61455.

UTILIZING A "PROFESSIONAL DEVELOPMENT PLAN" TO INTEGRATE MICROCOMPUTERS INTO VOCATIONAL CURRICULA AND INSTRUCTIONAL STRATEGIES

Vocational educators can carefully examine Category A in the profile (Table 1) and begin to envision how the content of the eight competencies included in this category will enable them to develop a personal plan for microcomputer competency (Tesolowski, Wallin, Roth, & Rankin, 1984). Competency A.1 defines the elements and planning strategies involved in developing a comprehensive plan for implementing computer-based instruction (CBI) in a local education agency (LEA). This instructional unit presents practices that have been implemented in select exemplary programs in the nation. Competency A.2 explores the vocational instructor's role in the plan identified for implementing CBI in the LEA (A.1). Varying practices are reviewed in Unit A.2, which will assist vocational teachers in preparing a microcomputer implementation plan.

The content included in Competency A.3 enables vocational educators to assess their personal levels of microcomputer competency. Self-report test items are included for a representative set of pertinent content areas or domains related to computer literacy. Vocational teachers can identify their strengths and weaknesses on the basis of this self-assessment measure. Upon completing this diagnostic-prescriptive instrument, vocational educators can profile their results on a chart. On the basis of their strengths and weaknesses, vocational instructors can set initial personal goals (Competency A.4) for microcomputer competency.

Competency A.5 facilitates the development of a personal plan for microcomputer competency. Vocational teachers who participate in this unit of instruction are encouraged to develop a Professional Development Plan that includes long-range goals; short-term objectives; and the identification of instructional strategies, methods techniques, materials, and resources that will facilitate the accomplishment of these goals and objectives. In addition, participants will monitor their timeline in regards to when they initiate and conclude selected learning activities. Finally, vocational teachers will record whether or not they believe they have successfully achievedtheir goals and objectives. Competencies A.6, A.7, and A.8 assist vocational educators in working through the processes of implementing, evaluating, and modifying their personal plans for microcomputer competency.

After vocational instructors construct their Professional Development Plans for microcomputer competency (A.5), they can implement their plans by fully utilizing all of the units of instruction for the 39 competencies clustered in Categories B, C, D, and E. An alternative to using all of the units of instruction is to selectively choose units based on the needs identified in the personal plans, their district's or school's needs, and their personal interests (Roth, Tesolowski, Rankin, & Blackman, 1984).

THE NEED FOR A PERSONAL COMMITMENT TO APPLY MICROCOMPUTERS IN VOCATIONAL EDUCATION

Competencies identified for this handbook can serve as an invaluable starting point for vocational instructors who want to integrate microcomputers into their professional future. Vocational educators can visually inspect the categories and respective competencies, examine their own teaching situations, and begin to formulate their own individualized plans for applying microcomputers in their programs as well as in their personal lives.

The stage is now set for vocational educators to decide where and how microcomputers will fit into their teaching futures. Competencies identified through this research project can enhance their perspectives of the potential of microcomputers in vocational education. However, vocational teachers must individually develop personal plans for microcomputer competency that will serve their professional needs as well as the needs of their respective programs.

The decision to develop a plan or not is of utmost importance. Plans can be modified as teachers' computing interests and programmatic needs change with the times. Whatever vocational educators personally decide to do, they should not allow this contemporary technology to pass them by. All vocational teachers must critically examine the role of microcomputers in their professional lives.

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Unit 1

Define the Elements of a Local Education Agency (LEA) Plan for Computer-Based Instruction (CBI)

UNIT OBJECTIVE

Upon completion of this unit, the learner will know what components are ideally included in a computer-based instruction system for a local education agency. This knowledge will be demonstrated through completion of the unit achievement indicators.

SPECIFIC OBJECTIVES

Upon completion of this unit, the learner will:

1) Discuss the importance of developing a comprehensive plan for implementing CBI in a LEA.
2) List seven general recommendations that will facilitate the overall process of developing a comprehensive plan for CBI in a LEA.
3) Describe the computer committee method of initiating and developing a comprehensive plan for CBI in a LEA.
4) Discuss the content of a LEA's philosophy or mission statement for CBI.
5) Describe the content of a LEA's goals for CBI.
6) Discuss the content of a LEA's objectives for CBI.
7) Describe five categories of personnel that are frequently included in a plan for implementing CBI in a LEA.
8) Discuss five major considerations of purchasing equipment that should be examined in the planning process for CBI in a LEA.
9) Describe the planning process of selecting materials for CBI in a LEA.
10) Discuss planning strategies that can be used to increase the success of in-service staff development activities for CBI in a LEA.
11) Describe budget considerations related to personnel, materials, equipment, and staff training that should be examined in the planning process for CBI in a LEA.
12) Discuss the two-percent solution to budgeting CBI in a LEA.
13) Describe the process and ramifications of using staggering timelines, also known as the phasing-in process, when planning for CBI in a LEA.
14) Discuss eight recommendations that should be considered when planning the evaluation component for CBI in a LEA.
15) Explain the objects and process of analysis in the evaluation component with regard to progress on plan implementation, staff utilization, curricular adaptation, and learner outcomes.
16) Discuss the benefits of a centralized Institute of Computer Technology designed to serve the needs of three LEAs.
17) List resource people knowledgeable about exemplary programs using computer-based instruction.

Developing a Delivery System to Implement Computer-Based Instruction in a Local Education Agency

BY: DR. DENNIS G. TESOLOWSKI

Local education agencies throughout the United States find themselves being pressured to acquire microcomputers for their classrooms. In too many cases, schools or LEAs are responding to these demands without preparing appropriate planning strategies, staff development activities, and evaluation (Sturdivant, 1983). Numerous and complex issues arise when a LEA begins developing and implementing a plan for CBI. The mission of bringing computers into schools and making them available to students requires careful thought, planning, leadership, and organization. Critical decisions must be made regarding curricula, equipment, equity, funding, goals, objectives, staffing, and staff development (McClellan, 1984).

DEVELOPING A COMPREHENSIVE PLAN FOR CBI

Problems can be avoided during the implementation of CBI if a LEA participates in adequate planning (Steber, 1983, April). A systematic approach to planning will ultimately identify curriculum and applications, needed software, and appropriate hardware. Preferably, these critical programmatic components will be identified in their stated priority order. LEAs should conduct careful planning strategies in the following components of a systematic plan prior to implementation: philosophy or mission, goals, objectives, personnel, equipment, purchases, materials selection, staff development, budget considerations, timelines, and evaluation.

LEAs can begin by analyzing the CBI that currently exists in their systems. An understanding of what is being taught as well as what is being learned by students and staff will facilitate planning. Furthermore, LEAs can determine goals related to instructional computing, administrative applications, computer management, and staff development through a needs assessment.

Steber (1983, April) indicates that the overall planning process can be enhanced by utilizing the following guidelines:

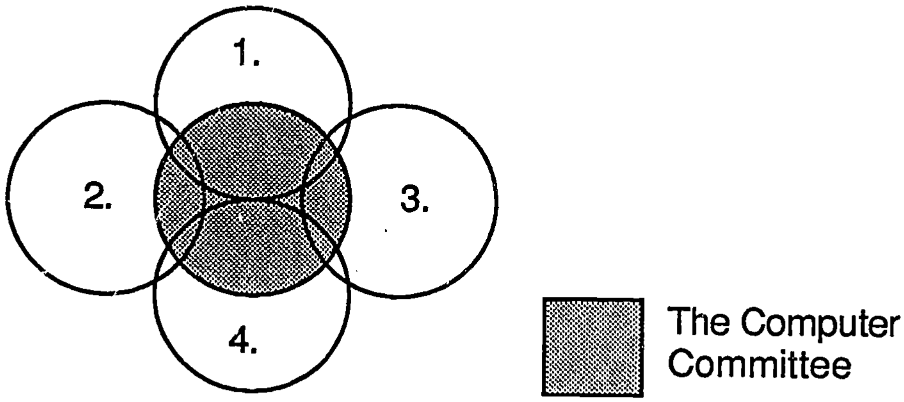
1. Identify personnel who are interested in CBI and want to be involved in the planning and implementation processes in order to avoid the problems associated with a top-down, forced situation.
2. Begin the process on a small scale while encouraging staff and student interest.
3. Apply practical comparative shopping techniques before making decisions which affect curriculum, software, or hardware acquisitions.
4. Assess facilities within the LEA to determine whether or not equipment can be appropriately housed.
5. Organize a computer education committee and/or department(s) with the intent to service all educational areas within the LEA. This activity can minimize departmental and student exclusivity and deal with concerns related to equity.
6. Involve staff members as rapidly as possible once they have committed themselves to participate in order to avoid exclusivity.
7. Consider being a resource for other LEAs in order to enhance what is being accomplished in your system.
8. Set reasonable goals within the limits of the LEA's resources. This is a difficult task due to the highly developmental state of computers.

Identifying a Starting Point

Initially, LEAs must identify a person or persons, depending upon the size of the system, to provide the necessary and critical leadership needed in the planning process. This person's position could be titled the Computer Coordinator or something similar. Ideally, this individual should possess expertise to provide expected leadership, be extremely interested in computers, and be willing to devote the necessary time to this position (Montana Task Force on Computer Education, 1983). The Computer Coordinator's position is thoroughly described in the section of this unit on personnel.

Creating Communication Linkages through a Computer Committee

Before the planning process can be implemented, it is necessary to establish a starting position and a destination. In order to facilitate the implementation of CBI throughout the entire LEA, it is imperative that the Computer Coordinator involve representative faculty, administrators, and staff in a computer committee. This committee, which should ideally represent students, patrons, schools, and the central office, must be actively involved in the identification of the LEA's current status and future goals with regard to CBI. McClellan (1984) presents a schematic diagram to demonstrate how the computer committee can interact with other elements of the LEA.



The four circles surrounding the computer committee represent the following: (1) the school board and community; (2) the schools, including building administrators, classroom teachers, and media specialists; (3) the curriculum or subject area committees; and (4) the central administration. This type of model lends itself to shared decision-making and district-wide coordination. Of course, the eventual success of this system depends upon how receptive the central office is to the committee's recommendations. Individuals selected to serve on the computer committee must be able to communicate with and provide leadership to individuals in the respective group which they represent. An effort should be made to allow everyone to have input into the decision-making process, **allowing leaders at all levels to contribute to the plan.** Once a LEA has created a computer committee, provided it with quality leadership, and carefully selected members of the committee, it must systematically implement the planning process in order to move the committee productively. Each LEA should develop its own priorities based on its unique situation and history.

DEVELOPING COMPONENTS OF THE PLAN

Each LEA's plan should begin with a philosophy statement that provides general direction for the overall educational program. The philosophy statement should also provide goals that establish programmatic parameters. These goals should then naturally lead to objectives, scope and sequence, and activities that allow teachers to move from general expectations to learner outcomes that are clearly identifiable in teachers' lesson plans. This ultimate plan for instruction is referred to as a "curriculum," defined as a plan for the education of students during their enrollment in school which clarifies what will be taught, when it will be taught, and in what ways it will be taught (Minnesota Department of Education, 1983).

Establishing a Philosophy

In order to establish an implementable plan, LEAs should have an underlying philosophy. It is necessary to have a clear philosophical statement that explains the motivations that led the LEA into involvement with technology, describes the assumptions and beliefs upon which the plan is built, and suggests the general results that the plan is designed to produce (Minnesota Department of Education, 1983). A philosophy statement gives direction and focus to a LEA's efforts and facilitates communication between a district's leaders and its constituents. A publicly stated philosophy can be instrumental in developing widespread support from the staff and community.

A technological philosophy should include information related to the following items:

1. Identify the population that is going to be served and the extent to which it will be involved. This statement could serve to address equity issues related to age, sex, race, and physical ability.
2. Explain what the LEA is attempting to accomplish for each of the participants in the targeted population.

3. Establish why the program should be implemented and project the expected positive benefits or impacts on the community.

The nature of the plan that evolves from the philosophy will determine who has access to the technological resources of the district. A LEA may desire to serve all staff and students; however, it may have to build up resources over a period of time in order to fully comply with this charge. Therefore, it is possible for a LEA's philosophy to state the principle of "technology for all," while, in practice, the district's plan may initially provide resources only to specific schools or grade levels. It is important that LEAs begin the process by carefully examining their existing district philosophies to ascertain the extent to which they adequately address the incorporation of technology into instructional programs (Minnesota Department of Education, 1983).

Examples of Philosophy Statements

The introduction to the District of Columbia Public Schools' 5-year plan for computer literacy (Computer Literacy Planning Group, 1982) begins by presenting a segment of its existing philosophy or mission:

> The mission of the District of Columbia Public Schools is ". . . to promote excellence by providing a viable and comprehensive instructional program (pre-kindergarten through twelfth grade) leading to the attainment of knowledge, competencies, and skills which upon completion will enable each student to function as a useful citizen." While the mission of the school system need not change, the strategies used to successfully accomplish the mission must be updated.
>
> The continuing development of new technologies, especially of computers, is revolutionizing American society. The impact of computer spans age, economic, and ethnic lines. In the District of Columbia, with its heavy concentration of white collar industry, computers are used in businesses to manage data and information; as communication devices they link us with the rest of the country and the world. The Federal and District governments, the major local employers, along with their counterparts in the private sector, are now requiring some degree of computer literacy for many positions that are becoming available. Even during times of high unemployment, the local newspapers carry page after page of advertised positions requiring computer skills.
>
> Our students, as consumers, have felt the impact of computer technology. When making purchases, they have seen electronic scanners "read" product labels without understanding the intricate nature of the transaction. At home, their parents receive computerized utility, telephone, and credit card bills. Clearly, the need for some degree of computer literacy has become necessary "to function as a useful citizen." (p.1)

The Cupertino Union School District in Cupertino, California, is a K-8 system located in the Silicon Valley. This LEA, serving elementary and middle school students, has stated its philosophy clearly and concisely:

> All students in the Cupertino schools will have an opportunity to become computer literate. Computer literacy is the ability to function in a computer and technology oriented society. Students will understand computers and their applications and implications in the world around them. They will develop the skills necessary to communicate with computers and recognize the computer's capabilities and limitations ("Computer Literacy Curriculum K-8," 1984).

Identifying Goals

After a LEA has established its philosophy, it should identify the goals of its computer literacy or technology program. The Minnesota Department of Education (1983) has indicated that goals can be determined on the basis of population served; programmatic phases, including awareness, implementation and refinement; or expanding existing curricula.

Goals, which are broad in scope, can be developed for the general population, community, students, instructional staff, and administrative staff. If goals are developed in phases, each phase will have its own dynamics, and planned activities will have to be changed and adjusted as the LEA plan progresses. Activities should be built into the awareness phase in order to provide a common base of knowledge from which to launch future activities and phases of the plan. The implementation phase should permit an extension and application of the knowledge introduced in the awareness phase. The refinement phase should facilitate evaluation and modification of the plan. Finally, goals can be identified by determining the extent to which technology will enhance already existing general curricula. The computer committee should identify goals which will expand and extend present curricula to include technology. This task might best be accomplished by exploring content areas. Because these three dimensions are interrelated, all of them should be addressed in the completed plan. However goals are developed, they should naturally lead to objectives that will facilitate the accomplishment of the LEA's philosophy or mission.

Examples of goal statements. McClellan (1984) listed seven long-range goals for a K-12 computer education plan:

1) All students in the district will have an opportunity to acquire basic knowledge about computers and their impact on society.

2) All students will be trained to use and be given regular access to computer tools.

3) A computer science department will be introduced at the high school level which will assist in providing computer courses to as many students as possible and will provide courses for those students wanting to pursue advanced studies.

4) Computer education will be integrated throughout the curricula.

5) The compute will be used to assist in the development of individualized instruction for all students.

6) The impact of the computer on traditional curriculum areas will be evaluated, with changes made accordingly.

7) Staff will be developed to the level necessary to accomplish the above goals. (p. 9)

The Arlington Public Schools in Arlington County, Virginia, believe that the school system has the responsibility to prepare students for life and work in a world where computers play a major role. To fulfill this mission, they have established the following three goals:

> Computer Literacy — to provide students with skills and knowledge that support the responsible use of computers as tools in a number of applications.
>
> Computer Science — to educate students in problem solving, system design, programming, computer-science theory, and ethical aspects of computer use.
>
> Computers in Instruction — to provide a wide variety of computer-based tools and programs for support of instruction in all appropriate disciplines. (Task Force on Computers in Schools, 1983, p. 1)

These three goals are followed by comprehensive program descriptions and specific recommendations for their elementary schools, intermediate schools, high schools, career centers, and special populations. These descriptions focus on an overview, objectives, instruction and curriculum, staff development, equipment, software, and supplies. This plan also includes an overview and recommendations in the categories of maintenance, general recommendations, and budget estimates.

As a result of the work of two Microcomputer Advisory Committees representing elementary and secondary education, the Livermore Valley Joint Unified School District in Livermore, California, created separate goal statements for elementary, middle, and high schools. These tentative goals meet instructional and program needs of each level of instruction:

ELEMENTARY SCHOOLS:

* To develop an awareness of how computers are used in work.
* To develop the ability to operate a computer in an instructional situation, i.e., Computer Assisted Instruction.
* To explore the language used in microcomputer instruction, e.g., BASIC.
* To explore problems and concepts that are normally obscured by tedious computations.

MIDDLE SCHOOLS:

* To develop an **awareness** and understanding of what computers can do effectively.
* To develop the understanding necessary to **write** beginning computer programs using BASIC (Beginners All-purpose Symbolic Instructional Code).
* To develop the ability to use the computer in estimations and calculations related to various learning programs, i.e., science, math, etc.

HIGH SCHOOLS:

* To develop knowledge and skill in the **operation** of basic microcomputers.
* To develop an awareness and understanding regarding the **impact** of computers on society and its members.
* To develop the basic skills necessary in **applying** appropriate programs to a vocational situation, i.e., word processing, data management, etc.
* To develop the knowledge necessary to **modify** existing computer programs.

* To develop the ability to write programs for computers using a variety of languages, i.e., BASIC, PASCAL, FORTRAN, etc. (Heineman, 1983, p. 4)

Lyons Township High School (LTHS) in LaGrange, Illinois, does not actually present goal statements, but LTHS has developed a rationale for its computer program in the form of three separate phases (Gahala, 1982). Their program description clearly indicates that early planning concentrated on the computer literacy phase and that later phases evolved out of these initial experiences:

1. The literacy program in which students and staff become familiar with the operation of computers, learn how to operate them, and experience their application to various subject matter and vocational areas [sic].
2. The curricular phase in which computer assisted instruction is integrated into the instructional program of all disciplines, the humanities as well as math and science [sic].
3. The competency phase in which some students may elect to become competent in the programming of computers, systems analysis, and the applications of computers in selected vocational areas [sic]. (pp. 1-2)

This evolution lends itself to the programmatic phases process of goal development described by the Minnesota Department of Education (1983). That process essentially focused on awareness, implementation, and refinement.

Creating Objectives

The creation of general, program, and instructional objectives is a critical aspect of a LEA's plan. Objectives serve as an integral component of the system's curricula. The Minnesota Department of Education (1983) presents the following eight reasons for developing a district curriculum:

1. To clarify for students, staff, and community the district's mission.
2. To define why learner outcomes/objectives teachers have responsibility/accountability to cover.
3. To define what outcomes/objectives students should learn at what grades and in which courses.
4. To define how instruction is to be organized so as to reduce unproductive repetition and important content variations.
5. To maintain reasonable consistency within a district's offerings so that students are able to receive approximately the same content in various sections of an offering.
6. To establish a common base from which local educators, individually and in a group, can plan for instruction.
7. To identify resources that teachers may use to teach specific outcomes and thus enhance the quality of instruction and reduce preparation time.
8. To help integrate learning in the various disciplines. (pp. 5-6)

When we review these reasons for developing a curriculum, the importance of objectives becomes more apparent.

Once a LEA's computer committee has identified a variety of broad educational goals, useful for the community's school district, it can begin prioritizing its needs. Then the task at hand is to create the specific programmatic objectives which will enable the LEA to fulfill its mission. Various LEAs will use different processes to develop objectives and resulting curricula. Educational systems have the flexibility to develop separate objectives and courses in computer literacy and computer science, or they can integrate the curriculum that evolves from these objectives into existing curricula in various disciplines.

Some states, such as Texas, are mandating sweeping curricular revisions which require the incorporation of computer literacy into their existing curricula. In an effort to clarify the definition of computer literacy and provide direction to computer literacy as a curriculum component, the Texas Education Agency staff has developed a series of strands of computer literacy objectives and some optional models of delivery. The strands of objectives included:

1. Computer-related terminology and computer use;
2. The history and development of computing devices;
3. Using the computer as a tool;
4. Communicating instructions to the computer;
5. Computer-related occupations and careers (Pratscher, 1983, April/May).

Grady (1983) states that the need for state agencies and curriculum organizations to provide leadership in the areas of goals and objectives is one of the five major issues affecting the integration of computers into existing curricula.

Many LEAs are electing to develop courses in computer literacy and science, in addition to integrating computer technology into all of their current areas. After a LEA has identified broad programmatic objectives, it will be necessary to determine the scope and sequence of objectives to be met across subject areas and age or grade levels in the system. Glenn Fisher (1983), a School Computer Specialist with the Alameda County Superintendent of Schools Office in Hayward, California has assisted several school districts in the planning process. The scope and sequence which have surfaced in his work generally include computer awareness at the elementary level, computer literacy with an introduction to programming at the middle school level, and a variety of electives for further study at the high school level.

Examples of objectives and scope and sequence. The Department of Defense Dependents Schools (DoDDS) (1982) educational computing program has adopted a wide variety of school uses of computer technology. The DoDDS plan was developed to enable students to study computer processes and to permit the use of computers as a tool for learning in all curricular areas. Their plan called for the use of computers in local school administration and for support of the total school program. Each of these potential uses was identified for its contribution to the ability of teachers to provide effective learning experiences and thereby meet the individual and collective needs of students. The DoDDS view of educational computing encompasses the total perceived integrated uses of computers in the schools from grades K-12.

A comprehensive listing of general, program, and instructional objectives was developed for the DoDDS. The numerical coding system that they used follows:

1.0 1.1 1.11

General Objectives ________

Program Objectives ________

Instructional Objectives ________

The DoDDS expects instructional objectives to be further defined by enabling objectives as determined by classroom teachers.

The following objectives, which are the basis for the DoDDS curriculum, were also used as the foundation of California's Assessment Program for the measurement of computer literacy of their sixth and twelfth grade students during the 1982-1983 school year (Division of Planning, Evaluation, and Research, 1984). In parentheses at the end of each instructional objective are the grade levels which represent, respectively, the entry level for initiating instruction and the earliest level at which proficiency can be expected for most students. For example, (K-4) indicates that instruction related to the particular objective should be initiated in kindergarten and proficiency should not be expected before the conclusion of the fourth grade. These grade levels, such as (6-12), indicate the scope and sequence of computer-based instruction for the entire system.

1.0 Computer Literacy — Demonstrate understanding of the capabilities, applications, and implications of computer technology.

- 1.1 Interact with a computer and/or other electronic devices.
  - 1.1.1 Demonstrate ability to operate a variety of devices which are based on electronic logic. (K-4)
  - 1.1.2 Demonstrate ability to use a computer in the interactive mode. (1-4)
  - 1.1.3 Independently select a program from the computer resource library. (1-6)
  - 1.1.4 Recognize user errors associated with computer utilization. (1-8)
- 1.2 Explain the functions and uses of a computer system.
  - 1.2.1 Use an appropriate vocabulary for communicating about computers. (1-8)
  - 1.2.2 Distinguish between interactive mode and batch mode computer processing. (2-8)
  - 1.2.3 Identify a computer system's major components, such as input, memory, processing, and output. (4-8)
  - 1.2.4 Recognize tasks for which computer utilization is appropriate. (3-12)
  - 1.2.5 Describe the major historical developments in computing. (4-12)
- 1.3 Utilize systematic processes in problem solving.
  - 1.3.1 Choose a logical sequence of steps needed to perform a task. (K-2)
  - 1.3.2 Diagram the steps in solving a problem. (1-4)
  - 1.3.3 Select the appropriate tool and procedure to solve a problem. (1-6)

1.3.4 Develop systematic procedures to perform useful tasks in areas such as social studies, business, science, and mathematics. (4-8)

1.3.5 Write simple programs to solve problems using a high-level language, such as PILOT, LOGO, or BASIC. (4-8)

1.4 Appraise the impact of computer technology upon human life.

1.4.1 Identify specific use of computers in fields, such as medicine, law enforcement, industry, business, transportation, government, banking, and space exploration. (1-12)

1.4.2 Compare computer-related occupations and careers. (6-12)

1.4.3 Identify social and other nontechnical factors which might restrict computer utilization. (6-12)

1.4.4 Recognize the consequences of computer utilization. (6-12)

1.4.5 Differentiate between responsible and irresponsible uses of computer technology. (6-12)

2.0 Computer Science — Demonstrate understandings of computer systems including software development, the design and operation of hardware, and the use of computer systems in solving problems.

2.1 Write structured and documented computer software.

2.1.1 Write well-organized BASIC programs which include the use of color, sound, and graphic statements. (7-10)

2.1.2 Write programs which demonstrate advanced programming techniques used to solve problems in business, scientific, or entertainment applications. (9-12)

2.1.3 Write programs in an additional high-level language such as PASCAL, COBOL, or FORTRAN. (10-12)

2.1.4 Write programs in a low-level language, such as machine language or assembler. (11-12)

2.2 Demonstrate knowledge of the design and operation of computer hardware.

2.2.1 Demonstrate unassisted operation of at least two different configurations of computers and their peripherals. (8-11)

2.2.2 Use a special-purpose computer or computer-interfaced devices to monitor or control events by sensing temperature, light, sound, or other physical phenomena. (8-12)

2.2.3 Describe the computer's digital electronic circuitry in terms of binary arithmetic and logical operators. (10-12)

2.2.4 Perform vendor-authorized minor maintenance on the computer system. (10-12)

2.3 Use computer systems in problem solving.

2.3.1 Use data processing utilities, including word processing and data base management, in problem solving. (9-12)

2.3.2 Translate software from one language to another or to another version of the same language. (10-12)

2.3.3 Analyze different solutions to the same problem. (11-12) (pp. 2-5)

Dr. Gary G. Bitter, Professor of Computer Education at Arizona State University in Tempe, Arizona, authored a five-part series entitled "The Road to Computer Literacy: A Scope and Sequence Model," published in Volume 2, Numbers 1, 2, 3, 4, and 5 of *Electronic Learning*. The articles present Dr. Bitter's approach to developing a computer literacy curriculum for a LEA. Local education agencies are faced with answering two broad and important questions: "What are the topics we should teach?" and "When should we introduce these topics?" Dr. Bitter indicates that there are no simple, absolute answers to these questions, and that these issues will continue to be debated in the future.

The scope and sequence model presented on the following pages is the result of Dr. Bitter's review of computer literacy curricula across the nation, as well as 16 years of experience working with computers, teachers, and students. This scope and sequence has been designed using a definition of computer literacy that is clearly divided into two areas: computer awareness and computer programming. Awareness topics, which require limited or no use of computers, serve as a medium to classroom discussion, activities, and projects. Programming topics require the availability of computers. This scope and sequence includes the grade levels at which topics should be introduced. However, Dr. Bitter indicates that the year by which topics are to be mastered cannot be identified for most of these topics because computer literacy is in its novice stages and the state-of-the-art is constantly changing. He strongly recommends that this scope and sequence be used only as a guide and not as the final

COMPUTER LITERACY SCOPE AND SEQUENCE

	TOPICS	COMPUTER AWARENESS													PROGRAMMING												
		K	1	2	3	4	5	6	7	8	9	10	11	12	K	1	2	3	4	5	6	7	8	9	10	11	12
K	What a Computer Is	IA	C	C	C	C	C	C	C	C	R	R	R	R													
K	Following Directions	IA	C	C	C																						
K	Vocabulary	IA	C	C	C	C	C	C	C	C	C	C	C	C													
K	Programming Programmable Devices														IA	C	M										
K	Turtle Graphics (Making Shapes)														IA	C	C										
1ST GRADE	What a Computer Can Do		IA	C	C	C	C	C	C	C	R	R	R	R													
1ST GRADE	Learning to Use a Computer		IA	C	C	C	C	C	C	C	C	C	C	C													
1ST GRADE	Using the Keyboard		IA	C	C	M																					
1ST GRADE	Turtle Graphics (Moving Shapes)															IA	C	C									
2ND GRADE	Computer Advantages			IA	C	C	C	C	C	C	C	C	C	C													
2ND GRADE	Computer Disadvantages			IA	C	C	C	C	C	C	C	C	C	C													
2ND GRADE	Computers in Our Lives			ID	C	C	C	C	C	C	C	C	C	C													
2ND GRADE	Everyday Applications			ID	C	C	C	C	C	C	C	C	C	C													
2ND GRADE	Future			ID	C	C	C	C	C	C	C	C	C	C													
2ND GRADE	Turtle Graphics (Rotations, etc.)																IA	C	C	C							
2ND GRADE	LOGO (Sprites)																IA	C	C	C	C	C	C	C	C	C	C
3RD GRADE	History				ID	C	C	C	C	C																	
3RD GRADE	Logic				IA	C	C	C	C	C	C	C	C	C				IA	C	C	C	C	C	C	C	C	C
3RD GRADE	How a Computer Works				IA	C	C	C	C	C	C	C	C	C													
3RD GRADE	Parts of a Computer				IA	C	C	C	C	C	C	C	C	C													
3RD GRADE	LOGO Programming																	IA	C	C	C	C	C	C	C	C	C
3RD GRADE	Problem Solving with LOGO																	IA	C	C	C	C	C	C	C	C	C
		K	1	2	3	4	5	6	7	8	9	10	11	12	K	1	2	3	4	5	6	7	8	9	10	11	12
4TH GRADE	Hardware					ID	C	C	C	C	C	C	C	C													
4TH GRADE	Software					ID	C	C	C	C	C	C	C	C													
4TH GRADE	Flowcharting					IA	C	C	C	C	R	R	R	R					IA	C	C	C	C	C	C	C	C
4TH GRADE	Storyboarding					IA	C	C	C	C	R	R	R	R					IA	C	C	C	C	C	C	C	C
4TH GRADE	BASIC: PRINT & REM																		IA	C	C	C	C	R	R	R	R
4TH GRADE	BASIC: LET																		IA	C	C	R	R	R	R	R	R
4TH GRADE	BASIC: INPUT																		IA	C	R	R	R	R	R	R	R
4TH GRADE	BASIC: GO TO																		IA	C	R	R	R	R	R	R	R
4TH GRADE	Formulas (Variables & Constants)					IA	C	C	C	C	C	C	C	C					IA	C	C	C	C	C	M		
4TH GRADE	String Data																		IA	C	C	C	C	C	C	R	R
4TH GRADE	Relations					IA	C	C	C	M									IA	C	C	C	M				
4TH GRADE	Binary Numbers					IA	C	C	C	C	C	C	C	C													

LEGEND

- IA—Introduction with Activities
- ID—Introductory Discussion
- C—Expansion of Discussion from Previous Grades
- R—Review
- M—Mastery

Editor's Note: *This Scope and Sequence Chart can be read in two ways. If you're a third grade teacher, and you want to find out what topics the author suggests that you introduce to your students, refer to the "Third Grade" section on the left-hand side of the chart. To find out what topics you should now be expanding upon or reinforcing, find Grade 3 on the horizontal column at the top of the page and read down.*

		COMPUTER AWARENESS													PROGRAMMING												
	TOPICS	K	1	2	3	4	5	6	7	8	9	10	11	12	K	1	2	3	4	5	6	7	8	9	10	11	12
5TH GRADE	Computer Generations						ID	C	C	C																	
	Computers						IA	C	C	C	M									IA	C	C	C	C	C	C	C
	BASIC: IF-THEN																			IA	C	R	R	R	R	R	R
	BASIC: ON-GO TO																			IA	C	R	R	R	R	R	R
	BASIC: READ-DATA																			IA	C	R	R	R	R	R	R
	Word Processing						IA	C	C	C										IA	C	C	C	C	C	C	C
6TH GRADE	Computer Types							ID	C	C	R	R	R	R													
	Data Handling							IA	C	C	C	C	C	C													
	Computer Languages							IA	C	C	C	C	C	C													
	Looping							IA	C	C	C	M									IA	C	C	C	C	C	C
	BASIC: FOR-NEXT																				IA	C	C	C	C	C	C
	BASIC: Random Number																				IA	C	C	C	C	C	C
	Problem Solving with BASIC																				IA	C	C	C	C	C	C
	Graphics																				IA	C	C	C	C	C	C
		K	1	2	3	4	5	6	7	8	9	10	11	12	K	1	2	3	4	5	6	7	8	9	10	11	12
7TH GRADE	Modeling								IA	C	C	C	C	C													
	Robotics								ID	C	C	C	C	C													
	Social Issues								ID	C	C	C	C	C													
	Data Bases								IA	C	C	C	C	C													
	BASIC: Arrays (One-Dimensional)																					IA	C	C	C	C	C
	BASIC: functions																					IA	C	C	C	C	C
8TH	Computer Crime									ID	C	C	C	C													
	Algorithms									IA	C	C	C	C									IA	C	C	C	C
	BASIC: Arrays (Two-Dimensional)																						IA	C	C	C	C
	Graphics (Sound & Color)																						IA	C	C	C	C
9TH GRADE	Computer Capabilities										ID	C	C	C													
	Computer-Related Fields										ID	C	C	C													
	BASIC: Simulation Programming																							IA	C	C	C
	BASIC: Matrices																							IA	C	C	C
	BASIC: Files																							IA	C	C	C
	Pilot: Introductory Language Commands																							IA	C	C	C
		K	1	2	3	4	5	6	7	8	9	10	11	12	K	1	2	3	4	5	6	7	8	9	10	11	12
10TH	Prediction, Interpretation, Generalization of Data											IA	C	C													
	Artificial Intelligence											IA	C	C													
	Pascal: Introduction																								IA	C	C
11TH	Computer Systems												ID	C													
	Sampling Techniques												IA	C												IA	C
	Statistical Application												IA	C												IA	C
	Pilot: Programming																									IA	C
12TH	Computer Survival													ID													
	Invasion of Privacy													ID													
	Pascal: Advanced																										IA
	Data Bases: Advanced																										IA

answer. The following chart, reproduced with permission of *Electronic Learning*, appears in the first article in this five-part series (Bitter, 1982, September). The other four articles, which further define the content of this chart in terms of objectives and activities, are included in the Appendix of this unit of instruction (Bitter, 1982, October; 1982, November/December; 1983, January; 1983, February).

Obviously, everyone does not agree with the philosophy of integrating computer literacy throughout all grade and age levels of a K-12 system. Arthur Luehrmann (1984, April), a veteran leader in the field of educational computing, does not believe it is realistically possible to have all students become computer literate by having teachers and students all over the school learning how to compute at the same time. Instead of using a fragmented scope and sequence model from kindergarten through twelfth grade, Luehrmann strongly advocates the adoption of a separate one-semester computer literacy course in grades 7 through 9. Essentially, Luehrmann urges LEAs to put all of their eggs in one basket. He describes this model as the "beachhead approach" to computer literacy because its goal is to establish a safe and secure base of operations for the diffusion of computer literacy throughout the school system. Once this course is successfully in place, all or most students can achieve certain computer literacy goals. The single course approach allows LEAs to be more accountable, since student growth and development can be more easily monitored.

Several prerequisite skills could be taught in elementary schools prior to this course. Keyboarding skills could be offered in grades 3 or 4. Survival skills, such as turning the computer on, loading a program, running a program, and saving information on a diskette, could be taught through a word processing program in grades 4 or 5. An introduction to programming in LOGO or BASIC might also be introduced in the early grades. Following this beachhead class, LEAs should permit students to participate in another one-semester elective computer course prior to entering high school. Luehrmann indicates that high school students should be able to choose various courses in business data processing and computer science. A goal of every LEA could be to implement the Advanced Placement Computer Science course, as specified by the College Board, in their high schools as soon as possible. Luehrmann concludes by stating that "we are asking too much of our schools today in expecting them to integrate the computer **immediately** into their traditional curriculum. We must never forget that that is the ultimate goal of teaching computer literacy—to give students computer skills they can use in all of their traditional subjects." (p. 40)

IMPLEMENTATION ASPECTS OF THE PLAN

After a LEA has established a philosophy, identified goals, and created objectives, including a scope and sequence, it is necessary to consider the implementation scheme that will facilitate the accomplishment of the goals. At this point in the process, planners must progress along the continuum from ideal considerations to realistic expectations. This is best accomplished through a thorough understanding of the following implementation factors of the plan: personnel, equipment purchases, materials selection, staff development, budget, timelines, and evaluation. The Minnesota Department of Education (1983) presented these characteristics in the following chart:

Goals/ Objectives	Scope and Sequence	Personnel	Equipment Purchase/ Deployment	Materials Selection/ Acquisition	Staff Development	Budget	Timelines
Learning to Use Computers	4th grade Language Arts						

Who	When	#s	Hours	Sessions	Length	Where	By Whom	$

This chart was developed to ensure that LEAs included all of the necessary components in their implementation plans. The component on staff development was expanded to demonstrate how a variable could be dealt with. During this stage of implementation, it is critical to realistically assess the resources available for each need. It is also important to experiment with various types of technology. The plan itself must not become more important than the needs which initially fostered the plan. Due to the fact that plans will be developed and implemented over a span of time, it is necessary that the plans be flexible and open to change as the need evolves. LEAs should reflect a vision of the future in their plans by thinking several years ahead in the current plan.

Personnel

School systems of varying sizes have different personnel needs. The identification of necessary personnel is critical to the success of a LEA's overall plan. Key personnel, in addition to the instructional staff, might include a Computer Coordinator, trainers, building contacts, laboratory aides, and clerical support.

A job description for the Computer Coordinator. The Department of Defense Dependents Schools (DoDDS) (1982) has developed a job description including a comprehensive listing of functions. This job description divides the position into general, program, and specific functions. The numerical coding system that they used follows:

```
                  1.0        1.1        1.11
General Function --┘          |           |
      Program Function -------┘           |
            Specific Function ------------┘
```

Functional statements in the job description have equal value, and sequence does not represent priority. All of the functions are important and each of them can be divided into performance sub-functions:

- 3.0 Computer Education Services—Coordinate school computer activities related to computer-based instruction, computer literacy, and computer science for a school or group of schools.
  - 3.1 Assess school classroom instructional needs.
    - 3.1.1 Identify hardware and software requirement.
    - 3.1.2 Survey appropriate instructional modes and potential levels of usage.
    - 3.1.3 Forecast in-service requirements.
    - 3.1.4 Provide regional coordinator and school personnel with assessment results and recommendations.
  - 3.2 Advise school personnel of available hardware, software, and supplies which will support individual classroom needs.
    - 3.2.1 Suggest material and software.
    - 3.2.2 Recommend appropriate maintenance plans.
    - 3.2.3 Maintain an inventory of computer equipment and available software.
  - 3.3 Provide technical assistance through in-service and consultation.
    - 3.3.1 Orient the professional staff concerning classroom application of computers.
    - 3.3.2 Conduct in-service training.
    - 3.3.3 Help staff members develop plans for efficient computer utilization for instructional purposes.
    - 3.3.4 Facilitate software development projects.
  - 3.4 Act as a point of contact for school computer activities.
    - 3.4.1 Maintain lines of communication between the regional coordinator and school personnel.
    - 3.4.2 Maintain lines of communication with other school computer coordinators.
    - 3.4.3 Develop a network of community contacts.
    - 3.4.4 Provide local media with news items.
- 4.0 School Administrative Support—Coordinate school computer support services for a school or group of schools.
  - 4.1 Coordinate with school personnel in accomplishing computer-assisted STUDENT SERVICES tasks.
    - 4.1.1 Facilitate collection and maintenance of school REGISTRATION information.

4.1.2 Provide computer assistance in the development of the school MASTER SCHEDULE.

4.1.3 Provide computer assistance in student SCHEDULING.

4.1.4 Provide computer assistance in the maintenance of student ATTENDANCE records.

4.1.5 Provide computer assistance in the maintenance of student PROGRESS REPORTS.

4.1.6 Generate required SUMMARY REPORTS from student services data base.

4.2 Assist EDUCATION SUPPORT PERSONNEL in the utilization of computer technology to accomplish their program support functions.

4.2.1 Assist the MEDIA SPECIALIST in using computer resources to acquire, circulate, and maintain media materials and equipment in support of the instructional program.

4.2.2 Assist PUPIL PERSONNEL SERVICES staff in the utilization of computer technology to manage information either required by or generated in the performance of their support functions.

4.2.3 Assist SPECIAL EDUCATION personnel and other TEACHER SPECIALISTS in the identification of special students' needs and in the monitoring of these students' educational programs.

4.3 Provide assistance in support of the automated MANAGEMENT OF SCHOOL RESOURCES.

4.3.1 Assist with DoDDS PERSONNEL records management in the school.

4.3.2 Assist with DoDDS FINANCIAL records management in the school.

4.3.3 Assist with DoDDS LOGISTICS records management in the school.

4.3.4 Assist with DoDDS ADP management in the school.

4.4 Support program PLANNING, EVALUATION, and IN-SERVICE activities in the school.

4.4.1 Support school activities related to the DoDDS Five-Year CURRICULUM DEVELOPMENT Plan.

4.4.2 Provide computer assistance in the measurement of STUDENT ACHIEVEMENT, the ASSESSMENT OF EDUCATIONAL PROGRAMS, and in the support of IN-SERVICE TRAINING activities.

4.4.3 Provide IN-SERVICE TRAINING in computer technology for education support personnel.

4.4.4 Provide computer assistance with SURVEY AND QUESTIONNAIRE DEVELOPMENT and analysis. (pp. 7-8)

Trainers. LEAs should either identify a cadre of trainers from within the system or they should contract for services with a third party such as a university or private corporation. Experts contend that 60-70% of computer implementation costs are training related. The cost is high because this type of activity is so labor intensive (Pierce, October 10, 1983).

The Houston Independent School District (HISD), which is a vast system with extensive resources, has a team of six full-time training specialists. This team serves the needs of students, teachers, administrators, parents, and all other involved personnel. HISD developed and implemented its own technology training and certification program since only 3% of the universities and colleges offered a single computer course for prospective teachers as recently as 1980. The district made a commitment to retaining teachers who upgraded their technical skills through merit pay incentives (Department of Technology, 1982, 1983).

Building contacts. Depending upon the size of a school district and the schools within the district, individual schools should retain a Computer Coordinator or a building contact. Districts with large secondary school campuses may have the resources to hire full-time Computer Coordinators who are in charge of all technology-related aspects of their instructional programs. The Computer Coordinator would conduct his or her assigned duties, as previously described, at the building level. For districts that do not have the extensive resources necessary to hire building-level Computer Coordinators, the utilization of building contacts may be more appropriate. Classroom teachers could be trained to be building contacts. Depending upon the size of the operation at each school, these contacts could be provided with release time from regular teaching responsibilities and/or provided with a salary supplement. In either case, the Computer Coordinator or the building contact serves an important role in the LEA's support network. This individual could provide classroom teachers with immediate assistance and follow-up support after in-service staff development activities; he or she could also be responsible for scheduling equipment and materials. These responsibilities could be assumed by a building-level media person, if this individual were already employed on a full-time basis. The Minnesota Department of Education (1983) describes the following duties and responsibilities for a building contact:

The building contact acts as the communication link between building staff and the district coordinator.

The building contact assists the district coordinator in establishing district-wide programs related to technology.

The building contact acts as a representative on appropriate faculty advisory committees at the building level.

The building contact assists with the implementation of activities related to technology.

The building contact assists in the budget development and control as related to technological equipment and supplies.

The building contact provides guidance in building level selection of equipment and material organization.

The building contact keeps materials such as computer diskettes and documentation updated to newest versions. (pp. 37-38)

LEAs can insure the overall success of their district-wide technology programs by assigning staff or faculty, on a part-time or full-time basis, the responsibility for servicing each participating school at the building level.

Laboratory aides. If a school maintains a separate technology laboratory, it would be beneficial to have a full-time aide assigned to it. This individual would be expected to monitor whether or not equipment is functioning properly and recommend when equipment needs servicing. The person assigned to this position would maintain supplies such as diskettes, documentation, and paper for printers. In addition, he or she would maintain a schedule for using equipment, log usage, provide assistance for identifying courseware, assist in the supervision of equipment, assist students, and make sure that the laboratory is kept orderly and clean (Vanatta, 1981). This position should be paid, but it does not have to be filled with a professional (Minnesota Department of Education, 1983).

Clerical support. To further insure the success of a LEA's overall plan, clerical support should be provided for the technology program at all levels. The size of the district and the number of staff members at various levels will determine how many people are needed in the area of clerical support (Minnesota Department of Education, 1983).

Equipment Purchases

Equipment is the most visible part of a LEA's overall technology program. Consequently, LEAs frequently spend a disproportionate amount of time on this aspect of the planning process. Decisions about equipment should be made after instructional decisions have been made. Detailed information about writing specifications for hardware and software is included in the unit of instruction on Competency B.5. The Minnesota Department of Education (1983) indicates that the following issues should play an important role in the equipment section of the plan.

Matching technology to instructional needs. The process of selecting equipment should focus on matching instructional needs to the characteristics of the products being evaluated. LEAs should consider the special features of the equipment they are purchasing as well as the product support available. For example, in the overall area of computing, a district's instructional play might call for equipment resources in one or more of the following usage categories:

1. Student awareness of computer operation uses:

   The need is for computers that can be used to demonstrate several applications, though not necessarily in regard to any target curriculum area.

2. Student skills in the fundamentals of computer programming:

   The need is for computers that can be used for fundamental programming activities using an easy-to-learn language.

3. Student use of applications in various subject areas:

   The need is for computers that have available a wide variety of subject area applications.

4. Student skills in sophisticated computer programming activity:

   The need is for computers that can be used with more complex programming languages and have the memory and calculating capacity to handle more sophisticated programs. (Minnesota Department of Education, 1983, p. 39)

If a LEA is primarily interested in the usage category related to sophisticated computer programming activities (4), it may be most concerned with technical features such as memory and external storage. If this is the case, it would want to closely examine brands that meet these needs. It should be remembered that less expensive brands may only be able to meet the needs of usage categories (1) and (2). Consequently, buying the brand would not be a bargain since its technical features would not match the district's needs. Some brands may have extremely powerful capabilities for the usage category (4), but they may not be applicable in subject areas (3). LEAs must weigh their needs against the technological capabilities of a product.

Features vs. support. After a LEA has decided where computer equipment is going to be used, it can narrow down the field of equipment and begin to differentiate among brands. Individuals with a technical orientation may only focus on the technical features of the equipment, considering only memory size, external storage capacity, computational speed, outside appearance, number of keyboard keys, and sophistication of graphics and sound features. However, as computer technology matures, many products begin to look alike on a technical basis. When this occurs, the availability of support for the product becomes critically important. The availability of the following support items should be considered: courseware, textbooks, instructional manuals, training, maintenance service, and the integrity and reliability of the company selling the product (Minnesota Department of Education, 1983).

General use vs. dedicated use. A variety of instructional needs, as presented earlier in the four usage categories, may require a LEA to use several brands of equipment. Some LEAs may want to purchase only one brand of microcomputer in order to simplify internal support functions such as maintenance, courseware acquisition, and teacher training. In this case, a LEA should buy computers capable of supporting the collective needs of computer awareness, subject area applications, and programming. On the other hand, a LEA might want to purchase different brands to meet varying programmatic needs at different grade levels throughout the district. However, using different brands within the same application category, such as in the teaching of beginning programming, simply for the purpose of exposing students to more than one brand, is not recommended (Minnesota Department of Education, 1983).

Planning for the long range. LEAs must realize that computer equipment has a useful life span of 3 to 5 years. Districts often progress in stages and establish their technology programs over time. Subsequently, the equipment purchased to meet a district's needs in the first year of a plan may not be sufficient to meet its needs in the third year of the plan. From a formative perspective, LEAs should assess their instructional needs and re-examine their equipment needs every few years. Districts should not expect to purchase new equipment simply to keep pace with the state-of-the-art. Ideally, the LEA plan should identify equipment that is useful and flexible for a period of years. Districts can catch up with technological improvements when their instructional needs warrant the purchase of new equipment (Minnesota Department of Education, 1983).

Placement of equipment. Like the selection of equipment, the placement of equipment within school buildings should be a function of identified instructional needs. The choice should not be between segregating the equipment in separate laboratories or integrating it into various classroom environments. LEAs must decide on a configuration that best meets their overall needs. If a teacher occasionally uses a videodisc unit to make a demonstration, this need could best be met through a check-out system from a central location. If a LEA plans to integrate technology throughout its curricula, it might be tempted to obtain equipment for each subject area or grade level department. However, if the equipment will be used more often and efficiently by having classes or individual students scheduled into a microcomputer laboratory on a need basis, the desire for departmental ownership should be put aside.

The Indianapolis Public Schools in Indianapolis, Indiana, have computers available in classrooms, usually mathematics; in computer laboratories in the mathematics areas; or in media centers or other central locations, depending upon identified instructional needs. The primary advantage of placing microcomputers in subject area classrooms is their immediate availability for teachers to perform demonstrations and for students use during class periods. The major disadvantage is that students are denied access while classes are in session that do not use the computers. Security is not a problem if teachers keep classroom doors locked when they are away from their rooms. Microcomputers are portable and can be easily moved between classrooms.

Computer laboratories have the advantage of a fixed, accessible location. A full-time laboratory aide is very desirable if quantities of valuable equipment are kept in these laboratories. Large laboratories can be utilized by entire classes or students can be sent to them to work on an independent basis. A media center location can serve basically the same purpose as a separate technology or microcomputer laboratory (Vanatta, 1981).

Regardless of where a LEA houses equipment, it must keep an accurate inventory. Monitoring the location of all computer equipment as it is acquired, moved, and repaired should be included in a specific person's position description with adequate time provided for the task (Minnesota Department of Education, 1983). Units of instruction on competencies in Category D treat this topic in greater detail.

Material Selection

Based on the four usage categories presented earlier, LEAs will want to purchase courseware (software), documentation, films, filmstrips, cassettes, video tapes, videodiscs, and textbooks to meet their identified instructional needs. Some sources that may assist planners or teachers in the identification of these materials include: commercial publishers or vendors, magazines, professional journals, conferences, professional organizations, and published software directories. If at all possible, computer courseware should be evaluated before purchasing. Obviously, the best way to evaluate materials is to use them. Some evaluations can be found in sources such as magazines and professional journals. However, reading an evaluation is not as effective as conducting your own. Both instructional and technical criteria should be used when evaluating courseware. Instructional criteria are the most important, since the courseware must be appropriate for and fit into the curriculum for which it is being purchased (Minnesota Department of Education, 1983).

Units of instruction on Competencies B.4, B.5, C.4, and E.2 will focus specifically on aspects of courseware identification, acquisition, and evaluation.

Staff Development

"Getting the teaching staff excited and trained seems to be the key to success . . . . You have to make the teachers comfortable with their own computer literacy, or they're threatened by the kids" (Fritz, 1984, January). Petruso (1981, November) describes a four-step approach to in-service that would alter teachers' attitudes toward acceptance of a new technology, provide situations that would allow them to feel comfortable and capable of handling microcomputers, and assist them in developing and implementing computer-related teaching units. Phase one provides large groups of teachers with information on such topics as learning modes and computers, and the impact of computers on education and society. The second phase on equipment operation is the most critical with respect to allowing teachers to overcome their fear of operating computers (Townsend & Hale, 1981, November). Pratscher (1983) states that if teachers do not experience some degree of success within the first 30 minutes of hands-on training, they will become frustrated and have difficulty progressing. Phase three trains teachers to use special software and classroom management programs related to data management systems, word processing, test development, and grading. In the fourth and final phase, teachers are exposed to computer software and instructional uses related to their own curriculum disciplines.

The Livermore Valley Joint Unified School District in Livermore, California, has operated under the principle that a successful computer technology program must include in-service training for teachers with hands-on experiences followed by continued training for more than one year (Heineman, 1983). The need for continuous in-service training was also identified in *A Compilation of Considerations Regarding the Use of a Computer to Help Teach the School Curriculum*.

Grossnickle and Laird (1983, May) report on effective and ineffective strategies for implementing and institutionalizing computer technology into local school environments. The Rand Study which they summarize, reported that effective strategies were those adapted to the reality of the local setting. The following seven effective strategies, when applied simultaneously, can facilitate successful implementation of computer technology across programs of a LEA:

1. Provide concrete, teacher-specific, and extended training.
2. Provide classroom assistance from district staff.
3. Allow teachers to observe the application of computers in other classrooms, schools, or districts.
4. Conduct regularly scheduled meetings that focus on practical problems.
5. Allow teachers to participate in the decision-making process.
6. Develop educational materials locally.
7. Involve the administration in in-service staff development activities.

As stated previously, in the section on trainers, in-service staff development activities should be provided for students, teachers, administrators, parents, and all other involved personnel. Grossnickle and Laird (1983, May) identify the critical importance of involving the administration. The Minnesota Department of Education (1983) indicated that administrators should be trained first for the following reasons:

1. As curriculum directors for their buildings, they should be aware of technological influences on all curriculum areas.
2. As building level coordinators of budgets, principals should be aware of costs in hardware, software, in-service training, personnel [sic].
3. Principals should have the same initial training as teachers so that they can act on a support and advisory level for their staffs.
4. Principals should be able to answer questions about what is going on "technologically" in their building (e.g., who is using word processing in their classes?). (p. 43)

Topics that could readily be included in in-service activities are: software selection criteria; review of software; authoring techniques; hardware selection criteria; hardware maintenance and repair procedures; introduction to computer language; introduction of computer-supported instruction into your district; and computer literacy or awareness topics such as history of computers, computers and society, career opportunities, the future, and the impact of computers on everyday life (Bitter, 1982, September/October). The Minnesota Department of Education (1983) has developed a model that presents a view of various levels of technological competency and describes the abilities that teachers would need at each level. The following table and the examples demonstrate how in-service training can be individualized to specific teachers' needs:

I. Basic Awareness Uses computers in the classroom for separate activities.	1) Can operate computer equipment. 2) Can locate and choose courseware for needs. 3) Can operate courseware.
II. Curriculum Awareness Modifies curriculum for computer activities.	4) Can evaluate courseware for quality. 5) Can develop curriculum in which computer use is integrated.
III. Technological Awareness Teaches about technical topics and creates new computer applications.	6) Can use authoring utilities. 7) Can write computer programs. 8) Can develop technology curriculum. 9) Can develop courseware.

Some examples illustrate the table.

Teacher A, first grade teacher, is curious about the computer, but doesn't know how it will work into his daily curriculum. This person is an ideal candidate for Level I, with some specific time spent on previewing software for the elementary level in various curriculum areas.

Teacher B, a fifth grade teacher who has reached Level I, knows that many of her students have used the computer. Would it be feasible to use a word processing package in creative writing with these students? She could integrate it into language arts time after finishing Level II and evaluating different word processing packages.

Teacher C has just been assigned two advanced computer classes for high school. She has been teaching beginning classes for two years, but realizes that the seniors who will be taking the advanced classes need solid preparation for college entrance. This teacher needs training at Level III. (pp. 44-45)

Once a LEA has determined its in-service needs, it must decide when various staff development activities should occur. A decision has to be made regarding whether teachers or other participants are to be trained during the school day, after school hours, on weekends, on special in-service days, or during the summer session. If teachers are available to hire substitute teachers for their classes. Questions related to whether or not teachers will receive stipends, recertification credits, or reimbursement of tuition for programs outside of the district also must be answered. The Minnesota Department of Education (1983) reports that in-service during regular school hours was most effective for many districts.

An example of in-service staff development activities. The Houston Independent School District (HISD) has organized its in-service training program into hundreds of 4-hour modules, providing 10,281 person-days of training in 1982. In February, 1982, the district began training computer specialists for each school through a "Teacher Technologist Training Program." This 296-hour training program consisted of 10 strands: computer operations, literacy, programming languages, technology resources, emerging technologies, scheduling and organization, word processing, data management, instructional applications, and self-study.

The training team in the HISD also developed a 12-hour program, which took place after school, for parents and their children from Chapter I schools. Through this program, parents learned how to use computers as a tutor to improve basic skills performance. The objectives of the program were to:

1. Reinforce basic skills.
2. Motivate students to learn.
3. Increase interactive, rather than passive, use of leisure time.
4. Stimulate cognitive development.
5. Increase time-on-task.
6. Develop writing skills.

7. Improve the home-learning environment.
8. Increase communication among parent, child, and teacher.
9. Equalize access to microcomputers.
10. Promote computer literacy.

Upon completion of this program, parents were allowed to check out computers and hand-held devices for up to two weeks. This program was designed to narrow the gap between families that could and could not afford high technology equipment in their homes. The program was also intended to equalize access to microcomputers.

All of the HISD's administrators, including the General Superintendent of his cabinet members, were trained in 1982. Five hundred administrators received 20 hours of training. Building principals, who serve as the most important change agents and set schools' goals for growth and development, were required to participate in four hours of training for each of the following five modules: computer literacy; planning and decision-making; hardware and software selection and evaluation; implementation issues; and emerging technologies and information sources. Other optional modules, designed for principals, include word processing, data management, telecommunications, on-line data bases, and constituent support systems, including parent and business/industry involvement (Sturdivant, 1983).

Budget Considerations

Every aspect of the planning process affects a LEA's budget. The manner in which these expenses are handled will vary widely among districts. The Minnesota Department of Education (1983) recommends that districts consider the budgeting aspects of the following major implementation factors: personnel, equipment, materials, and staff training.

Personnel. Costs related to personnel in a LEA's technology program must be considered in relationship to the following positions: Computer Coordinator, instructional staff, building contacts, laboratory aides, and clerical support. Decisions will have to be made about which positions are necessary and whether or not they will be filled with individuals who are already employed by the system. Furthermore, the LEA will have to determine whether various positions are full-time or part-time. For example, if building contacts are used in the system, then selected teachers could be provided with release time and/or additional compensation in return for accepting new responsibilities. Some of these positions could be filled by teachers who are placed on special assignments. One innovative approach is to establish cost-sharing between local businesses and the LEA in exchange for specialized training. In this situation, several teachers are selected to work as trainers with a local computer manufacturer's project. These teachers then provide this specialized training for the LEA's staff and students. Another budgeting option is to share a position with a neighboring LEA, allowing the staff person to concentrate his or her efforts and spread out the costs (Minnesota Department of Education, 1983).

Materials. It is of critical importance for LEAs to include a place in their budgets to purchase courseware/software. Related materials, such as textbooks, filmstrips, and video cassettes, may already be included in the budget. Since many LEAs are beginning with little, if any, courseware, they may want to earmark a special fund for this purpose over 3 to 5 years. After a LEA has acquired a workable base of courseware, then it may want to budget somewhat less for additions and replacements. The district's computer committee could evaluate software before large purchases are made. Furthermore, the acquisition of courseware should assist the LEA in meeting the needs identified through its goals and objectives (Minnesota Department of Education, 1983).

Equipment. No planning document or budget is complete without the allocation of money for the purchase of equipment. A LEA must purchase enough equipment to meet the needs that evolve from its goals and objectives. If a district cannot afford to purchase the necessary equipment to accomplish its planned goals and objectives, then it must either modify its goals and objectives or revise its projected timeline. Districts must decide how and when they are going to purchase equipment. They may want to equip several large laboratories initially, and then allocate a necessary amount in future annual budgets for maintenance and replacement. If LEAs cannot budget a large amount in any year, an alternative is to adopt a standard line-item in the budget so that the dollars are allocated every year. This allows a district to constantly update its hardware and maintain the latest technological advances. If this process is adopted, the district can use this information to determine how many qualified teachers are available to use the equipment needed for its projected in-service staff development.

In addition to the cost of equipment, LEAs should consider the expenses associated with the deployment of equipment such as special furniture and mobile carts. Furthermore, if a room must be remodeled, expenses associated with lighting, air conditioning, electrical supply, and modification of the physical structure may be incurred. Once again, it is extremely important that the district consider maintenance and replacement costs. LEAs may be able to purchase a maintenance contract from their local dealer. Other options are to obtain on-site maintenance for an additional fee or to train staff members in the district to maintain their equipment.

Staff training. Sixty to seventy percent of computer implementation costs are training related. The cost is high because this type of activity is excessively labor intensive (Pierce, October 10, 1983). Furthermore, there are hidden costs in addition to the actual training expenses. Staff may have to be provided with release time to participate in training. LEAs must either provide trainers from their own staffs or contract for services with external sources. In addition, training may require the district to purchase instructional materials and courseware. Another expense might be for related facilities, if the LEA's equipment is also being used by students during training. A final hidden expense could result from the need to transport equipment from several locations to a central site for occasional training use (Minnesota Department of Education, 1983).

The two-percent solution. David Moursund (1984), the editor-in-chief of *The Computing Teacher*, indicates that the amount of money spent on instructional computing by a LEA should depend upon its goals. However, when pressured for a more in-depth response, he has presented the two-percent solution. The idea is simple enough: a district budgets 2% of its total funds, year after year, for instructional computing. These funds could be acquired by reallocating current funds, passing a special perpetual tax, or a combination of these methods. Moursund recommends that these funds be used as follows: 50% for hardware,16.67% for software, 8.33% for in-service training, 16.67% for computer coordinators or other key staff, and 8.33% for contingency expenses. This contingency fund could be used for in-service training during the first year and for other purposes in other years. Funds could also be used for providing access to large-scale data banks, special-purpose peripherals such as videodisc equipment, hardware and software for students to borrow for home use, and establishing a community (neighborhood) school to provide community access to instructional computing equipment. Two percent is an adequate initial goal. However, it may prove to be quite inadequate over a long period of time. Moursund concludes that perhaps a few years from now he will be writing an editorial on the five-percent solution.

Timelines

An important aspect of implementing this overall plan is the establishment of timelines. Timelines are normally discussed after other implementation factors have been considered. Because the expenses associated with the acquisition of hardware and courseware, as well as the provision of in-service staff development activities, are usually quite high. LEAs may want to establish timelines that call for the staggered implementation of various elements of their goals and objectives.

If all goals cannot be accomplished simultaneously, then some criteria must be set for establishing priorities. If a LEA is concerned with practical needs, then vocational education may be a very high priority since those students will enter the technological marketplace first. On the other hand, some districts may decide that introducing students to technology at the primary levels is the most important aspect of the overall plan. This latter decision may be based on the need to provide students with the skills necessary at other levels within the LEA's curricula. If the LEA focuses on its existing curricula as the primary determinant of need, then the weak areas in its existing instructional program should be dealt with first. These instructional areas of the program may benefit rapidly from the integration of technology.

There are advantages and disadvantages to using a staggered approach to phasing technology into a LEA. The building block nature of most objectives does not necessarily allow us to teach what is desired at a given grade level, since prerequisite skills may not have been developed at earlier grade levels. Consequently, course content may constantly change as staff and students gradually build proficiency. Eventually, this causes objectives to be placed at ideal grade levels rather than at levels of convenience. The phase-in process may also create inconsistencies among teachers, since only selected teachers will initially be involved. Therefore, students may not see consistency in their instruction from year to year. This process also may not permit all students equal access to technology.

In summary, timelines must consider other elements of the overall plan. If all goals and objectives cannot be met at once, priorities must be established that take precautions to avoid long-term problems. The most critical concern is that timelines be realistic. Nothing is worse than to set impossible goals that cannot be met by staff and students (Minnesota Department of Education, 1983).

Evaluation

In this age of accountability, evaluation is a critical and necessary component of any plan. LEAs must periodically measure their progress against established goals. The evaluation phase can be expedited by stating program objectives in a measurable format. A variety of techniques can be used in designing an evaluation strategy. The Minnesota Department of Education (1983) lists the following recommendations:

* A rationale for evaluation should be established — what is the purpose of the evaluation? — how are the results going to be used?

* The recipients of the evaluation information should be identified.

* Key participants in the implementation of the objectives should be involved in developing the evaluation plan.
* Choosing selected objectives to evaluate may be more effective than evaluating all of the objectives in the plan.
* A variety of approaches (surveys, questionnaires, observations, interviews, tests, case studies, etc.) should be used.
* Staff, students, and community members should be included in the evaluation.
* It is important to monitor the process of content development as well as recording test results.
* Evaluation is an on-going process: evaluation results should be used to assist in revision of the plan and to aid in the decision-making process as well as provide appropriate information relative to the accomplishment of certain goals. (p.55)

Minnesota's Planning, Evaluating, and Reporting Legislation (PER), MS 123.741, requires that school districts determine what is being evaluated, how data is to be collected, and who will receive the report. Three areas of evaluation must be addressed:

AREA I: PROGRESS ON PLAN IMPLEMENTATION

What progress is being made on the implementation of the Technology Utilization Plan?

What: The plan must have a set of tasks which are assigned to a specific person or persons. Each task will have a timeline which indicates the critical stages of implementation.

How: Each person assigned one or more tasks will report regularly (monthly or bimonthly) to the appropriate administrator.

Who: The central office administrator assigned the responsibility for instructional program evaluation will prepare and disseminate appropriate reports for the school board, principals, certified staff, and community as necessary....

AREA II: STAFF UTILIZATION AND CURRICULAR ADAPTATION

Has the content of courses or daily lessons been changed to accommodate new technologies and has the behavior of the staff members delivering or managing the instruction changed as a result of the introduction of the plan?

What: Assuming the existence of a staff development and curriculum revision plan, identify the uses of technology by individual staff members with respect to each curricular area.

How: Course outlines and lesson plans will identify the integration/utilization of technology. In the adoption of learning materials for a curricular area, identify the appropriate technology in terms of hardware and courseware.

Who: The central office administrator assigned the responsibility for instruction or program evaluation will prepare and disseminate appropriate reports for the school board, principals, certified staff, and community as necessary....

AREA III: LEARNER OUTCOMES

What knowledge and attitudes have been acquired by the learners as a result of having introduced new technology into the instructional program? (This question should not imply that some type of controlled experiment needs to be conducted, but there should be a conscious effort to measure those outcomes stated in the goals which are desired as a result of having made changes in the instructional delivery system).

What: The goals and instructional objectives need to be stated in behavioral terms so that an appropriate data gathering procedure can be used.

How: The district's testing and evaluation plan should include assessment items which measure the stated goals and objectives.

Who: The central office administrator assigned the responsibility for instructional program evaluation will prepare and disseminate appropriate reports for the school board, principals, staff, and community as necessary. (pp.55-57)

RESOURCE PERSONS AND EXEMPLARY PROGRAMS

Throughout this unit of instruction elements of exemplary programs have been identified. In addition, references have been made to individuals who are associated with exemplary programs. These people and programs graciously shared their expertise and materials with this project. There is no doubt that these individuals could serve as valuable resources to anyone who is developing a comprehensive plan for implementing computer technology in their LEA or program. Before these resources are listed, one exemplary model in particular needs to be discussed.

Institute of Computer Technology

The Institute of Computer Technology (ICT), located in the heart of the Silicon Valley in Sunnyvale, California, is a joint venture of education and industry. The Institute was organized under a joint powers agreement by the following three LEAs: Freemont Union High School District, Los Gatos Joint Union High School District, and Sunnyvale School District. During 1982, ICT staff members actively consulted with 13 national electronic manufacturers and computer users, as well as the Santa Clara County Manufacturing Group and Industry-Education Council. In addition, they conducted planning and feasibility studies in cooperation with organizations such as the Consulting Exchange, SRI International, and American Institutes for Research. The mission or philosophy of the ICT is as follows:

> The Institute of Computer Technology (ICT) is an educational institution dedicated to providing students, teachers, and community members with opportunities for career development in an increasingly technological society. ICT was created as a partnership between industry and education — a participative partnership which will benefit both partners by utilizing an educational system to produce potential employees with the skills needed in today's sophisticated business climate. ("A Joint Venture of Education and Industry," 1983, p.2)
>
> The operating objectives of the Institute of Computer Technology include the following:
>
> **TO PROVIDE COMPUTER TECHNOLOGY COURSES** — ICT will develop and present computer-related courses of study that enhance career opportunities and facilitate access to current technology both for students and for other interested community members. The Institute will maintain continuous communication and involvement with industry to ascertain current educational needs. As a supplement to local school-system offerings, ICT will provide advanced and/or experimental programs.
>
> **TO PROVIDE A FRAMEWORK FOR THE GROWTH OF COMPUTER EDUCATION** — ICT will assist elementary and secondary school systems in developing computer technology programs. By producing more highly qualified and motivated students, ICT will encourage institutions of higher education to enrich their course offerings.
>
> **TO SERVE AS AN INNOVATOR IN EDUCATION** — ICT will employ a variety of teaching strategies. It will seek ways of enhancing the teaching of traditional subject matter by experimenting with subject groupings and new teaching methods made possible by computer technology. ICT will provide a laboratory for testing and refining new ideas and will develop programs that can be transferred to all levels of public education.
>
> **TO FOSTER COOPERATION BETWEEN INDUSTRY AND EDUCATION** — ICT will provide opportunities for school teachers and industry representatives to teach and work together, thus supporting an exchange of ideas and expertise between the two groups. ("A Joint Venture of Education and Industry," 1983, p.3)

On September 29, 1982, the Governor of the State of California approved the Hart Bill which provided ICT with $100,000.00 in statewide funds to conduct a program of education and training in computer technology for students in kindergarten through twelfth grade and adults. In addition to this initial grant, ICT is partially funded by the State of California at the rate of $4.00 for each hour that any student is in attendance. ICT receives $700.00 for a student who attends a one hour class for an entire school year. ICT's expenses exceed the State's funding; therefore, additional funding is continually sought from the community, foundations, technology industries, commercial firms, and federal agencies.

Many leading companies have been involved in supporting the ICT and assisting in the development of its programs. Contributions have included the following types of items:

—Public statements of support and endorsement

—Assignment of personnel to ICT activities such as the governing board, curriculum planning task forces, and operating staff

—Donations of equipment, materials, and supplies

—Contributions of funds for operations, including stipends for industry trainers and educators to develop curriculum and courses

—Making available technical training programs for adaptation to ICT use

—Providing in-house instructional space for ICT classes, staff development programs, and work-study programs

—Developing in-service training to help educators become more aware of and skillful with instructional uses of computers ("A Joint Venture of Education and Industry," 1983, p.10)

The Institute of Computer Technology provides the following substantial benefits to industry:

—An opportunity to influence public education in the development of programs that meet industry's needs

—A more stable and highly trained professional-technical work force

—Recruiting advantages due to students' involvement with participating companies

—The opportunity to test new products and to track equipment usage and maintenance records

—Increased computer awareness and usage among educators and the public ("A Joint Venture of Education and Industry," 1983, p.9)

The Institute has had as many as 1200 students enrolled in classes at one time (Kobryn, 1983, October). ICT operates classrooms in Saratoga High School and De Anza Elementary School. All students, whether they attend public or private schools, who reside within the geographical boundaries of the three previously identified school districts are eligible to attend ICT classes. These three school districts provide extensive computer applications within their own systems in addition to the comprehensive offerings of the ICT. The following is a list of the available and planned courses through ICT:

Using Computers
Introduction to LOGO
Introduction to BASIC Language
Intermediate BASIC Language
Advanced BASIC Language

Comparison of Programming Languages
Structured Programming with PASCAL (AP)
PASCAL Programming
FORTRAN Programming
COBOL Programming
Computer Architecture and Assembly Language

Computerized Accounting
VISICALC
Word Processing I
Word Processing II
Data Entry Occupations

Data Base Concepts
Data Communications
Data Structures
Computer Architecture
Operating System Concepts
File (computer) Organization
Simulation and Modeling

Technical Writing
Computer Law
Problem Solving Techniques
Problem Solving with a Microcomputer
Programming Methodology
Graphics Programming

Electronics I
Electronics II
Micro Processor Fundamentals
Digital Circuitry
Instrumentation
Microcomputer Maintenance
("A Joint Venture of Education and Industry," 1983, p.7)

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SUMMARY

The purpose of this unit of instruction is to familiarize vocational educators with the components of a district-wide plan for computer-based instruction. The importance of preparing a comprehensive plan for CBI in a local education agency is discussed. The need to use a computer committee that represents the entire LEA is presented. The conceptual structure of a comprehensive plan is thoroughly described. Elements of the overall plan include the following components: philosophy or mission, goals, objectives, personnel, equipment purchases, materials selection, staff development, budget considerations, timelines, and evaluation. Finally, an exemplary model, the Institute of Computer Technology, is described and a list of resource persons is included. The content of this unit of instruction provides a comprehensive description of the elements of a local education agency plan for computer-based instruction.

ACHIEVEMENT INDICATORS

1) Discuss the importance of developing a comprehensive plan for implementing CBI in a LEA.
2) List seven general recommendations that will facilitate the overall process of developing a comprehensive plan for CBI in a LEA.
3) Describe the computer committee method of initiating and developing a comprehensive plan for CBI in a LEA.
4) Discuss the content of a LEA's philosophy or mission statement for CBI.
5) Describe the content of a LEA's goals for CBI.
6) Discuss the content of a LEA's objectives for CBI.
7) Describe five categories of personnel that are frequently included in a plan for implementing CBI in a LEA.
8) Discuss five major considerations of purchasing equipment that should be examined in the planning process for CBI in a LEA.

9) Describe the planning process of selecting materials for CBI in a LEA.

10) Discuss planning strategies that can be used to increase the success of in-service staff development activities for CBI in a LEA.

11) Describe budget considerations related to personnel, materials, equipment, and staff training that should be examined in the planning process for CBI in a LEA.

12) Discuss the two-percent solution to budgeting CBI in a LEA.

13) Describe the process and ramifications of using staggering timelines, also known as the phasing-in process, when planning for CBI in a LEA.

14) Discuss eight recommendations that should be considered when planning the evaluation component for CBI in a LEA.

15) Explain the objects and process of analysis in the evaluation component with regard to progress on plan implementation, staff utilization, curricular adaptation, and learner outcomes.

16) Discuss the benefits of a centralized Institute of Computer Technology designed to serve the needs of three LEAs.

17) List resource people knowledgeable about exemplary programs using computer-based instruction.

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PART I OF A FIVE-PART SERIES

The Road to Computer Literacy:

A SCOPE AND SEQUENCE MODEL

THROUGHOUT THE COUNTRY, EDUCATORS ARE STRUGGLING TO prepare a computer literacy curriculum for their school or district. In doing so, they are faced with two broad, but important questions: "What are the topics we should teach?" and "When should we introduce these topics?"

The truth of the matter is that there is no definitive answer to either of these questions—right now, at any rate. The term Computer Literacy itself has many definitions, and what to teach and when to teach it are topics of continued debate.

What follows, then, is the way in which I define Computer Literacy. It takes the form of a Scope and Sequence chart, which lists a number of generally stated topics for instruction and indicates the grade level at which a particular topic might be introduced or expanded upon. This particular Scope and Sequence is based on my having reviewed numerous Computer Literacy curricula developed around the country, as well as my 16 years of experience working with computers, teachers, and students. Nevertheless, it is not meant to be the final word. Rather, it is intended to be used as a reference and a starting point for those schools which are planning their own Computer Literacy curriculum.

As the first in a five-part series, the chart provides a broad overview of one possible K-12 Computer Literacy curriculum. Future installments will be more specific, focusing on particular objectives for each of the topics to be covered in grades K-3, 4-6, 7-9, and 10-12, along with suggested teaching activities.

Computer Literacy Overview

COMPUTER LITERACY, AS I see it, is made up of two broad areas: Computer Awareness and Computer Programming.

In general, the Computer Awareness topics indicated in the chart require limited or no access to computers. Rather, they can serve both as topics for discussion as well as themes for classroom activities and projects.

The Programming topics, as you might expect, will require having computers available. These topics begin with programmable devices such as Big Trak (a programmable toy tank), and proceed to include LOGO. I've indicated that programming in BASIC begin at grade four and continue through grade twelve. (Only the universal BASIC commands have been included in this Scope and Sequence. All editing and microcomputer-specific BASIC commands have been omitted because of space constraints.) I've also recommended some Pilot-type programming for students in grades nine through twelve, and have suggested Pascal as the predominate programming language for 10th through 12th graders. No matter which programming language a student is working with, however, writing efficient programs as well as understanding the uses and limitations of a particular language will be important teaching and learning goals.

The Scope and Sequence

AS YOU READ THROUGH the Scope and Sequence chart, you'll notice that there are very few indications of when mastery of particular topics should be expected. This is not to say that the topics to be covered in a Computer Literacy curriculum will never be mastered, but rather that at this point, you should not assume previous knowledge of anything on the part of the student. Perhaps five years from now, after a full-blown Computer Literacy curriculum has been in place for a while, it'll make more sense to indicate at what grade levels you should assume mastery of particular topics.

Most likely, given your experiences as educators, you have your own ideas about that now. And, most likely, you have your own ideas about what topics should or should not be included in the chart as well as at what points particular topics should or should not be introduced. Let me reiterate: this Scope and Sequence is just a model. Treat it as a guide, not gospel.

Editor's Note: EL and Dr. Bitter invite all readers to send their comments and suggestions on the Computer Literacy Scope and Sequence and ideas for teaching the topics outlined to: Scope and Sequence, Electronic Learning, *50 W. 44th St., New York, NY 10036.*

By Gary G. Bitter

Dr. Gary G. Bitter, Professor of Computer Education at Arizona State University, Tempe, AZ, is the author of several educational computing books and articles, including a forthcoming computer literacy textbook titled Computers in Today's World *(John Wiley & Sons). He has worked with computers, children, and teachers for the past 16 years.*

COMPUTER LITERACY SCOPE AND SEQUENCE

COMPUTER AWARENESS

	TOPICS	K	1	2	3	4	5	6	7	8	9	10	11	12
K	What a Computer Is	IA	C	C	C	C	C	C	C	C	R	R	R	R
K	Following Directions	IA	C	C	C									
K	Vocabulary	IA	C	C	C	C	C	C	C	C	C	C	C	C
K	Programming Programmable Devices													
K	Turtle Graphics (Making Shapes)													
1ST GRADE	What a Computer Can Do		IA	C	C	C	C	C	C	C	R	R	R	R
1ST GRADE	Learning to Use a Computer		IA	C	C	C	C	C	C	C	C	C	C	C
1ST GRADE	Using the Keyboard		IA	C	C	M								
1ST GRADE	Turtle Graphics (Moving Shapes)													
2ND GRADE	Computer Advantages			IA	C	C	C	C	C	C	C	C	C	C
2ND GRADE	Computer Disadvantages			IA	C	C	C	C	C	C	C	C	C	C
2ND GRADE	Computers in Our Lives			ID	C	C	C	C	C	C	C	C	C	C
2ND GRADE	Everyday Applications			ID	C	C	C	C	C	C	C	C	C	C
2ND GRADE	Future			ID	C	C	C	C	C	C	C	C	C	C
2ND GRADE	Turtle Graphics (Rotations, etc.)													
2ND GRADE	LOGO (Sprites)													
3RD GRADE	History				ID	C	C	C	C	C				
3RD GRADE	Logic				IA	C	C	C	C	C	C	C	C	C
3RD GRADE	How a Computer Works				IA	C	C	C	C	C	C	C	C	C
3RD GRADE	Parts of a Computer				IA	C	C	C	C	C	C	C	C	C
3RD GRADE	LOGO Programming													
3RD GRADE	Problem Solving with LOGO													
4TH GRADE	Hardware					ID	C	C	C	C	C	C	C	C
4TH GRADE	Software					ID	C	C	C	C	C	C	C	C
4TH GRADE	Flowcharting					IA	C	C	C	C	R	R	R	R
4TH GRADE	Storyboarding					IA	C	C	C	C	R	R	R	R
4TH GRADE	BASIC: PRINT & REM													
4TH GRADE	BASIC: LET													
4TH GRADE	BASIC: INPUT													
4TH GRADE	BASIC: GO TO													
4TH GRADE	Formulas (Variables & Constants)					IA	C	C	C	C	C	C	C	C
4TH GRADE	String Data													
4TH GRADE	Relations					IA	C	C	C	M				
4TH GRADE	Binary Numbers					IA	C	C	C	C	C	C	C	C

PROGRAMMING

	TOPICS	K	1	2	3	4	5	6	7	8	9	10	11	12
K	What a Computer Is													
K	Following Directions													
K	Vocabulary													
K	Programming Programmable Devices	IA	C	M										
K	Turtle Graphics (Making Shapes)	IA	C	C										
1ST GRADE	What a Computer Can Do													
1ST GRADE	Learning to Use a Computer													
1ST GRADE	Using the Keyboard													
1ST GRADE	Turtle Graphics (Moving Shapes)		IC	C	C									
2ND GRADE	Computer Advantages													
2ND GRADE	Computer Disadvantages													
2ND GRADE	Computers in Our Lives													
2ND GRADE	Everyday Applications													
2ND GRADE	Future													
2ND GRADE	Turtle Graphics (Rotations, etc.)			IA	C	C	C							
2ND GRADE	LOGO (Sprites)			IA	C	C	C	C	C	C	C	C	C	C
3RD GRADE	History													
3RD GRADE	Logic				IA	C	C	C	C	C	C	C	C	C
3RD GRADE	How a Computer Works													
3RD GRADE	Parts of a Computer													
3RD GRADE	LOGO Programming				IA	C	C	C	C	C	C	C	C	C
3RD GRADE	Problem Solving with LOGO				IA	C	C	C	C	C	C	C	C	C
4TH GRADE	Hardware													
4TH GRADE	Software													
4TH GRADE	Flowcharting					IA	C	C	C	C	C	C	C	C
4TH GRADE	Storyboarding					IA	C	C	C	C	C	C	C	C
4TH GRADE	BASIC: PRINT & REM					IA	C	C	C	C	R	R	R	R
4TH GRADE	BASIC: LET					IA	C	C	R	R	R	R	R	R
4TH GRADE	BASIC: INPUT					IA	C	R	R	R	R	R	R	R
4TH GRADE	BASIC: GO TO					IA	C	R	R	R	R	R	R	R
4TH GRADE	Formulas (Variables & Constants)					IA	C	C	C	C	M			
4TH GRADE	String Data					IA	C	C	C	C	C	C	R	R
4TH GRADE	Relations					IA	C	C	C	M				
4TH GRADE	Binary Numbers													

LEGEND

IA—Introduction with Activities
ID—Introductory Discussion
C—Expansion of Discussion from Previous Grades
R—Review
M—Mastery

Editor's Note: *This Scope and Sequence Chart can be read in two ways. If you're a third grade teacher, and you want to find out what topics the author suggests that you introduce to your students, refer to the "Third Grade" section on the left-hand side of the chart. To find out what topics you should now be expanding upon or reinforcing, find Grade 3 on the horizontal column at the top of the page and read down.*

COMPUTER AWARENESS

Grade	TOPICS	K	1	2	3	4	5	6	7	8	9	10	11	12
5TH GRADE	Computer Generations						ID	C	C	C				
5TH GRADE	Counters						IA	C	C	C	M			
5TH GRADE	BASIC: IF-THEN													
5TH GRADE	BASIC: ON-GO TO													
5TH GRADE	BASIC: READ-DATA													
5TH GRADE	Word Processing						IA	C	C	C				
6TH GRADE	Computer Types							ID	C	C	R	R	R	R
6TH GRADE	Data Handling							IA	C	C	C	C	C	C
6TH GRADE	Computer Languages							IA	C	C	C	C	C	C
6TH GRADE	Looping							IA	C	C	C	M		
6TH GRADE	BASIC: FOR-NEXT													
6TH GRADE	BASIC: Random Number													
6TH GRADE	Problem Solving with BASIC													
6TH GRADE	Graphics													
7TH GRADE	Modeling								IA	C	C	C	C	C
7TH GRADE	Robotics								ID	C	C	C	C	C
7TH GRADE	Social Issues								ID	C	C	C	C	C
7TH GRADE	Data Bases								IA	C	C	C	C	C
7TH GRADE	BASIC: Arrays (One-Dimensional)													
7TH GRADE	BASIC: functions													
8TH	Computer Crime									ID	C	C	C	C
8TH	Algorithms									IA	C	C	C	C
8TH	BASIC: Arrays (Two-Dimensional)													
8TH	Graphics (Sound & Color)													
9TH GRADE	Computer Capabilities										ID	C	C	C
9TH GRADE	Computer-Related Fields										ID	C	C	C
9TH GRADE	BASIC: Simulation Programming													
9TH GRADE	BASIC: Matrices													
9TH GRADE	BASIC: Files													
9TH GRADE	Pilot: Introductory Language Commands													
10TH	Prediction, Interpretation, Generalization of Data											IA	C	C
10TH	Artificial Intelligence											IA	C	C
10TH	Pascal: Introduction													
11TH	Computer Systems												ID	C
11TH	Sampling Techniques												IA	C
11TH	Statistical Application												IA	C
11TH	Pilot: Programming													
12TH	Computer Survival													ID
12TH	Invasion of Privacy													ID
12TH	Pascal: Advanced													
12TH	Data Bases: Advanced													

PROGRAMMING

Grade	TOPICS	K	1	2	3	4	5	6	7	8	9	10	11	12
5TH GRADE	Computer Generations													
5TH GRADE	Counters						IA	C	C	C	C	C	C	C
5TH GRADE	BASIC: IF-THEN						IA	C	R	R	R	R	R	R
5TH GRADE	BASIC: ON-GO TO						IA	C	R	R	R	R	R	R
5TH GRADE	BASIC: READ-DATA						IA	C	R	R	R	R	R	R
5TH GRADE	Word Processing						IA	C	C	C	C	C	C	C
6TH GRADE	Computer Types													
6TH GRADE	Data Handling													
6TH GRADE	Computer Languages													
6TH GRADE	Looping							IA	C	C	C	C	C	C
6TH GRADE	BASIC: FOR-NEXT							IA	C	C	C	C	C	C
6TH GRADE	BASIC: Random Number							IA	C	C	C	C	C	C
6TH GRADE	Problem Solving with BASIC							IA	C	C	C	C	C	C
6TH GRADE	Graphics							IA	C	C	C	C	C	C
7TH GRADE	Modeling													
7TH GRADE	Robotics													
7TH GRADE	Social Issues													
7TH GRADE	Data Bases													
7TH GRADE	BASIC: Arrays (One-Dimensional)								IA	C	C	C	C	C
7TH GRADE	BASIC: functions								IA	C	C	C	C	C
8TH	Computer Crime													
8TH	Algorithms									IA	C	C	C	C
8TH	BASIC: Arrays (Two-Dimensional)									IA	C	C	C	C
8TH	Graphics (Sound & Color)									IA	C	C	C	C
9TH GRADE	Computer Capabilities													
9TH GRADE	Computer-Related Fields													
9TH GRADE	BASIC: Simulation Programming										IA	C	C	C
9TH GRADE	BASIC: Matrices										IA	C	C	C
9TH GRADE	BASIC: Files										IA	C	C	C
9TH GRADE	Pilot: Introductory Language Commands										IA	C	C	C
10TH	Prediction, Interpretation, Generalization of Data													
10TH	Artificial Intelligence													
10TH	Pascal: Introduction											IA	C	C
11TH	Computer Systems													
11TH	Sampling Techniques												IA	C
11TH	Statistical Application												IA	C
11TH	Pilot: Programming												IA	C
12TH	Computer Survival													
12TH	Invasion of Privacy													
12TH	Pascal: Advanced													IA
12TH	Data Bases: Advanced													IA

THE ROAD TO COMPUTER LITERACY
Part II: Objectives and Activities for Grades K-3

The road to computer literacy can begin as soon as young children enter Kindergarten. These objectives and teaching suggestions can help you get them started on the right foot.

By Dr. Gary G. Bitter

IN THE FIRST INSTALLMENT OF this series, I outlined a computer literacy scope and sequence model—a roadmap, if you will, for educators to use as a reference in planning their own computer literacy curriculum. In this second installment, we take a more detailed look at the computer literacy topics for grades K-3. These topics and their objectives are meant to serve only as guideposts along the road to computer literacy. As you develop your own computer literacy roadmap, you may want to change or modify the scope and sequence outlined here.

The topics for this computer literacy model are divided into two broad areas for each grade level: Computer Awareness and Programming. Under each Topic, I've listed Objectives, Introductory Activities, and suggested Curriculum Representation Areas for introducing and teaching the topics.

The Objectives: Under each Topic, there is a specific learning objective. These objectives could easily be broken down into smaller, more precise sub-objectives. For example, the topic "Parts of a Computer" could easily be broken into an objective for each part. I've purposely left these objectives somewhat open-ended, however, rather than prescribe a performance-based plan.

Remember that although I've suggested the introduction of these objectives during grades K-3, they are appropriate objectives for any student who has not been exposed to them. The discussion level, of course, is dependent on the audience.

The Curriculum Area: Since I believe that computer literacy should be infused into the total curriculum at each grade level, I've suggested curriculum integration areas for each Topic and its Objective. These, again, are meant to serve only as a suggestion for one way to make the computer a part of every subject area—not simply a tool for mathematics.

The Activities: For each Objective, I've suggested both introductory discussion kinds of activities as well as some "hands-on" activities. While most of the activities under the Computer Awareness topics do not require the actual use of a microcomputer, many of them can be enhanced by the *presence* of a microcomputer. The Programming topics, however, do require access to a machine.

One final note: We really lack a resource for more carefully developed activities for the teaching of computer literacy. While I would like to hear about your experiences with this Computer Literacy Scope and Sequence and its activities, I would also like to know about other activities you've developed to meet these objectives. You can send your ideas and activities to me in care of *Electronic Learning*.

Gary Bitter, Professor of Computer Education at Arizona State University, Tempe, AZ, is the author of several educational computing books and articles, including two forthcoming titles with co-author Nancy Watson: Apple LOGO Primer *and* Texas Instruments LOGO Primer, *published by Reston Publishing Co., Reston, VA. Dr. Bitter is also a member of* Electronic Learning's *Board of Advisers.*

New York Times News Service Photo

Kindergarten

COMPUTER AWARENESS

TOPIC: What a Computer Is

OBJECTIVE: The student can describe the computer as a machine or tool that can help solve problems (with words or numbers) quickly and easily.
CURRICULUM AREA: Reading/Language Arts
ACTIVITIES: • Look up the word "computer" in a dictionary and an encyclopedia. As you read aloud to students, note key words and concepts. • Gather pictures of a wide range of computers—both large and small—to show to and discuss with the class. Make the pictures into a bulletin board display. • Ask if any student has a microcomputer at home. If so, have that student tell how his or her family uses the computer.

TOPIC: Following Directions

OBJECTIVE: The student can follow verbal, written, and mimed directions.
CURRICULUM AREA: All
ACTIVITIES: • Play "Twister." Have students stand with eyes shut. Call out a series of commands to move their bodies in funny positions. Variation: identify groups (by sex, hair color, first initial, etc.) to make certain moves. When groups are in various positions, have students open their eyes and look around. • Play "May I?" giving directions like "one giant step," or "two baby steps." • Pass out picture-list of objects in classroom, and send students on "scavenger hunt." • Draw picture-map of classroom, and number certain spots. Have a student follow the numbered map around the room.

TOPIC: Vocabulary

OBJECTIVE: The student will become familiar with common computer words and their meaning.
CURRICULUM AREA: Reading/Language Arts
ACTIVITIES: • Have a computer word for the day, written on the chalkboard or posted on bulletin board. Define for students, using pictures if possible. • Compare certain words to parallel human activity, e.g., memory. • Later in the year, have students propose computer words for the day—both new and old terms. • Set up a concentration game, having students match words to corresponding pictures.

PROGRAMMING

TOPIC: Programming Programmable Devices

OBJECTIVE: The student can program a programmable device to carry out specific directions or activities.
CURRICULUM AREA: Math—counting, logical thinking, and spatial relationships
ACTIVITIES: • Teach the basic commands and demonstrate the device, e.g. "Big Trak." • Count with students the distance of each "unit" forward or backward. Find the amount each unit represents in a turn. Determine the number of steps it will accept. • Have the device travel in a square, rectangle, triangle, and circle. Have students operate. • Set up teams. Mark a target point X. Have each team try to program the device to reach Target X. (Make routes to X increasingly difficult over time.)

TOPIC: Turtle Graphics (Making Shapes)

OBJECTIVE: The student can program a microcomputer to instruct the "turtle" to make geometric shapes.
CURRICULUM AREA: Math—directions
ACTIVITIES: • Teach the basic commands Forward, Back, Right, Left, Home, Show Turtle. Have students practice giving the turtle single commands. • Explore length and width of the screen with turtle steps. • Have students make squares, rectangles, triangles and circles using turtle graphics commands. • Have student teams plot (on paper) designs which use these basic shapes ... stions: Cat, truck, snowman. Then have them place o... n with turtle graphics.

	TOPICS	COMPUTER AWARENESS K	1	2	3	4	5	6	7	8	9	10	11	12	PROGRAMMING	1	2	3	4	5	6	7	8	9	10	11	12
K	What a Computer Is	IA	C	C	C	C	C	C	C	C	R	R	R	R													
	Following Directions	IA	C	C	C																						
	Vocabulary	IA	C	C	C	C	C	C	C	C	C	C	C	C													
	Programming Programmable Devices														IA	C	M										
	Turtle Graphics (Making Shapes)														IA	C	C										

IA—Introduction with Activities ID—Introductory Discussion C—Expansion of Discussion from Previous Grades R—Review M—Mastery

First Grade

COMPUTER AWARENESS

TOPIC: What a Computer Can Do

OBJECTIVE: The student can describe realistically what a computer can and cannot do for humans.
CURRICULUM AREA: Social Studies
ACTIVITIES: • Have each student design a fantasy machine which will perform some task for a human being. As students present their "inventions" to the class, discuss whether a computer could be part of that machine. • Have students help compile on the chalkboard two lists: "What a Computer Can Do" and "What a Human Brain Can Do." Compare the two, noting what does what better.

TOPIC: Learning to Use a Computer

OBJECTIVE: The student can load and run a pre-programmed program on the computer.
CURRICULUM AREA: All
ACTIVITIES: • Demonstrate the steps involved with loading and running a program. Have students take turns operating the system. • Have students make up chart with directions on how to use the computer. Post at open house to teach parents about

(Continued)

(Continued)

TOPICS	Computer Awareness K	1	2	3	4	5	6	7	8	9	10	11	12	Programming K	1	2	3	4	5	6	7	8	9	10	11	12
1ST GRADE: What a Computer Can Do		IA	C	C	C	C	C	C	C	R	R	R	R													
Learning to Use a Computer		IA	C	C	C	C	C	C	C	C	C	C	C													
Using the Keyboard		IA	C	C	M																					
Turtle Graphics (Moving Shapes)															IC	C	C									

computers. • Assign groups to run a pre-programmed team activity, such as a game, drill and practice lesson, or simulation.

TOPIC: Using the Keyboard

OBJECTIVE: The student can locate and identify the letters, numerals, and special keys for operations and commands on a microcomputer keyboard.
CURRICULUM AREA: Reading/Language Arts—typing, paragraphs, grammar and grammatical requirements
ACTIVITIES: • Post diagram of keyboard on bulletin board. Compare to diagram of standard typewriter keyboard. Color in the special keys, such as the Enter or Return key, and discuss their purpose. • Show students how to use the keyboard to correct typing errors. • Have students write a sentence with 25 letters or more to type. Let them study the keyboard to locate the letters. Then time them to see how fast they can type their sentence.

PROGRAMMING

TOPIC: Turtle Graphics (Moving Shapes)

OBJECTIVE: The student can create various shapes and move them horizontally and vertically.
CURRICULUM AREA: Math—geometry, 3-dimensional thinking; Art—shapes, designs
ACTIVITIES: • Teach the students the commands Penup, Penerase, and Pendown, as well as Hide Turtle and Home. • Have students make a design which requires several movements of turtle with Penup and Pendown commands. (Suggestions: face with eyes, ears, and nose; house with windows, doors, and chimney; automobile with windows and doors.) • Let students "doodle," creating their own designs. (Reward students for good work by giving them blocks of "Doodle Time.")

Second Grade

COMPUTER AWARENESS

TOPIC: Computer Advantages

OBJECTIVE: The student will list speed, accuracy, and "repetitious activity" as advantages of a computer.
CURRICULUM AREA: Social Studies
ACTIVITIES: • Have students do 50 addition problems as fast as they can. Count the errors each makes. Then show students how quickly the computer can do those same problems without error. • Have students print one word 50 times. Then have the computer print that word 50 times. Which was easier and faster?

TOPIC: Computer Disadvantages

OBJECTIVE: The student will understand the computer as an impersonal, literal machine.
CURRICULUM AREA: Social Studies
ACTIVITIES: • Ask students to suggest questions a computer could not answer but a human could. (Suggestions: "Do you love me?" "Are you happy?") Note that computers cannot make personal judgments. • Have students misspell their names as they type them into the computer. What happens? • Have students type the command PRINT followed by their name in quotes. What happens? Then have them type the word WRITE followed by their name in quotes. What happens? Relate the results to the computer's language.

TOPICS	Computer Awareness K	1	2	3	4	5	6	7	8	9	10	11	12	Programming K	1	2	3	4	5	6	7	8	9	10	11	12
2ND GRADE: Computer Advantages			IA	C	C	C	C	C	C	C	C	C	C													
Computer Disadvantages			IA	C	C	C	C	C	C	C	C	C	C													
Computers in Our Lives			ID	C	C	C	C	C	C	C	C	C	C													
Everyday Applications			ID	C	C	C	C	C	C	C	C	C	C													
Future			ID	C	C	C	C	C	C	C	C	C	C													
Turtle Graphics (Rotations, etc.)																IA	C	C	C							
LOGO (Sprites)																IA	C	C	C	C	C	C	C	C	C	C

TOPIC: Computers in our Lives

OBJECTIVE: The student can identify several roles the computer plays in our daily lives.
CURRICULUM AREA: Social Studies; Science
ACTIVITIES: • Ask students to be Computer Detectives. Give points for every example of computer-use students can list in a day or two. Suggest they look for examples in their neighborhoods, ask their parents, or watch for computers on TV. To win a point, they must describe what each computer does. • Invite adults who use computers in their work to come describe their computers to the class. (Suggestions: policemen, bankers, store clerks, travel agents, journalists, librarians, government records clerks.) • Develop with the class a scenario for a science-fiction movie, *The Day the Computers Went On Strike*. What sorts of problems would the computer strike cause? Could we ever get along without computers again?

TOPIC: Everyday Applications

OBJECTIVE: The student can identify daily applications of computers, such as class attendance, paychecks, telephone bills, "cash machines."
CURRICULUM AREA: Social Studies—everyday living
ACTIVITIES: • Show students examples of computer-generated reports or bills. • Have students discuss places in the neighborhood where computers are being used, e.g., the grocery store, bank, etc. Take a field trip to local computer facilities.

TOPIC: The Future

OBJECTIVE: The student can predict new uses for computers in the future.
CURRICULUM AREA: Social Studies
ACTIVITIES: • Discuss movies they have seen which have robots, two-way TV, spaceships, and other computers in them. Discuss when they think those computerized machines will be part of our lives. • Have students make a list of jobs they would like a computer to handle in the future. How many of those tasks can a computer handle today? • Look at pictures of contemporary family living. (List where computers can be used in the pictures.)

PROGRAMMING

TOPIC: Turtle Graphics (Rotations, etc.)

OBJECTIVE: The student can use the commands of turtle graphics to rotate shapes to make designs.
CURRICULUM AREA: Math—geometry; Art—creative design
ACTIVITIES: • Show students how the Repeat command works. Program a square, circle, triangle, pentagon, etc. to rotate. Before executing, ask students to predict what designs will result. After executing, experiment with effects of single changes in the program. • Develop designs which wrap around the screen to create various designs.

TOPIC: LOGO (Sprites)

OBJECTIVE: The student can give color, directions and speed to sprites as well as create and control them.
CURRICULUM AREA: Science—speed, direction; Math—numerical; Art—shapes
ACTIVITIES: • Call up and identify all the sprites in the LOGO. Give each one speed, color, and direction. (Suggestion: have one sprite be the student's initial.) • Have students create sprites and make up stories to accompany the activities of the sprites.

(Continued on page 85)

(Continued from page 37)

3RD GRADE — COMPUTER AWARENESS

TOPICS	K	1	2	3	4	5	6	7	8	9	10	11	12
History				ID	C	C	C	C	C				
Logic				IA	C	C	C	C	C	C	C	C	C
How a Computer Works				IA	C	C	C	C	C	C	C	C	C
Parts of a Computer				IA	C	C	C	C	C	C	C	C	C
LOGO Programming													
Problem Solving with LOGO													

3RD GRADE — PROGRAMMING

TOPICS	K	1	2	3	4	5	6	7	8	9	10	11	12
History													
Logic				IA	C	C	C	C	C	C	C	C	C
How a Computer Works													
Parts of a Computer													
LOGO Programming				IA	C	C	C	C	C	C	C	C	C
Problem Solving with LOGO				IA	C	C	C	C	C	C	C	C	C

IA—Introduction with Activities ID—Introductory Discussion C—Expansion of Discussion from Previous Grades R—Review M—Mastery

Third Grade

COMPUTER AWARENESS

TOPIC: History

OBJECTIVE: The student can describe several historical computing devices.
CURRICULUM AREA: History; Social Studies; Math—place value (Abacus); multiplication (Napier Bones)
ACTIVITIES: • Have class design a large time line of computing inventions. On parallel time line, show other inventions to give historical context. • With class, draw the Computer's Family Tree, showing which machines were predecessors of which other machines. • Demonstrate the multiplication facts using Napier's bones, and place value using the Abacus.

TOPIC: Logic

OBJECTIVE: The student can apply "and" and "or" to logical thinking events.
CURRICULUM AREA: Math—logical reasoning
ACTIVITIES: • Form two teams, the Ands and the Ors. Read simple sentences aloud, leaving the conjunctions blank, and have student decide which conjunction fits in the blank. That team gets the point. • Progress to sentence in which either conjunction could fit. Teams compete for the point by being first to describe a situation which would make that sentence need their conjunction. • Get students to describe how "and" and "or" switches in a computer might work. Demonstrate with light switch, turning on for "and" situations and then off for "or" situations. Describe how

(Continued)

COMPUTER LITERACY

(Continued)

logic unit in a computer helps the computer to process information, controlling which impulses go along which electronic paths.

TOPIC: How a Computer Works

OBJECTIVE: The student can describe how a computer works, explaining Input, Memory, the Central Processing Unit, the Arithmetic Unit, and Output.
CURRICULUM AREA: Reading
ACTIVITIES: • Discuss how human beings do the functions of a computer. Input = hearing, seeing, feeling, smelling, tasting, etc. CPU = brain: memory, reasoning, understanding. Output = speaking, signalling, writing, etc. • Break down problem-solving into a string of simple functions. In one column, show how a human being would add 3 and 7 (hear question, memorize, add, memorize, speak answer). In other column, show how a computer would answer same question (input, store, add, process, store, output).

TOPIC: Parts of a Computer

OBJECTIVE: The student can name the parts of a computer, including Input, Output, Memory, Arithmetic/logic unit, and central processing unit.
CURRICULUM AREA: Reading
ACTIVITIES: • Post large, simplified diagram of computer, showing five basic components. List functions of computer on chalkboard, then draw arrows to link each function with appropriate parts of the machine. Trace through the diagram the route of a problem being solved. • On bulletin board, collect pictures of different devices that provide input, output, and memory for a computer. These would include disks, cassettes, punch cards, paper tape, CRTs, line printers, voice (input and output). Group the pictures in the three categories. • Open a microcomputer case, and show students memory, microprocessor, semi-conductors, etc. Look at an enlarged photo of a microcomputer chip. • Have students discuss difference between a general-use computer and a calculator or an arcade game, in terms of which basic parts have been limited.

PROGRAMMING

TOPIC: LOGO Programming

OBJECTIVE: The student can combine the ideas of turtle geometry and sprites to create animations and sequential graphic displays.
CURRICULUM AREA: Math—geometry
ACTIVITIES • Have students write programs, utilizing capabilities of LOGO. • Have students generate their own projects, utilizing the capabilities of LOGO. • Have the class, or teams, create animated Fall Scene. Assign to each student one segment (procedure) of the scene (including falling leaves, swaying trees, cars moving, clouds sailing, etc.) Place all the procedures together to show the animated scene.

TOPIC: Problem Solving with LOGO

OBJECTIVE: The student can use LOGO to solve problems in various curriculum areas.
CURRICULUM AREA: All
ACTIVITIES: • Assign problems which require LOGO programming to solve. • Set up experiments using LOGO and have student's estimate the outcomes. EL

THE ROAD TO COMPUTER LITERACY

Part III: Objectives and Activities for Grades 4-6

Throughout the upper elementary grades, students can expand their knowledge and understanding of programming, beginning with a non-mathematical introduction to BASIC.

IN LAST MONTH'S INSTALLMENT of this series, we examined specific computer literacy objectives and activities for Grades K–3. Those objectives focused primarily in the area of computer awareness. While the objectives for Grades 4–6 also include computer awareness topics, such as hardware, software, computer generations and flow charting, the thrust of the scope and sequence at this level turns to programming. And the programming language that it centers around is BASIC. Why BASIC? For one thing, it is the most widely used computer language in elementary and secondary schools today; for another, it is available for all microcomputers; and, for a third, until a more conversational computer language comes along, it is, in my opinion, the best language for students.

The programming topics for these grades are introduced sequentially, based on my experience in helping young students become familiar with the computer and the language. Although most BASIC books begin with computing sums, differences, products, etc., I believe it's important for young students (particularly those with "mathphobia") to get an immediate "feeling" for the potential non-mathematical options of the computer. Therefore, I suggest introducing the PRINT and INPUT statements first.

Another consideration in selecting the statements to introduce at these grade levels was to choose those statements that are generic to most computers. Therefore, CATALOG, EDIT, etc. are not included as specific objectives here. Nevertheless, in your expansion of the topic "Learning to Use the Computer" (introduced in First Grade), you should include a discussion of those statements, along with an explanation of your computer's unique characteristics or commands. One word of caution, however: Teaching a particular system's shortcuts may hinder students who have access to other systems at home or at a club. Therefore, I recommend playing down all the "tricks-of-the-trade commands" unless students ask for them or discover them on their own.

In teaching programming, I also recommend the "Guided Discovery" approach. In other words, rather than providing specific instruction, provide guidance with appropriate questions.

As you read through these topics and objectives, keep in mind that they are meant to serve only as a guideline or starting point for setting up your own computer literacy objectives and curriculum. Furthermore, while I've suggested a few beginning activities for each topic, there are obviously many other activities and projects that can help teach or reinforce these objectives. I'd like to hear about activities you have used successfully in your classroom. You can write to me in care of *Electronic Learning*.

A COMPUTING WORD SEARCH

P	R	D	E	P	T	S	I	L	A	T	G	V	T	A	B	H
I	E	A	S	L	T	F	A	T	N	O	O	K	H	S	Y	E
L	T	E	C	E	T	O	A	C	T	O	S	B	G	T	U	S
O	U	R	D	H	B	D	T	O	O	F	U	U	O	P	A	A
T	P	O	E	M	D	A	G	X	O	B	B	G	O	O	R	B
U	M	N	L	I	R	N	S	R	Y	R	O	O	E	A	T	A
P	O	R	A	C	D	O	R	I	E	L	L	L	E	N	D	T
N	C	U	C	R	T	T	L	T	C	M	T	N	I	R	P	A
I	A	T	S	O	E	R	Y	O	W	E	N	T	X	E	T	D
I	I	E	A	L	N	B	L	G	C	T	X	E	N	R	O	F
N	U	R	P	E	N	A	R	T	R	O	F	K	S	I	D	L

Here's a ready-to-photocopy computer literacy activity for your students. There are 40 computer terms—BASIC commands, names of languages, etc.—hidden in the puzzle above. They run forwards, backwards, and diagonally. The leftover letters spell out a message to our readers in a sentence that looks like this: ______ ____ ____ ______ ___.

(Answers on page 94.)

By Dr. Gary G. Bitter

Gary Bitter, Professor of Computer Education, Arizona State University, Tempe, AZ, is the author of several educational computing books and articles, including the forthcoming title with co-author Ruth A. Camuse: Using a Computer in the Classroom, *to be published by Reston Publishing, Co., Reston, VA, March, 1983.*

Fourth Grade

COMPUTER AWARENESS

TOPIC: Hardware

OBJECTIVE: The student can describe computer hardware as the physical components or equipment of a computer system, and identify those components.
CURRICULUM AREA: Language Arts; Reading
ACTIVITIES: • Have students collect computer store ads, catalogs, and flyers, or write to companies for catalogs. Using these, create a class computer file with index cards describing various computer components. • When cards are completed, divide them into categories for INPUT, OUTPUT, CENTRAL PROCESSING UNIT, and MEMORY. • Have students "build" computer systems by putting together sets of cards. (Discuss compatibility of different manufacturers' equipment.) As students "shop" in the file, others may role play as salespersons for computer companies, and try to sell their products by highlighting the best features.

TOPIC: Software

OBJECTIVE: The student can define software as a set of instructions, called a program, that tells a computer what to do.
CURRICULUM AREA: Language Arts; Reading
ACTIVITIES: • Explain to students that a computer can't do anything unless it is given a set of instructions or programs called software. (Note the difference between applications software and systems software.) • Discuss different types of applications software or programs, and explain that those programs are written in special languages. • Work with students to invent a special language which could program a robot to vacuum a room.

TOPIC: Binary Numbers

OBJECTIVE: The student can understand the use of 0 and 1 as the numerals used by computers to represent numbers, letters, and symbols.
CURRICULUM AREA: Math
ACTIVITIES: • Ask students to show how many different ways they can show the number 5 (Roman numeral V; the number 5; holding up five fingers). Then write "101" on the chalkboard and ask them what number they think that is. Explain that "101" is the number 5 in the binary number system. • If necessary, review with students our decimal system. Then explain that the binary system is based on the number 2 and uses only two numbers, 0 and 1. • Draw a chart like the one below. Have students fill in our number for each binary number. • Explain the "on-off" idea of a light switch, where "on" equals 1 and "off" equals 0. Note that different on-off "switches" in a computer are used to represent numbers and letters.

BINARY NUMBER

Eights	Fours	Twos	Ones	OUR NUMBER
	1	0	1	5
		1	1	
1	0	0	1	
1	1	0	0	
	1	1	1	

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(Continued)

4TH GRADE

TOPICS	COMPUTER AWARENESS K	1	2	3	4	5	6	7	8	9	10	11	12
Hardware					ID	C	C	C	C	C	C	C	C
Software					ID	C	C	C	C	C	C	C	C
Binary Numbers					IA	C	C	C	C	C	C	C	C
Flowcharting					IA	C	C	C	C	R	R	R	R
Storyboarding					IA	C	C	C	C	R	R	R	R
BASIC: PRINT & REM													
BASIC: LET													
BASIC: INPUT													
BASIC: GOTO													
Formulas (Variables & Constants)					IA	C	C	C	C	C	C	C	C
String Data													
Relations					IA	C	C	C	M				

TOPICS	PROGRAMMING K	1	2	3	4	5	6	7	8	9	10	11	12
Hardware													
Software													
Binary Numbers													
Flowcharting					IA	C	C	C	C	C	C	C	C
Storyboarding					IA	C	C	C	C	C	C	C	C
BASIC: PRINT & REM					IA	C	C	C	C	R	R	R	R
BASIC: LET					IA	C	C	R	R	R	R	R	R
BASIC: INPUT					IA	C	R	R	R	R	R	R	R
BASIC: GOTO					IA	C	R	R	R	R	R	R	R
Formulas (Variables & Constants)					IA	C	C	C	C	C	M		
String Data					IA	C	C	C	C	C	C	R	R
Relations					IA	C	C	C	M				

IA—Introduction with Activities/ID—Introductory Discussion/C—Expansion of Discussion from Previous Grades/R—Review/M—Mastery

TOPIC: Flow Charting (also Programming Topic)

OBJECTIVE: The student can identify common flow chart symbols, write a simple flow chart for a program and convert it to BASIC.
CURRICULUM AREA: All
ACTIVITIES: • Write a flow chart programming a robot to perform simple classroom tasks. (*Editor's Note*: A full description of this activity can be found in Dr. Bitter's book *Exploring with Computers*, published by Julien Messner-Simon & Schuster, 1981.) Identify, as you use them, the symbols for START-STOP, INPUT-OUTPUT, DECISION, PROCESS, and CONNECTOR. • Post the chart and have small groups of students write flow charts programming the robot to perform other tasks. Have groups trade flow charts and act out the directions. • Write a flow chart for a day in school. Include classes, lunch, special assemblies, and choices of recess or library.

TOPIC: Storyboarding (also Programming Topic)

OBJECTIVE: The student can develop a short picture program and prepare a storyboard for each display, using graph paper.
CURRICULUM AREA: Language Arts; Art
ACTIVITIES: • Have students design their initials five centimeters high on storyboard graph paper. Convert into a BASIC program. • Design logos for TV networks, movie studios, record labels, or sports teams on graph storyboards, and convert into BASIC programs. • On a series of storyboards, prepare a demonstration of addition, using graphics to represent items being added. Write the programs in BASIC, or use LOGO graphics.

PROGRAMMING

TOPIC: BASIC—PRINT and REM

OBJECTIVE: The student can write BASIC programs using the PRINT and REMARK statements.
CURRICULUM AREA: Language Arts—spelling, writing; Math
ACTIVITIES: • Explain the function of the PRINT statement, discussing the use of line numbers, quotation marks, and commas in writing programs. • Let students practice using the PRINT statement. What happens when they use quotation marks around a simple math problem? What happens without the quotation marks? • Explain the REM statement and why it is important in good program writing. • Have students program the computer to print a picture on the monitor, using "X's" or symbols, such as the asterisk. • Work with the class to print their initials eight centimeters high, using the letter "X." • Have students program the computer to print a letter to their parents, telling about their experience with the computer. If a printer is available, get printouts of their letters for them to take home.

TOPIC: BASIC—LET

OBJECTIVE: The student can use the LET statement in a BASIC program.
CURRICULUM AREA: Reading; Math
ACTIVITIES: • On the chalkboard, print the following examples of programs using the PRINT and LET statements. Have students predict the computer output:

```
10 LET X = 5               10 LET A$ = "YES"
20 LET U = 7               20 LET B$ = "NO"
30 LET R = 10              30 PRINT A$, B$
40 PRINT X, X + U, X*R     40 END
50 END
```

• Set up examples of programs which illustrate storage of variables. Before running, ask students to predict the output. Ask what happened to the value of X. • Explain that line 30 replaces line 10 and that there can only be one value of X.

```
10 LET X = 10
20 LET K = 20
30 LET X = 40
40 PRINT X, X + K, K + K, X + X
50 END
```

TOPIC: BASIC—INPUT

OBJECTIVE: The student can use the INPUT statement in a BASIC computer program.
CURRICULUM AREA: Reading; Math
ACTIVITIES: • Give the students the following two programs. Have them determine when it's necessary to use the dollar sign with an INPUT statement.

```
10 PRINT "WHAT IS YOUR FAVORITE NUMBER?"
20 INPUT M
30 PRINT "YOUR FAVORITE NUMBER IS"; M
40 END

10 PRINT "WHAT IS YOUR NAME?"
20 INPUT B$
30 PRINT "YOUR NAME IS"; B$
40 END
```

• Give students programs with "bugs" in them. For example, leave out the dollar sign or the semicolon in the program above.

Have the students correct the program (debug it) and run on the computer.

TOPIC: BASIC—GOTO

OBJECTIVE: The student can use the GOTO statement in a BASIC program.

CURRICULUM AREA: Reading; Math

ACTIVITIES: • Ask students what they think an "endless loop" is. Then, print the following program on the chalkboard and ask them to predict what will happen when they run the program on the computer:

```
10 PRINT "I LOVE E.T."
20 GOTO 10
30 END
```

• Have students draw a flow chart to illustrate the use of the GOTO statement to repeatedly print their names. Then, have them write and run their programs.

TOPIC: Formulas—Variables and Constants (also Computer Awareness Topic)

OBJECTIVE: The student can write a formula in BASIC including variables and constants, and can understand the order of operations.

CURRICULUM AREA: Math; Science; Social Studies

ACTIVITIES: • Have students enter equations with and without parentheses to determine the order of operations. • Have students measure the classroom walls. Divide the group into two teams. Have one team plug length and width into formula $A = L \times W$ to find out how much carpet the room needs. Have the other team plug into $P = 2L + 2W$ to see how long a border strip would need to be run around the top of the walls. • Have both groups write BASIC programs using INPUT and PRINT to solve these problems.

TOPIC: String Data

OBJECTIVE: The student can use words in a BASIC computer program.

CURRICULUM AREA: English; Social Studies

ACTIVITIES: • Have the students give the output of the BASIC program:

```
10 PRINT "WHAT IS THE WEATHER TODAY?"
20 INPUT A$
30 PRINT "THE WEATHER TODAY IS"; A$
40 END.
```

• Have students distinguish between string data and numbers by asking them to INPUT A and a name and then INPUT A$ and the same name. • Have a student report about key punch data cards, explaining how holes are placed to represent certain letters. Have students "write" their names by punching out holes in cards. • With class members, list other forms of INPUT and OUTPUT—paper tape, optical scanner, etc. Discuss how these might be coded for different letters. Compare them to other codes such as Morse code or Braille.

TOPIC: Relations (also Computer Awareness Topic)

OBJECTIVES: The student can understand the relations "less than" (<), "equal to" (=), and "greater than" (>), and can use them in a computer program.

CURRICULUM AREA: Math; English; Spelling; Social Studies

ACTIVITIES: • Illustrate the relations "less than" (<) and "greater than" (>) on the chalkboard. Discuss how "equal to" may be combined to expand the relations. Use numbers to practice the relations on paper. • Write a BASIC program using IF/THEN statements to illustrate the three relations. • Demonstrate the relation for "equal to" using letters: IF X$ = "YES" THEN 80.

(Continued)

(Continued)

	TOPICS	CA K	CA 1	CA 2	CA 3	CA 4	CA 5	CA 6	CA 7	CA 8	CA 9	CA 10	CA 11	CA 12	P K	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 9	P 10	P 11	P 12
5TH GRADE	Computer Generations						ID	C	C	C																	
	Counters						IA	C	C	C	M									IA	C	C	C	C	C	C	C
	BASIC: IF-THEN																			IA	C	R	R	R	R	R	R
	BASIC: ON-GOTO																			IA	C	R	R	R	R	R	R
	BASIC: READ-DATA																			IA	C	R	R	R	R	R	R
	Word Processing						IA	C	C	C										IA	C	C	C	C	C	C	C

(CA = COMPUTER AWARENESS; P = PROGRAMMING)

Fifth Grade

COMPUTER AWARENESS

TOPIC: Computer Generations

OBJECTIVE: The student can explain the impact of the vacuum tube, transistor, and integrated circuits upon the computer revolution.
CURRICULUM AREA: Math—graphing; Social Studies; History
ACTIVITIES: • Assign small groups to report on the vacuum tube, the transistor, the integrated circuit, and the chip. How did each advance computer technology? Look especially at improved speed, cost advantages, and changes in size. • Draw a family tree for computers, or prepare a bulletin board timeline, showing the generations of computers.

TOPIC: Counters (also Programming Topic)

OBJECTIVE: The student can explain the counter statement X = X + 1, and variations of it.
CURRICULUM AREA: Math
ACTIVITIES: • One student, playing X, writes a numerical value on the board. As other students call out "X = X + 1", the student has to keep changing the value. Act out X = X + 2 and Y = Y − 1. Ask students to figure out a formula to count by fives. Write these programs in BASIC and run them. • Have students explain this program:

```
10 PRINT "WHAT IS YOUR NAME?"
20 INPUT B$
30 LET A = A + 1
40 PRINT A, B$
50 GO TO 10
60 END.
```

• Have students create other programs using the counters.

PROGRAMMING

TOPIC: BASIC—IF-THEN

OBJECTIVE: The student can write a program using the IF-THEN statement for branching.
CURRICULUM AREA: Math; Reading; Social Studies
ACTIVITIES: • Write a flow chart to ask for a number, print the number, and designate whether it is even or odd. Convert this to a BASIC program. • Program a multiple-choice question. Have the computer indicate whether the chosen answer is right or wrong. • Using IF-THEN statements and a counter, write 10 multiple-choice multiplication questions. Show at the end how many were answered right or wrong. • Have students write social studies and science quiz questions for each other.

TOPIC: BASIC—ON-GOTO

OBJECTIVE: The student can make use of the ON-GOTO statement in a BASIC computer program.
CURRICULUM AREA: Math; Social Studies; Reading
ACTIVITIES: • Write a flow chart which illustrates the ON-GOTO statement. • Have students write short trivia quizzes, and program them in BASIC using the ON-GOTO STATEMENT. • Help students to write a program to simulate the tossing of a die 50 times. Use an ON-GOTO statement and a counter to accumulate the results.

TOPIC: BASIC—READ-DATA

OBJECTIVE: The student can use the READ-DATA statement to enter data into the computer.
CURRICULUM AREA: Math
ACTIVITIES: • Have students use the READ-DATA statement to add the numbers 10, 15, 20, and 30. Have them write the same program using the INPUT statement. Discuss which method works better in different situations. • Program:

```
10 READ A, B, C, D
20 PRINT A, A + B, C − A, D
30 DATA 10, 20, 30, 40
40 END.
```

• Have students predict the program output before running.

TOPIC: Word Processing (also Computer Awareness Topic)

OBJECTIVE: The student can explain the applications of word processing, and write a letter using a word processing program on a microcomputer.
CURRICULUM AREA: Writing; Language Arts
ACTIVITIES: • Use an overhead projector to look at a form letter, a legal document (affadavit, lease, etc.), page of a technical manual, and a newspaper article. Discuss how a word processor might be useful in writing any of these. • Give students copies of a badly written story to correct by hand. Demonstrate how the story might be edited on a word processor. • As a class, write an announcement about a class activity, using the word processor program.

Sixth Grade

COMPUTER AWARENESS

TOPIC: Computer Types

OBJECTIVE: The student can distinguish between a mainframe, a mini, and a microcomputer.
CURRICULUM AREA: Reading
ACTIVITIES: • Divide the class into groups representing the mainframes, the minis, and the micros. Have each group comb through computer ads and catalogs for models fitting their category. Each group should prepare a catalog showing various models, noting speed, memory, cost, and applications. • Have groups trade their catalogs and discuss the pros and cons of each type. • Have a student report on the difference between digital and analog computers. *(Continued on page 90)*

COMPUTER LITERACY

(Continued from page 48)

TOPIC: Data Handling

OBJECTIVE: The student can understand the uses of a computer to process data.
CURRICULUM AREA: Reading; Social Studies
ACTIVITIES: • Discuss the term "data bank" with your students. Have them suggest different kinds of data banks that might be useful to them in school (e.g., important dates in history). • Invite the business manager of the school district to speak to the class, explaining what kind of data is handled by the school computer. • Have small groups of students create a data bank about someone in each group, listing such things as "color of hair," "favorite sport," and "height." Then have each group leader read the data in the data bank while other groups try to guess whom the data bank is about. • Have students research various existing data banks in the country and report on the purpose of each.

TOPIC: Computer Languages

OBJECTIVE: The student can identify the common computer languages and their applications.
CURRICULUM AREA: English; Reading; Math
ACTIVITIES: • Assign teams to research various computer languages (BASIC, LOGO, COBOL, FORTRAN, Pascal, etc.), and have the teams report on their languages, including what the names stand for, year developed and their primary application areas. • Have students "sell" a particular language to other students who assume roles of a small business owner, corporate executive, school principal, scientist, engineer, or student.

TOPIC: Looping (also Programming Topic)

OBJECTIVE: The student can explain looping and its advantages in computer programming.
CURRICULUM AREA: Math
ACTIVITIES: Have students draw a flow chart to add five 100 times. Convert to a BASIC program. Relate to multiplication. Write a looped subtraction problem to illustrate division. • Discuss looping situations in everyday life, such as in alphabetizing a list of names. • Write a BASIC program to divide 1750 by five continually until there is no remainder. Use a counter to count the number of times 1750 can be divided by five. Print the result. • Discuss "nested loops," where one loop is completed between steps of another loop.

PROGRAMMING

TOPIC: BASIC—FOR-NEXT

OBJECTIVE: The student can utilize the FOR-NEXT statement in a BASIC computer program.
CURRICULUM AREA: Math
ACTIVITIES: • Have the students write a short program using the GOTO statement. Write the same program with the FOR-NEXT statement. • List some uses of the FOR-NEXT statement in a BASIC computer program. • Have students INPUT values (including negative numbers) for N in the following program. Ask them to predict the OUTPUT before running.

```
10 PRINT "GIVE VALUE OF N."
20 INPUT N
30 FOR I=1 TO 15 STEP N
40 PRINT I
50 NEXT I
60 END
```

• Write a program to illustrate a "nested loop."

TOPIC: BASIC—RANDOM NUMBER

OBJECTIVE: The student can use the RANDOM statement to write BASIC program simulations.

TOPICS — 6TH GRADE

COMPUTER AWARENESS

TOPICS	K	1	2	3	4	5	6	7	8	9	10	11	12
Computer Types							ID	C	C	R	R	R	R
Data Handling							IA	C	C	C	C	C	C
Computer Languages							IA	C	C	C	C	C	C
Looping							IA	C	C	C	M		
BASIC: FOR-NEXT													
BASIC: Random Number													
Problem Solving with BASIC													
Graphics													

PROGRAMMING

TOPICS	K	1	2	3	4	5	6	7	8	9	10	11	12
Computer Types													
Data Handling													
Computer Languages													
Looping													
BASIC: FOR-NEXT							IA	C	C	C	C	C	C
BASIC: Random Number							IA	C	C	C	C	C	C
Problem Solving with BASIC							IA	C	C	C	C	C	C
Graphics							IA	C	C	C	C	C	C

CURRICULUM: Social Studies; Science; Math—probability and statistics

ACTIVITIES: • Demonstrate use of the RANDOM statement to program the tossing of a die. • Have the class write a program to simulate crossing a river. Random conditions may include success, drowning, partial success, and return to try again. • Discuss how the random number generator can be used in video game simulations. Study a video game and list the random conditions which seem to be part of the program. • Discuss how a flight simulator, randomly giving flight conditions, may be used to train pilots.

TOPIC: Problem Solving with BASIC

OBJECTIVE: The student can solve problems by writing a BASIC program.

CURRICULUM AREA: All

ACTIVITIES: • Convert a graph of social studies data to a BASIC computer program. • Run a classroom opinion poll and graph the results using BASIC. • Write a BASIC program to simulate a science experiment. • Write a BASIC program to solve math problems, formulas, and equations.

TOPIC: Graphics

OBJECTIVE: The student can use a microcomputer to create graphics.

CURRICULUM AREA: Math; Art

ACTIVITIES: • Use the graphics mode to print your name on the screen. Have students do the same with their names. • Have students create art matrices, preparing a storyboard first, then programming the graphics. • List different graphics features of the class' computer system. Have students choose one feature (such as color or low- or high-resolution) and draw a graphic which uses it in an interesting way.

THE ROAD TO COMPUTER LITERACY

Part IV: Objectives and Activities for Grades 7-9

If the fundamentals of computer awareness and BASIC programming skills are acquired during grades K-6, junior high school students can delve into more complex subjects like simulation programs and social issues.

IN THE LAST TWO INSTALLMENTS of this series, we concentrated on building a foundation of computer literacy skills during grades K-3 and 4-6—skills essential in understanding what a computer is and how it works, including such topics as binary numbers, computer vocabulary and using the keyboard. We also introduced students to the rudiments of programming in BASIC with topics like story boarding, flowcharting and BASIC commands.

Having had this introduction to BASIC programming skills, students in grades 7-9 no longer program for programming's sake. Instead, they write programs to solve algorithms, simulate an event or produce graphics and sound. By starting with a specific objective, like tossing a coin, drawing a picture or composing a song, these junior high schoolers learn the necessary problem-solving skills to meet that objective with a computer program. Hopefully, students will be able to bring all their skills under one roof by writing a simulation program which includes graphics, sound and color (if available) as a final term project.

Chris Longfield, 15, a student at Marist High School, Atlanta GA.

By Dr. Gary G. Bitter

As their skills are put to more practical use, students begin to acquire a better understanding of the advantages—and limitations—of computers. They recognize computers as a powerful problem-solving tool for performing tasks that require vast amounts of paperwork, machine-like accuracy or multiple solutions. But they also understand that certain problems are more easily solved on paper or with other tools, and that many tasks—those which require thinking or creativity—are better left to humans.

When considering the following activities for classroom use, I suggest you keep this paradoxical nature of computers in mind. Try not to limit your awareness discussions to the impersonal and dehumanizing side of computers, and try not to assign problems that only computers solve well. To do so is to deprive students of a full understanding of the computer revolution.

The activities in this installment are designed to introduce students to some broader concepts about computers, but they are just that—an introduction. These first steps are, as before, open to changes to better suit your curriculum. I suggest that you use them only as a guideline.

I look forward to hearing about your classroom successes and suggestions for activities as we near the home stretch on this road to computer literacy. Write to me in care of *Electronic Learning*.

Editor's Note: Because of the variations in BASIC, certain modifications of the programming activities may be necessary. Check your user's manual for modifications before assigning the programs listed in the activities.

(Continued)

Gary Bitter, Professor of Computer Education at Arizona State University, Tempe, AZ, is the author of several educational computing books and articles, including two forthcoming titles with co-author Nancy Watson: Apple LOGO Primer *and* Texas Instruments LOGO Primer, *published by Reston Publishing Co., Reston, VA. Dr. Bitter is also a member of* Electronic Learning's *Board of Advisers.*

Photo courtesy of United Press International

Seventh Grade

COMPUTER AWARENESS

TOPIC: Modeling

OBJECTIVE: The student can develop a specific plan to solve general problems.
CURRICULUM AREA: Math; Social Studies; Reading; Science
ACTIVITIES: • Create various-sized rectangles on the chalkboard. Have students record lengths, widths and perimeters of each. Identify a model (in this case a formula) to find the perimeter of a rectangle. Develop other models (formulas) to compute the area of any region enclosed by lines. • Have students collect data on the school population for the past ten years. Using this information, develop a model to predict the enrollment for the next ten years.

TOPIC: Robotics

OBJECTIVE: The student can discuss robotics and give examples of applications.
CURRICULUM AREA: Science; Social Studies
ACTIVITIES: • Look up the word "robotics" in various resources. Have students collect fiction and non-fiction articles on robotics and bring them into class for discussion. Discussion topics should include robot intelligence; the credibility of science fiction robots presented on TV, in movies and in books; advantages and disadvantages of robots; future impact of robots on jobs and people; and the Japanese plan to find new jobs for people displaced by robots. Point out that there will be many new jobs to manufacture, maintain and market the robots. • Determine if there are any robot applications in nearby factories or businesses. If so, plan a field trip to the site so that students can see robots in action. • Assign a short essay or story to each student on the topic of robotics. Topics could include robotics in factories; a report on the development of robotics in the last ten years; or a story on what robots might be doing in the year 2100.

TOPIC: Social Issues

OBJECTIVE: The student can discuss the impact of computers on our lives.
CURRICULUM AREA: All
ACTIVITIES: • Have students prepare a debate on the positive and negative aspects of computers. Encourage them to bring in examples from articles, real-life situations and other sources to back up their arguments. • Have each student write an essay on a computer-related social issue. Topics could include dehumanization; technological culture shock; the "computer generation"; minority disadvantages in a computerized society; the computer revolution; privacy; "instant democracy" (computerized voting and poll-taking); automation; and advantages for the handicapped. • Have student groups interview psychologists, ACLU members, sociologists, computer programmers, businesspersons, and teachers in the community to determine their views and concerns about computers in society. • Organize student skits to dramatize both positive and negative computer-related social issues.

TOPIC: Data Bases

OBJECTIVE: The student can explain the purpose of a data base and list several examples.
CURRICULUM AREA: All
ACTIVITIES: • Have the students list as many data bases as possible (airlines, medical records, banks, school files, government offices etc.). List possible categories of information for each. • Contact various government agencies (IRS, Health Dept. etc) to determine the number of computers they use and the number of people listed in their data base files. If a school printout is available, use it to show how information is printed and categorized. • Develop a detailed bulletin board display of the airline data base and how it generally works.

7TH GRADE TOPICS	COMPUTER AWARENESS													PROGRAMMING												
	K	1	2	3	4	5	6	7	8	9	10	11	12	K	1	2	3	4	5	6	7	8	9	10	11	12
Modeling								IA	C	C	C	C	C													
Robotics								ID	C	C	C	C	C													
Social Issues								ID	C	C	C	C	C													
Data Bases								IA	C	C	C	C	C													
BASIC: Arrays (One-Dimensional)																					IA	C	C	C	C	C
BASIC: Functions																					IA	C	C	C	C	C

IA—Introduction with Activities ID—Introductory Discussion C—Expansion of Discussion from Previous Grades R—Review M—Mastery

PROGRAMMING

TOPIC: BASIC: Arrays (One Dimensional)

OBJECTIVE: The student can utilize one dimensional arrays in BASIC programs.
CURRICULUM AREA: All
ACTIVITIES: • Have students write a BASIC program using a one dimensional array to read and print 10 test scores. Have them modify the program to find the average score. • Ask students to explain what this program does:

```
10 DIM A(20)
15 FOR I=1 to 20
20 INPUT A(I)
30 NEXT I
40 FOR J=1 to 20
50 LET B=B + A(J)
60 NEXT J
70 FOR R = 1 to 20
80 PRINT A(R); A(R) * A(R)
90 NEXT R
100 PRINT "THE SUM =" ; B
110 END
```

• Describe situations where the one dimensional array is very useful. *(Continued on page 46)*

(Continued from page 44)

TOPIC: BASIC:Functions
OBJECTIVE: The student can use BASIC statements to define functions.
CURRICULUM AREA: All
ACTIVITIES: • Have students use the DEF statement to define a function for use in a computer program. Write a BASIC program to graph a function. For example:

```
10 For I = 1 to 40
20 PRINT TAB (I)
30 PRINT "*"
40 NEXT I
50 END
```

• Have students graph Y = X + 1 first on paper and then using a computer. Make sure they draw the X/Y axis on the computer. Select another function, such as Y = 2X + 4 and have students take turns plotting the points on a chalkboard. Then plot the graph on a computer. • Discuss the value of functions. Include how functions are used to describe application data.

8TH GRADE TOPICS	COMPUTER AWARENESS K	1	2	3	4	5	6	7	8	9	10	11	12	PROGRAMMING K	1	2	3	4	5	6	7	8	9	10	11	12
Computer Crime									D	C	C	C	C													
Algorithms									IA	C	C	C	C										IA	C	C	C	C
BASIC: Arrays (Two Dimensional)																							IA	C	C	C	C
Graphics (Sound & Color)																							IA	C	C	C	C

Eighth Grade

COMPUTER AWARENESS

TOPIC: Computer Crime
OBJECTIVE: The student can describe several criminal uses of computers.
CURRICULUM AREA: Social Studies
ACTIVITIES: • Research data to compare the average amount of money lost in physical robberies and computer robberies. Also collect information on the number of detected computer crimes which are prosecuted successfully. • Have students write a report on a major computer crime (such as the "round down" fraud of 1968) and present it to the class. • Create a bulletin board display of the types of computer crimes and examples of present-day safeguards to deter this type of crime. Include electronic funds transfer frauds and embezzlements, computer whizzes who create havoc on computer systems and vandalism of computers.

TOPIC: Algorithms (also Programming Topic)
OBJECTIVE: The student can give an example of an algorithm and its application.
CURRICULUM AREA: Math; Science; Social Studies
ACTIVITIES: • Have the students list all the algorithms they know. • As a class, write an algorithm for assigning a letter grade to a class test, for changing Celsius to Fahrenheit, for averaging grades, and for dividing one fraction by another. • Discuss the advantages of using algorithms in computer programs.

PROGRAMMING

TOPIC: BASIC: Arrays (Two Dimensional)
OBJECTIVE: The student can write a BASIC program utilizing a two dimensional array.
CURRICULUM AREA: All
ACTIVITIES: • Discuss uses of the two dimensional arrays in programming, listing reasons why computers are ideal for array analogies. • Set up a two dimensional array of your class to include name, address, city, state, zip code, telephone number, sex, age, etc. Have each item be one column of the array. • Discuss why an array is convenient to use and how large an array is needed for your class and school district. • Explain the following BASIC program:

```
5 DIM K$(10, 10)
10 FOR I = 1 to 5
20 FOR R = 1 to 3
30 PRINT "TYPE A FIRST NAME"
40 INPUT K$ (I,R)
50 NEXT R
60 NEXT I
70 FOR B = 1 to 5
80 FOR C = 1 to 3
90 PRINT K$ (B,C)
100 NEXT C
110 NEXT B
120 END
```

TOPIC: Graphics (Sound and Color)
OBJECTIVE: The student can utilize sound and color in a computer program.
CURRICULUM AREA: Art; Music; Graphic Applications to All
ACTIVITIES: • Discuss how your microcomputer can be made to produce music and sound. Hold a contest with two categories for the best computerized song and the best graphics. Display the entries at open house. • Illustrate examples of both graphics and music in a program and advantages/disadvantages of using either or both. Include discussion of business, education and home applications. Demonstrate the difference between low and high resolution. • Have students write a program to flash all the colors on the screen. As a class, write a program to produce different colored squares on the screen. (Continued on page 48)

(Continued from page 46)

Ninth Grade

COMPUTER AWARENESS

TOPIC: Computer Capabilities

OBJECTIVE: The student can discuss general computer capabilities.
CURRICULUM AREA: All
ACTIVITIES: • Have the student list all the things they think computers—from micros to mainframes—can do and why. Give examples of tasks a computer can do, but which are more advantageous for humans to do. Then list activities which a computer cannot do and why. • Have student teams choose a field such as science, education, government, medicine etc., and study the difference between "human" tasks and "computer" tasks in that field. Discuss each group's findings and draw general conclusions about those findings.

```
10 DIM X(2)
20 LET X(1) = 0
30 LET X(2) = 0
40 FOR X = 1 to 100
50 LET N = INT (RND(X) + 1.5)
60 LET X(N) = X(N) + 1
70 NEXT X
80 PRINT "HEADS ="; X(1)
90 PRINT "TAILS ="; X(2)
100 END
```

Have students change line 40 to read FOR X = 1 to 1000. Explain that the answer is not always 50/50 because of the laws of probability. • As a class, write a computer simulation of a historic event. Draw a flow chart of the event. Assign groups to program each part. • As a term project, assign students to write a computer simulation program using graphics, sound and color, if available. The projects could be in arcade-format or could include group exploration simulations.

9TH GRADE	COMPUTER AWARENESS													PROGRAMMING												
TOPICS	K	1	2	3	4	5	6	7	8	9	10	11	12	K	1	2	3	4	5	6	7	8	9	10	11	12
Computer Capabilities										IB	C	C	C													
Computer-Related Fields										IB	C	C	C													
BASIC: Simulation Programming																							IA	C	C	C
BASIC: Matrices																							IA	C	C	C
BASIC: Files																							IA	C	C	C
Pilot: Introductory Language Commands																							IA	C	C	C

TOPIC: Computer-Related Careers

OBJECTIVE: The student can name the most common computer-related careers and the general responsibilities of each.
CURRICULUM AREA: Career Education
ACTIVITIES: • Collect data from employment agencies, colleges and universities on the most in-demand computer-related jobs, the responsibilities and education required, the average salary, and courses or degrees available. Assemble the data on a bulletin board, along with advertisements, articles, want ads, or other related resources. Include information on computer specialists (programmers, system analysts, software developers, etc.) and non-specialists (engineers, teachers, secretaries etc.) • Find examples of programmer aptitude tests (Computer Learning Center, Washington, D.C.) and vocational education tests that measure computer skills. Discuss other skills and talents—logical thinking, attention to detail, knowledge of mathematics, typing, etc.—that are required for computer-related jobs. • Have students interview career counselors, computer specialists, math/computer teachers and others to determine their outlook on computer-related fields.

PROGRAMMING

TOPIC: BASIC: Simulation Programming

OBJECTIVE: The student can write a BASIC program to simulate some event or activity.
CURRICULUM AREA: All
ACTIVITIES: • List the purposes of simulation programs. Have students explain the following program for simulating the toss of a coin:

TOPIC: BASIC: Matrices

OBJECTIVE: The student can use the BASIC matrix command and apply it to problems.
CURRICULUM AREA: Math—application to the real world.
ACTIVITIES: • Discuss matrices and their application in the real world. • Get access to several matrix problems with solutions and write a program using the BASIC MAT statements to solve them. Compare answers. • Find a book which shows the actual BASIC programs for the MAT commands. Discuss the advantages of having the computer store programs.

TOPIC: BASIC: Files

OBJECTIVE: The student can build a file to be accessed by a BASIC program.
CURRICULUM AREA: All
ACTIVITIES: • Discuss the application of files and determine the format required for your computer. • Write a BASIC program using a file. • Find several large programs which use files and determine their value in programming.

TOPIC: Pilot: Introductory Language Commands

OBJECTIVE: The student is familiar with the introductory Pilot commands.
CURRICULUM AREA: All
ACTIVITIES: • Discuss the use of Pilot and its advantages. • Discuss the difference between BASIC and Pilot. Write a multiple choice response activity in both languages. • Write a multiple choice social studies exam using Pilot. EL

THE ROAD TO COMPUTER LITERACY

Part V: Objectives and Activities for Grades 10-12

While computers in secondary education used to be limited to advanced science and math students, the goal now is to expose all students to computers and computer applications in a variety of curriculum areas.

SINCE MANY ELEMENTARY AND junior high schools still do not offer separate computer literacy courses, the activities and objectives presented in the last three installments of this series were integrated into all curriculum areas.

Upon reaching high school, these same students are more likely to have the opportunity to choose a computer literacy, computer science, programming or data processing course as an elective. That does not mean, however, that English, foreign language, social studies, business and other non-computer teachers should abandon computer literacy as an objective in their own subject areas.

The reason is simple: Computers are not only becoming commonplace in all curriculum areas (a survey by Market Data Retrieval has revealed that nearly 60 percent of all high schools have at least one micro), but they

Several activities require students to make graphs, similar to those shown above, which are based on survey results and election predictions.

By Dr. Gary Bitter

Gary Bitter, professor of Computer Education, Arizona State Univesity, Tempe, AZ is the author of several educational computing books and articles, including Microcomputer Applications for Calculus *(Prindle, Weber & Schmitt, Boston, MA, 1983).*

are also becoming widespread tools in many professional fields. As a result, the need to prepare all students—not just advanced math and science students—for a future with computers becomes all the more urgent.

In short, I suggest that teachers of all disciplines consider integrating some of the following activities into their lesson plans, especially since this may be the last exposure to formal education in computer literacy for many students.

As we bring this scope and sequence series to a close, I hope that you have found the ideas and activities useful as a starting point toward developing a computer literacy program in your school. I look forward to hearing about other models and computer literacy programs that you have found especially successful. Write to me in care of *Electronic Learning*, 730 Broadway, New York, NY 10003.

Editor's Note: *The following is a summary of the Computer Literacy Topics for grades K-9, covered in previous installments of this Scope and Sequence.*

Kindergarten: • What a Computer Is • Following Directions • Vocabulary • Programming Programmable Devices • Turtle Graphics (Making Shapes)

1st Grade: • What a Computer Can Do • Learning to Use a Computer • Using the Keyboard • Turtle Graphics (Moving Shapes)

2nd Grade: • Computer Advantages • Computer Disadvantages • Computers in Our Lives • Everyday Applications • Future • Turtle Graphics (Rotations) • LOGO (Sprites)

3rd Grade: • History • Logic • How a Computer Works • Parts of a Computer • LOGO programming • Problem Solving With LOGO

4th Grade: • Hardware • Software • Flowcharting • Storyboarding • BASIC: PRINT; REM; LET; INPUT; GOTO • Formulas (Variables and Constants) • String Data • Relations • Binary Numbers

5th Grade: • Computer Generations • Counters • BASIC: IF-THEN; ON-GOTO; READ-DATA • Word Processing

6th Grade: • Computer Types • Data Handling • Computer Languages • Looping • BASIC: FOR-NEXT; Random Number • Problem Solving with BASIC • Graphics

7th Grade: • Modeling • Robotics • Social Issues • Data Bases • BASIC: Arrays (One Dimensional); Functions

8th Grade: • Computer Crime • Algorithms • BASIC: Arrays (Two Dimensional) • Graphics (Sound & Color)

9th Grade: • Computer Capabilities • Computer-Related Fields • BASIC: Simulation Programming; Matrices; Files • PILOT: Introductory Language Commands

(Continued)

COMPUTER LITERACY

	TOPICS	COMPUTER AWARENESS													PROGRAMMING												
		K	1	2	3	4	5	6	7	8	9	10	11	12	K	1	2	3	4	5	6	7	8	9	10	11	12
10TH	Prediction, Interpretation, Generalization of Data											IA	C	C													
10TH	Artificial Intelligence											IA	C	C													
10TH	Pascal: Introduction																								IA	C	C

IA—Introduction with Activities / ID—Introductory Discussion / C—Expansion of Discussion from Previous Grades / R—Review / M—Mastery

Tenth Grade

COMPUTER AWARENESS

TOPIC: Prediction, Interpretation and Generalization of Data

OBJECTIVE: The student can write programs to collect and organize data and interpret, predict or generalize the output.
CURRICULUM AREA: All
ACTIVITIES: • As a class, write a program to survey students on what radio stations they listen to, their favorite musician/author/color, or their favorite subject in school. Have students take turns entering their opinions. Include a graph of the results as final output. • Discuss how national elections are predicted by polls such as Gallup and Harris. How accurate are these polls? Have groups of students conduct computer polls to predict the outcome of the class election, a school board election or a millage vote. Compare each group's results and determine the range of accuracy after the election. • Write a computer program to graph the population in your city, school and state for the last 50 years. (Census information should be available at the city, county or state office of statistics.) From this graph, generalize about the population next year, ten years from now and 50 years from now.

TOPIC: Artificial Intelligence

OBJECTIVE: The student can define artificial intelligence and discuss its impact on the future.
CURRICULUM AREA: Social Studies; Science; Literature
ACTIVITIES: • Review literature on the history of artificial intelligence. (Articles have recently appeared in *Business Week*, *Science Digest*, *Creative Computing*, and *Scientific American*.) Discuss implications for the 80's, 90's and the next century. • Assign a book about artificial intelligence. (Suggested titles: *Introduction to Artificial Intelligence: Can Computers Think?*, Boyd and Fraser 1978; *Micro Millennium*, Viking Press 1980; *The Third Wave*, Morrow 1982) • Have students research Japanese projections that the fifth generation of computers will have artificial intelligence. (Articles on this topic have appeared recently in *Business Week*, *Info World*, *Computer World*, *Time* and *Newsweek*.) • Discuss improvements in computer chess programs in the last 20 years. Compare the capabilities of current chess programs and programs made in the 1970's. Explain that the new programs examine more alternatives to making chess moves and are much more extensive. • Have students prepare an essay on artificial intelligence. Suggested topics include the difference between artificial intelligence and cybernetics, do machines think?, and how machines become intelligent.

PROGRAMMING

TOPIC: Pascal: Introduction

OBJECTIVE: The student can write simple Pascal programs.
CURRICULUM AREA: Programming; Computer Science; Reading; Literature
ACTIVITIES: • Discuss the general applications of Pascal and why it is called a structured language. • Have students work with a Pascal computer simulation program like *Karel the Robot* (Cybertronics International, Morristown, NJ; (415) 566-4566) to get familiar with Pascal. • Have students convert some of their BASIC programs into Pascal. Discuss the differences of each language.

	TOPICS	COMPUTER AWARENESS													PROGRAMMING												
		K	1	2	3	4	5	6	7	8	9	10	11	12	K	1	2	3	4	5	6	7	8	9	10	11	12
11TH	Computer Systems												ID	C													
11TH	Sampling Techniques												IA	C												IA	C
11TH	Statistical Application												IA	C												IA	C
11TH	Pilot: Programming																									IA	C

Eleventh Grade

COMPUTER AWARENESS

TOPIC: Computer Systems

OBJECTIVE: The student is familiar with brands and types of computer systems.
CURRICULUM AREAS: Computer Science; Data Processing
ACTIVITIES: • Have students collect brochures from major computer companies and make a comparative listing of the systems. Include type of computer (micro, mini, mainframe, pre-programmed learning aids etc.), cost, purpose, speed, peripherals, memory and other functions. Summarize the advantages and disadvantages of each. Discuss the components that make up a computer system. • Have a computer sales representative give a speech on a computer system. • Have students create a model of a system and label all the parts. Have them draw a system of the future and write a paper on how it works, added features, what it's used for, how much it costs, etc.

TOPIC: Sampling Techniques (also Programming)

OBJECTIVE: The student can set up a sampling technique for making decisions or predictions.
CURRICULUM AREAS: Math; Science; Social Studies; Statistics
ACTIVITIES: • If possible, have a representative from a poll service or a statistician lead a discussion panel with your class on

(Continued)

sampling techniques. Discussion topics could include ways of gathering data, where polls are conducted and why, factors to consider when compiling data. ● Have small groups gather information and write a report on the factors involved in picking samples to predict election outcomes. Include party affiliation, regional influence, occupation, sex, ethnic background, and past voting history. Relate these to writing a computer program which analyzes this data. ● List the professions which depend heavily on sampling: insurance, sales, television, politics, etc. Discuss what influence survey results have on each of these.

TOPIC: Statistical Application (also Programming)
OBJECTIVE: The student can use the computer to do statistical computations.
CURRICULUM AREAS: All
ACTIVITIES: ● Have students use a commercial statistical package to compute mean, standard deviation and related statistics of several class tests. Have students write a program to compute the mean and standard deviation of their own tests. ● Have a sales representative demonstrate statistical software to show its many capabilities. Discuss advantages of mainframes, minis and microcomputers for doing statistical computations.

PROGRAMMING:

TOPIC: PILOT Programming
OBJECTIVE: The student can develop programs using PILOT.
CURRICULUM AREAS: Computer Science; Programming
ACTIVITIES: ● Have students write a detailed multiple choice test for a subject of their choice using PILOT. Include a post-test and a printout of final score, percentage of correct answers, and mean score of several tests. ● Have small groups write a PILOT program with graphics. Have them share the programs with other classes. ● Discuss the features of PILOT and compare it to BASIC and Pascal. ● As a final project, have students prepare a multiple choice testing program in PILOT for another teacher to use in class. Require that the program use graphics (charts or diagrams), compute scores, and compile statistical information about the class results.

	TOPICS	COMPUTER AWARENESS														PROGRAMMING													
		K	1	2	3	4	5	6	7	8	9	10	11	12		K	1	2	3	4	5	6	7	8	9	10	11	12	
12TH	Computer Survival													ID															
12TH	Invasion of Privacy													ID															
12TH	Pascal: Advanced																											IA	
12TH	Data Bases: Advanced																											IA	

Twelfth Grade

COMPUTER AWARENESS

TOPIC: Computer Survival
OBJECTIVE: The student is aware of the future impact of computers on society.
CURRICULUM AREAS: All
ACTIVITIES: ● Have students review studies indicating the future role of computers on our society. Have them write a report on their findings. Issues to look for include the social impact, impact on trade unions, employment, and government predictions on jobs. ● Have students read at least one futuristic novel about technology. Suggested titles are *Brave New World* (Huxley), *Future Shock* and *The Third Wave* (Toffler), *1984* (Orwell), and Ray Bradbury fiction. Discuss the similarities and differences between fictional accounts of computers and scientific fact. Hold a debate on this topic. ● Discuss preparations for making people computer literate (teaching the role of computers, what computers can do and cannot do, computer applications, and communications). ● Compare the role of computers in various professions both now and in the future. Make a table listing education, politics, business, and other professions on one side, and "past", "present" and "future" across the top. Have the class fill in the table. ● Have each student write a paper on their future plans for living with computers.

TOPIC: Invasion of Privacy
OBJECTIVE: The student can explain what kind of information computer files contain and what laws protect that information.
CURRICULUM AREAS: Social Sciences; Computer Science; Computer Literacy
ACTIVITIES: ● Have students list all the data banks that store information about themselves. Discuss security measures for keeping this information private. ● Visit a credit bureau and have someone explain what information is on the bureau's computer, its purpose, methods of security, changes to be made if there are errors, and how individuals can access their file. ● List all the government data banks you can think of and the purpose of each. Refer to a directory of federal institutions for more listings. Include lists of the types of information on each.

PROGRAMMING:

TOPIC: Pascal: Advanced
OBJECTIVE: The student can write a Pascal program to solve problems.
CURRICULUM AREAS: Computer Science; Programming; Application to all.
ACTIVITIES: ● Have students list all the Pascal statements and compare them to BASIC statements ● Write an advanced program for math, physics, chemistry, geology, social studies, or other classes in each language. Discuss advantages and disadvantages of each. ● Have students read a self-study Pascal text such as *Apple Pascal* (McGraw-Hill 1981) and *Speaking Pascal* (Hayden 1981).

TOPIC: Programming Data Bases: Advanced
OBJECTIVE: The student can outline the procedure to prepare, access, and update a data base.
CURRICULUM AREAS: All
ACTIVITIES: ● Have a travel agent, businessperson or bank teller who works with data bases talk to the class on requirements of a data base. Include preparation, security, access, updating, etc. ● Have the class prepare a data base of information on each student: name, social security number, sex, age, class schedule, etc. ● Have the class design a security system for the data base they developed for the class. EL

Define the Vocational Instructor's Role in the Local Education Agency (LEA) Plan for Computer-Based Instruction (CBI)

UNIT OBJECTIVE

Upon completion of this unit, the learner will describe the role of the vocational instructor implementing computer-based instruction in a local education agency. This knowledge will be demonstrated through completion of the unit achievement indicators.

SPECIFIC OBJECTIVES

Upon completion of this unit, the learner will:

1) Describe the importance of integrating computer technology into vocational curricula.
2) List 3 reasons why vocational instructors will never be replaced by computers.
3) Explain the basic needs that teachers have related to CBI.
4) Discuss the importance and critical aspects of vocational instructors' attitudes toward CBI.
5) List 5 techniques that may enhance self-motivation as well as knowledge, skills, and attitudes about computers.
6) Discuss the golden rule and 10 commandments of computer-based education.
7) List and explain the 10 sections of a Microcomputer Implementation Plan.

Developing a System to Facilitate the Vocational Instructor's Role in Implementing Computer-Based Instruction

BY: DENNIS G. TESOLOWSKI

Vocational instructors and their local education agencies are being pressured, directly or indirectly, to apply computer technology in their programs. In order to effectively integrate computer-based instruction into an existing vocational curriculum, a vocational instructor must possess an appropriate attitude, knowledge, and skills. These qualities can be enhanced through the fulfillment of a well designed planning strategy (Sturdivant, 1983). In the unit of instruction for competency A.1, it was clearly stated that LEAs have to make critical decisions regarding curriculum, equipment, equity, funding, goals, objectives, staffing, and staff development (McClellan, 1984).

With regard to these decisions, vocational instructors can be assured that vocational education programs will not be given primary consideration to house CBI unless they and their local vocational directors work as active lobbyists and/or advocates to advance this need. This belief that vocational education may lag behind in the computer revolution can be supported by reviewing state-of-the-art computer use in LEAs nationwide. Upon reviewing the status of computer-based instruction in a small sample of LEAs across the United States, it became apparent that CBI is primarily housed in either the mathematics or science departments. In this limited survey, a single LEA reported the shared leadership between its vocational education and mathematics departments. Ray Schaljo, computer technology coordinator for the State of Illinois, states:

> One of our considerations is that we don't want the computer to get identified with any one area of the curriculum .... We're getting some pressure from the purists, but I think the computer literacy in and of itself is something that spans all curriculum areas. (Green, 1984, April/May, p.20)

This overall trend clearly supports the need for involving vocational instructors in the planning process for implementing CBI in a LEA.

THE IMPORTANCE OF INTEGRATING CBI INTO VOCATIONAL CURRICULA

Computer-based instruction has the potential to significantly affect vocational education as it is known today. Judd (1983) refers to its potential as the order-of-magnitude training effect. For example, he describes a computerized videodisc system that reduced the training time necessary to teach cardiopulmonary resuscitation from more than 100 minutes to 10 minutes or less. History has demonstrated that the order-of-magnitude changes have an impact far beyond the particular field in which they occur. For example, the invention of the automobile not only meant that individuals could travel 30 miles an hour instead of three, but it created suburbs, increased our society's overall mobility, and provided teenagers with a new independence. Similarly, Gutenberg's invention of the printing press not only made the reproduction of books 10 times faster, but it made learning available to the masses. Suddenly anyone who could read was able to acquire knowledge which had previously been held only by priests and scholars.

Order-of-magnitude technological changes modify the entire context in which that technology is embedded. Judd (1983) indicates that the personal computer has led education to the threshold of an order-of-magnitude change. His justification for this belief is that new computer technology in the form of microcomputers has been made available at the individual level. He uses the analogy that trains had traveled 50 to 60 miles per hour long before automobiles, but not until the advent of the motorcar could individuals take advantage of the increased speed of transportation. Likewise, although giant mainframe computers have had significant computational power for more than two decades, only when microcomputers became widely available could their influence on everyday life become pervasive.

If computer technology is going to have the significant effect on education and learning that Judd (1983) suggests, then it is imperative for vocational educators to integrate CBI into their programs. In order for this vast movement to be accomplished, vocational instructors will have to be highly motivated and they will have to increase their personal knowledge, skills, and attitudes about computers.

MICROCOMPUTERS WILL NEVER REPLACE VOCATIONAL INSTRUCTORS

> . . . a teacher who won't have a computer in his or her classroom is like a ditch digger who won't learn to use a steam shovel. Like a steam shovel, a computer is a tool. It can increase the power a teacher can apply to a learning situation, but it does not replace the teacher. In a competitive world, ditch diggers who refuse to adapt are going to go out of business. (Judd, 1983, p.121)

Vocational educators, like educators in general, must come to grips with the fact that computers will never replace them as instructors. There are interpersonal needs in the teaching-learning environment that computers are incapable of handling. It is safe to assume that not even fifth generation computers will be able to fill those needs. People need people (Naisbitt, 1984): this is the primary reason why futuristic visions of students studying in carrels at home, tapping into library resources, and learning new material from videodiscs are not likely to materialize. The idea that schools will disappear ignores the fact that groups of people do things that individuals do not do in isolation.

The following reasons are representative of why computers will never replace vocational educators:

1. Teachers are needed to motivate students at various times.
2. Teachers need to pace student use of the computer, to mix practical experience with conceptual advances, and to intersperse periods of personal contact with periods of intense concentration.
3. Teachers know when to push a lazy student and when to ease up on a student who is having personal problems.
4. Teachers are able to spontaneously link skills students learn in classrooms to the real world. This skill cannot be premeditated or planned into a curriculum.
5. Teachers must select curriculum materials and software for their programs.
6. Teachers are able to guide and encourage students' efforts to explore subjects in greater depth.
7. Teachers can generate interaction by encouraging the exchange of ideas through debate and group participation. (Judd, 1983)

Vocational educators must realize that computers can exponentially increase their instructional power in the classroom or laboratory; furthermore, they must realize that computers cannot replace them as invigorating human beings. As computers begin to take over some of the basics of education, teachers will be given the responsibility for teaching values, motivation, and possibly religion (Naisbitt, 1984). Ideally, vocational instructors can be humanistic educators and teacher-technologists by involving students in active and direct learning and by utilizing computer technology to keep students educationally occupied in a predictable manner (Harlow, 1984).

STATISTICS ABOUT THE APPLICATION OF MICROCOMPUTERS

Varying statistics are frequently reported regarding the availability and application of microcomputers in schools across the United States. During the Spring of 1982, the National Education Association (NEA) conducted a research project entitled "Computers in the Classroom." In this investigation, a national sample including 1700 elementary and secondary school teachers was surveyed. Respondents to this survey included 1208 teachers or 72.5% of the sample. Data gathered in this study was published in the final report entitled *A Teacher Survey NEA Report: Computers in the Classroom* (Norman, 1983).

The following statements, which are summarized from this investigation, reflect the state-of-the-art of computers in education:

1. 65.2% of all teachers work in school systems where computers are used for administrative purposes.
2. 28.8% of the teachers reported the presence of a computer in their schools.
3. 10.9% of the teachers reported the presence of computers in classrooms.
4. 54.2% of the teachers receive computer-processed information; however, this information generally concerns student test performance. Fewer percentages of teachers reported receiving other kinds of information having some relevance to classroom instruction.
5. 37.6% of all teachers reported that they were encouraged by their school administrations to use computers in their classrooms. This encouragement was provided through the provision of a school computer (28.8%), in-service training (28.0%), and computer programs (15.4%). According to teachers, the greatest sources of encouragement to use computers with students came from other teachers (35.1%), school principals (24.5%), family and friends (21.7%), and students (18.8%).
6. 20.8% of the teachers have received computer training from universities, colleges, or local education agencies. In general, teachers reported that they were not well informed about any computer knowledge or skill area probed.
7. Teachers are interested in learning about computer application programs (59.1%), how to operate a computer (58.8%), and how to write computer programs (56.6%). Teachers were especially interested in learning about computer instructional applications for enrichment purposes and for maintaining student records. 82.6% of the teachers reported an interest in taking an instructionally-related computer course.
8. The majority (50% or more) of the teachers support a computer management policy that would promote the use of computers to improve teaching and learning, require coherent planning and preparation for computer projects, involve teachers in policy and project decision making, and provide computer opportunities for all students.
9. Teachers believe that educational changes will occur as computers are applied in schools. In general, teachers viewed computers as having a positive effect on their sense of professional challenge (66.4%), teaching effectiveness (60.7%), and job satisfaction (47.1%). More specifically, teachers believe that there will be an increased demand for teachers with computer skills (63.2%), a common practice of learning by computers in school (51.4%) and out of school (49.7%), and a common perception of computer skills as a basic form of knowledge (49.3%). Teachers did not believe computers would render many teaching skills obsolete (reported unlikely by 43.3% of all teachers), replace teachers (46.9%), or fade as a focus of instructional interest (56.4%).
10. 11.2% of all the teachers reported that they have used computers for instructional purposes, although only 6.2% were using the computer during the spring of 1982.
11. The average number of computer terminals or work stations available to teachers who use them ranged from 2.6 at the elementary level to 5.2 at the senior high school level. In terms of weeks during the school year, teachers who use computer terminals or work stations have access to them 33.7 weeks at the elementary level and 40.9 weeks at the senior high level.
12. 53.4% of the teachers reported that they were dissatisfied with the amount of software available and 46.3% were dissatisfied with the quality.
13. The greatest percentages of teachers reported the application of computers in connection with mathematics (70.7%), reading (34.7%), and computer literacy (32.0%). The majority of teachers (50% or more) used various computer instructional applications. 86.3% of the teachers reported using drill-and-practice applications, while 50% indicated that they never use testing applications.

14. 7% of the teachers reported that computers have a positive effect on students' motivation, subject interest, attention span, self-confidence, and cognitive learning.

15. Teachers reported that they used instructional computing to foster awareness of computers (56.0%), to develop basic computer skills (52.0%), to develop programming skills (34.7%), and to develop skills in another subject such as mathematics and reading (50.7%).

16. In general, the greatest needs among teachers are for computer knowledge and experience. More specifically, teachers need software (42.2%), personal knowledge about computing (28.1%), and more computers (21.9%).

These findings seem to support the need for vocational educators to become more involved in computer-based instruction. Furthermore, it can be surmised that vocational educators' needs are at least equal to or greater than the identified needs of educators in general. Educators have identified a tremendous need for additional hardware, software, and knowledge and experiences in the form of training and resources related to computer-based instruction.

ATTITUDES TOWARD COMPUTER TECHNOLOGY

Many educators, including vocational teachers, are developing an attitudinal problem which may be referred to as computerphobia (Widmer & Parker, 1983-84, Winter). The fear of computers, frequently referred to as cyberphobia, is a common affliction affecting millions of Americans (Norris & Lumsden, 1984, January).

Remember the term "anxiety reactions" discussed by Toffler (1970) in *Future Shock*. He indicates that this physical and/or mental reaction is the result of adapting to constant change. This dilemma, whether it is real or imagined, is caused by the speed with which these changes are occurring. This situation, related to coping with change, is compounded when individuals do not have any choice as to whether or not they want to change. Weinberg (1982, August) attributes the fear of computers to individual feelings of lost control and predicts a worsening of the situation as society becomes increasingly computerized. Technological advances within the computer industry have been swifter than our ability to comprehend and integrate them into our educational systems (Friedman, 1982, November-December).

This concern about not having a choice in regards to technological growth and change is relevant. Microcomputers have arrived amidst great expectations of parents, students, administrators, and society at large. Whether educators like it or not, microcomputers are appearing in their classrooms. Moursund (1982) reported that more than 100,000 microcomputers were in use in education in the United States, and the number has been increasing exponentially since that time. This tremendous growth has been spurred on by the development of microcomputers, high student interest, increased parental support, decreasing costs of computer power, expanded storage media, and cheaper peripherals (Friedman, 1982, November-December).

In spite of this prolific expansion, Anderson (1981) reports that most teachers are fearful when it comes to computers; meanwhile, Kelman (1982, February) and Calkins (1982, September) have indicated that teachers and administrators range somewhere between apathetic and hostile in their attitudes toward computers (Norris & Lumsden, 1984, January). Vocational educators have differing attitudes toward computer technology and computer-based instruction. The possession of positive general attitudes toward computers certainly can enhance vocational instructors' commitments about fulfilling their role in the LEA plan for CBI.

The following 10 items can be used to obtain a general attitudinal measure toward computers. These 10 items were extracted as an identifiable factor dimension entitled "General Attitudes Toward Computers" from an initial 30 item instrument (Reece & Gable, 1982). The original instrument included 10 cognitive (C) statements, 10 behaviorable (B) statements, and 10 affective (A) statements. Please respond to these items by recording a response of 1 to 5 for each of them. These responses represent the following feelings on a 5-point Likert-type scale:

General Attitudes Toward Computers

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Item	Code	Statement	Rating
1	B	I will use a computer as soon as possible.	1 2 3 4 5
2	B	I will take computer courses.	1 2 3 4 5
3	A	Learning about computers is exciting to me.	1 2 3 4 5

4	C	Computers can be used to save lives....................................	1 2 3 4 5
5	A	Computers make my life enjoyable.	1 2 3 4 5
6	A	I enjoy computer work..	1 2 3 4 5
7	A	Having computers in the classroom would be fun for me..................	1 2 3 4 5
8	B	I would like to get a job where I had to work with computers.	1 2 3 4 5
9	B	If I had the money, I would buy a computer..............................	1 2 3 4 5
10	A	I like learning on a computer..	1 2 3 4 5

A positive general attitude toward computers is represented by a total score of 35 or higher on these 10 items. A total score lower than 35 could be indicative of a "computerphobia" as well as a lack of knowledge and experience related to computers.

ENHANCING KNOWLEDGE, SKILLS, AND ATTITUDES THROUGH SELF-MOTIVATION

Professionals with the desire to increase their knowledge and gain experiences with computers function at varying levels of motivation. Rarely are two or more individuals motivated in the same manner. Some vocational teachers learn most effectively through a group or tutorial situation such as the traditional in-service staff development workshop. Others may learn best alone or in the company of a private or semi-private instructor.

Some suggestions for enhancing self-motivation and increasing one's knowledge, skills, and attitudes about computers include the following:

1. Realize that the computer is a "personal" computer. It is an extension of the user's mind and it can be customized and tailored to fit his or her individualized needs.
2. The computer can be used to solve problems. Once a comfort level has been achieved, learning is secondary to the goal of "problem-solving."
3. The computer makes communication easier and more efficient so that many jobs can be accomplished more readily.
4. A computer can save a great deal of time and money in some cases.
5. The computer can increase a professional's job skills and employment marketability.
6. The computer is fun.
7. The computer can extend a professional's imagination, knowledge, and skill base.
8. Become involved in courses, staff development workshops, and self-directed learning activities about computers. Attempt to blend theoretical information with hands-on activities related to computers.
9. Set reasonable time limits for learning selected computer functions.
10. Take a microcomputer home with you and experiment with it.
11. Purchase hardware or software after carefully reviewing programmatic and personal needs.
12. As knowledge and skills are acquired, share them with as many other people as possible.
13. Attempt to motivate other individuals who are resistant to computer technology.
14. Try to be involved with group-teaching projects and other endeavors related to computer technology.
15. As soon as is realistically possible, reward yourself with a personal computer. (Emmett, 1983, December)

THE GOLDEN RULE AND TEN COMMANDMENTS OF COMPUTER-BASED EDUCATION (CBE)

As plans are developed for integrating computer-based instruction into vocational programs, classroom instructors must be involved in every aspect of the process. If the system is to be effectively utilized as a teaching tool, classroom teachers must participate in the decision-making process. This overall planning process can be facilitated by reflecting upon the golden rule and 10 commandments of CBE (Aiken, 1981, March).

Golden Rule of CBE

"Teach unto others as you would like to be taught" (p. 39). Aiken stresses the urgency of utilizing interesting CBE lessons. Unfortunately, the large majority of lessons are boring. Once students become bored, they tend to lose interest and either not finish the lesson or, at best, learn very little.

Ten Commandments of CBE

The following 10 commandments suggest methods of implementing the golden rule of CBE:

Commandment 1: Select reliable hardware.
Commandment 2: Consider the people-machine interface.
Commandment 3: Guarantee good maintenance.
Commandment 4: Select good courseware.
Commandment 5: Choose appropriate software.
Commandment 6: Make computers accessible outside class.
Commandment 7: Adequately train teachers.
Commandment 8: Administration must provide teacher support.
Commandment 9: Elicit community and parent support.
Commandment 10: Motivate students properly. (pp. 39-41)

Many of these concerns are expanded upon in later units of instruction in this resource guide. Hopefully, these 10 suggestions will be taken into consideration in the LEA's overall plan as well as at the classroom or programmatic level.

WRITING A MICROCOMPUTER IMPLEMENTATION PLAN

The Houston Independent School District (HISD) requires instructional leaders, such as vocational teachers, to submit a Microcomputer Implementation Plan prior to acquiring hardware and software for computer-based instruction (Department of Technology, 1983). HISD prefers that a team be involved in completing this implementation plan to ensure that provisions for the coordination of software, location, scheduling, and training are taken into account. A copy of this Microcomputer Implementation Plan has been included in this unit of instruction in order to facilitate a clearer understanding of this process.

Prior to completing a Microcomputer Implementation Plan, school planners, such as vocational instructors, are asked to address such questions as:

*What are the students' needs?
*What software is available?
*How can microcomputers help meet these needs?
*Which students will have access to the computers?
*What new kinds of curriculum need to be developed?
*How many microcomputers are needed?
*Where will the microcomputers be located?
*How will teachers, students, and administrators be trained?
*What kind of staffing pattern will be needed?
*How can parents become involved?
*What other educational technologies besides computers are available to integrate into the curriculum? (Sturdivant, 1983, p.57)

The following explanation for each of the 10 sections of HISD's Microcomputer Implementation Plan has been quoted from an article entitled "Technology Training: In Search of a Delivery System," by Patricia Sturdivant, Associate Superintendent of HISD.

I. Program Description:

. . . the specific applications are delineated in explaining whether the goal is to teach computer programming or word processing; whether it is tutorial or for enrichment; how the subject area is addressed; which basic skills are included; whether or not it is for a special program; and whether the setting is in a laboratory or a classroom. (p.57)

II. Objectives for the Proposed Program.

The objectives must be stated as educational outcomes and must be measurable. (p.57)

III. Target Population:

Funding sources should be considered; local funds may be used for all students without restrictions. Federal and state compensatory funds may be spent only for students who meet certain eligibility criteria. Planners are to indicate the specific grade level to be served, the number of students at that grade level, and the subject area to be addressed. (p.57)

IV. Staffing:

The plan asks for the number of staff needed to implement the plan, those currently employed, and the number of new staff required. At least two teachers who ultimately will use the computers must be selected for training. Then, if one teacher is unavailable there is a backup person who can assume responsibility for the computer program. Interested teachers usually will volunteer for the program once it is announced, but they should be aware that they may have to attend training after school and on weekends. (p.57)

V. Staff Training:

Effective use of computers in education requires extensive in-service. Training must, of course, be tied to hardware purchases since adequate preparation is crucial to effective implementation. The staff must be trained before computers can be ordered.

Plans for staff training might include:

*A half day of awareness training for the entire staff.

*Use of *Microcomputers in School* (1983), a commercially-produced videotape series, for in-service.

*Two days of operator training in a hands-on format for every teacher who works directly with computers. (p.58)

VI. Hardware Requested:

The prospective user must identify needs and choose software before hardware is selected since equipment must support the application desired. Equipment pu[illegible]ses must support the instructional priorities of the District, such as reading/language arts, mathematics, [illegible]nce, and computer literacy. The minimum memory size for computer-assisted instruction is 32K; 48K [illegible] recommended. The minimum configuration for programming instruction is 16K, except for hand-held devices. (p.58)

VII. Type(s) of Application(s) to be Implemented:

*Drill and Practice

*Tutorial

*Simulation

*Problem solving

*Programming

*Data Management

*Word Processing (p.58)

VIII. Programs:

Campus technology planners are asked to list the titles, levels of software, vendor names, and prices. Users are urged to choose from the District's approved software listing. These programs are selected by a committee of experts who review the technical and pedagogical quality of programs. (p.58)

IX. Proposed Location for Equipment:

Users specifiy the number of rooms needed and whether they are classrooms, laboratories, libraries, or other facilities. The electrical requirements of the equipment are taken into account in ordering modifications as are special security provisions. The plan offers several bits of advice on making decisions about location:

*If portability is important, place the computers on wheeled carts

*Be security conscious

*Keep computers away from temperature extremes

*Avoid areas with chalk dust

*Use covers when equipment is not in use (p.58)

X. Scheduling Plan:

Scheduling, always a difficult task, is often influenced by the location of the equipment and the application. It is recommended that no student spend less than 15 minutes or more than two hours per day on the computer. No more than three students should be scheduled on one computer at the same time unless they work under the teacher's direction. It is also important to indicate whether the computers will be used during school hours, or after. (p.58)

XI. Prior Implementation Plans:

. . . requires that any prior implementation Plans filed by the school be listed according to the date submitted. Indicate whether the plans were approved or not approved. Note whether this is an extension or revision of a prior plan. (Department of Technology, 1983, p.30)

XII. Funding Assistance Requested:

Any additional funding assistance must be explained. Be specific and attach additional pages, if necessary, to explain funding needs. (Department of Technology, 1983, p.30)

Additional Comments:

This section provides space for any comments you may wish to make. (Department of Technology, 1983, p.30)

The following pages include an actual copy of a "Microcomputer Implementation Plan" and the "Criteria for Evaluation" that are currently used by the HISD Department of Technology (1983, pp.8-12; 16).

HOUSTON INDEPENDENT SCHOOL DISTRICT
MICROCOMPUTER IMPLEMENTATION PLAN

SCHOOL: ______________________ PRINCIPAL: ______________________

ADDRESS: ______________________ TELEPHONE: ______________________

I. **PROGRAM DESCRIPTION.** INDICATE TYPE OF PROGRAM, SUCH AS COMPUTER LITERACY/COMPUTER PROGRAMMING, TUTORIAL/REINFORCEMENT/REMEDIATION, CAI, SUBJECT AREA, BASIC SKILL AREA, SPECIAL PROGRAM (e.g., TALENTED AND GIFTED), CLASSROOM OR LABORATORY SETTING.

II. **OBJECTIVES FOR THE PROPOSED PROGRAM.** MUST BE STATED IN MEASURABLE TERMS.

III. **TARGET POPULATION.**

	No. of Students	Subject(s)		No. of Students	Subject(s)
K	________	________	7	________	________
1	________	________	8	________	________
2	________	________	9	________	________
3	________	________	10	________	________
4	________	________	11	________	________
5	________	________	12	________	________
6	________	________			

IV. **STAFFING.** (CURRENTLY EMPLOYED AND/OR NEW)

_____ Number of staff needed to implement plan

_____ Number currently employed

_____ Number of new staff required

Liaison Person: ______________________________

Describe the duties of each identified staff member:

____

____

____

____

____

____

____

____

____

V. **STAFF TRAINING.** INDICATE NUMBER OF PERSONS IN EACH AREA TO BE TRAINED.

_____ Hands-On

_____ Courseware Applications

_____ Administrator In-service

_____ Computer Literacy

_____ Specify local plan for making the staff aware of technological applications (minimum 1/2 day)

_____ Programming Languages (list) ______________________________

_____ Other (please specify) ______________________________

____

VI. **HARDWARE REQUESTED:**

Number	Item	Price (each)	Total Cost
_____	Apple IIe	_____	_____
_____	Disk Drive	_____	_____
_____	Monitor (Color)*	_____	_____
_____	Monitor (Green)	_____	_____
_____	Printer (EPSON MX 80 FT)	_____	_____
_____	Game Paddles	_____	_____
_____	Language Card	_____	_____

(*NEED FOR COLOR MONITOR MUST BE JUSTIFIED IN SECTION VIII.)

OTHER:

_____	_____	_____	_____
_____	_____	_____	_____

VII. **TYPE(S) OF APPLICATION(S) TO BE IMPLEMENTED.** CHECK ONLY THOSE APPLICATIONS WHICH ARE DIRECTLY ADDRESSED.

_____ Drill and practice
_____ Tutorial
_____ Simulation
_____ Problem solving
_____ Programming
_____ Data management
_____ Classroom management
_____ Word processing

VIII. **PROGRAMS.** SOFTWARE TO BE USED BY TYPE(S) OF APPLICATION(S) CHECKED ABOVE. (IF PROGRAMS ARE NOT ON THE APPROVED LIST, ATTACH AN EPIE COURSEWARE REVIEW OR A PUBLISHED REVIEW FROM A JOURNAL WITH BIBLIOGRAPHIC SOURCE NOTED.)

Title and Level	Publisher/Vendor	List Price

IX. **PROPOSED LOCATION FOR EQUIPMENT:** (EACH COMPUTER NEEDS 4.5 AMPS.)

Location _____

Type of Room(s) _____

Room Number(s) _____

Electrical Requirements _____

X. **SCHEDULING PLAN.** DESCRIBE HOW STUDENTS WILL BE SCHEDULED TO USE THE COMPUTERS AND THE LENGTH OF TIME FOR USE BY EACH STUDENT. SPECIFY HOW COMPUTERS WILL BE USED BEFORE OR AFTER NORMAL SCHOOL HOURS.

XI. **PRIOR IMPLEMENTATION PLANS SUBMITTED:**

Date Submitted _____ Not Known _____

Approved _____ Not Approved _____ Extension _____ Revision _____

XII. **FUNDING ASSISTANCE REQUESTED?** NO _____ YES _____
(EXPLAIN BELOW.)

ADDITIONAL COMMENTS: _____

NOTE: This form must be routed to the Area Office for approval before it is submitted to the Department of Technology. Unsigned forms will be returned to the originator.

SUBMITTED BY:	____________________ PRINCIPAL	________ DATE
REVIEWED BY:	____________________ AREA OFFICER	________ DATE
RECEIVED BY:	____________________ DEPARTMENT OF TECHNOLOGY	________ DATE
APPROVED BY:	____________________ DEPARTMENT OF TECHNOLOGY	________ DATE

MICROCOMPUTER IMPLEMENTATION PLAN CRITERIA FOR EVALUATION*

SCHOOL: ______________________ DATE: ______________

POINTS

I. ____ (5) Plan reflects a knowledge of implementation issues (addressed in the videotape series entitled *Microcomputers at School* available at each Area Office).

II. ____ (5) **Objectives** are well defined.

III. ____ (5) **Target population** is reasonably served by the number of microcomputers.

IV. ____ (5) The **person(s) responsible** for working with the computers are clearly identified.

V. ____ (10) **Staff** is already trained. Provisions for training are specified. Adequate attention is given to the need for staff training. Staff is willing to attend in-service. A half-day staff awareness training session is scheduled.

VI. ____ (10) The **equipment configuration** is appropriate for the need defined.

VII. ____ (2) The **type(s) of application** are identified.

VIII. ____ (15) Specific **software** has been identified. (If the emphasis is on computer programming, then support materials [e.g., textbooks and sequentially organized print materials] are identified.)

IX. ____ (8) The physical **location** is practical and addresses cost effectiveness considerations.

X. ____ (5) A specific **schedule** is developed which reasonably serves the target students identified.

XI. ____ (10) School is willing to contribute to the **financing** of the proposed plan (hardware and/or software).

XII. ____ (10) The plan addresses District priorities. ______________________

____

COMMENTS: Reactions to overall quality of the proposal (10): ______________________

____

TOTAL POINTS = ________

Reviewed by: ______________________

Date: ______________________

*These criteria are used by the Department of Technology to evaluate the quantitative and qualitative dimensions of your plan. It is suggested this page be duplicated and used to evaluate individual plans before submission for approval.

SUMMARY

The purpose of this unit of instruction is to familiarize vocational instructors with the scope of their role in the local education agency plan for computer-based instruction. The importance of integrating computer technology into vocational curricula is discussed. Seven reasons why vocational instructors will never be replaced by computers are presented. A comprehensive listing of teachers' needs and feelings related to computer-based instruction are included. The importance and critical aspects of vocational instructors' attitudes toward CBI are discussed. Fifteen techniques for enhancing self-motivation, as well as knowledge, skills, and attitudes about computers are presented. The golden rule and its accompanying 10 commandments of computer-based education are listed. Finally, a Microcomputer Implementation Plan and criteria for evaluation are presented. Each of the ten sections of this plan is explained.

ACHIEVEMENT INDICATORS

1) Describe the importance of integrating computer technology into vocational curricula.
2) List 3 reasons why vocational instructors will never be replaced by computers.
3) Explain the basic needs that teachers have related to CBI.
4) Discuss the importance and critical aspects of vocational instructors' attitudes toward CBI.
5) List 5 techniques that may enhance self-motivation as well as knowledge, skills, and attitudes about computers.
6) Discuss the golden rule and 10 commandments of computer-based education.
7) List and explain the 10 sections of a Microcomputer Implementation Plan.

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Unit 3

Conduct a Personal Assessment of Microcomputer Competency

UNIT OBJECTIVE

Upon completion of this unit the learner will understand his or her personal competency with microcomputers and computer literacy. This understanding will be demonstrated through the completion of the self-assessment diagnostic-prescriptive computer literacy profile and the unit achievement indicators.

SPECIFIC OBJECTIVES

Upon completion of this unit, the learner will:

1) Define the term computer literacy.
2) Describe a conceptual structure of computer literacy.
3) Record his or her personal level of competency in administering computer-related policies and procedures (Domain I) for a vocational laboratory or classroom.
4) Record his or her personal level of competency in teaching with or about computers (Domain II) in a vocational laboratory or classroom.
5) Record his or her personal level of competency in using suitably programmed computers as aids in learning, managing information, and solving problems (Domain III) in a vocational laboratory or classroom.
6) Record his or her personal level of competency in developing procedures for solving a problem and writing the procedures in a form the computer can understand and carry out (Domain IV) in a vocational laboratory or classroom.
7) Record his or her personal level of competency in understanding the capabilities and limitations of computers (Domain V) as they are used in a vocational laboratory or classroom.
8) Record his or her personal level of competency in understanding social issues related to computers and technology (Domain VI) in the vocational laboratory or classroom.
9) Record his or her level of competency in understanding the fundamental concepts and terms related to computers (Domain VII) in the vocational laboratory or classroom.
10) Graphically profile his or her personal level of competency within the seven domains of computer literacy.
11) Identify his or her strengths and weaknesses as indicated through this self-assessment profile of computer literacy.

The content of this unit of instruction has been extracted from the research project entitled "Computer Literacy: Definition and Survey Items for Assessment in Schools." This project, which was directed by Marlaine E. Lockheed, Educational Testing Service (ETS), was conducted for the National Center for Education Statistics under contract 400-82-0024 with the U.S. Department of Education. The project was a cooperative endeavor by the Educational Testing Service (ETS) of Princeton, New Jersey; the Human Relations Research Organization (HumRRO) of Arlington, Virginia; and Instructional Computing, Incorporated (ICI) of Minneapolis, Minnesota.

The Impact of Computer Technology Upon Vocational Education

BY: DR. DENNIS G. TESOLOWSKI

Vocational education is currently affected by contemporary technological changes. The information revolution, characterized by rapid developments and reduced costs in electronic information technologies and global information networks, is affecting all vocational disciplines. This evolution has been accelerated by the introduction of low-cost microcomputers into vocational programs throughout the nation. The number of microcomputers available for instructional use by public school students had tripled between the fall of 1980 and the spring of 1982. Twenty-two percent of the elementary schools and sixty percent of the secondary schools surveyed by Wright (1982) reported having microcomputers.

As the capabilities of microcomputers increase and costs continue to decline, it is not unreasonable to expect that, eventually, all elementary and secondary students will regularly have access to computers. Bell (1983, September) states that never before has so much computing power been available to teachers and students at such low costs. The potential of computers across vocational disciplines is vast. Computers can be used to facilitate the teaching and learning process. They readily serve as tools in most vocational subject matter areas. Furthermore, as a specific object of study, computers can prepare students for a multitude of new careers in technology (Nasman, 1982; Office of Technology Assessment, 1982).

Due to the job-specific requirements and educational benefits of computers in vocational education, it is necessary for vocational teachers to increase their working knowledge of computers. This professional development can be enhanced by collecting base-line data. Vocational instructors can more readily increase their knowledge about computers if they have an understanding of what there is to know about computers. A brief introduction to computers and base-line data can be acquired by participating in a thorough self-assessment. This self-assessment of one's ability to apply the computer in a vocational laboratory or classroom can be facilitated through a general knowledge of computer literacy and its conceptual structure.

COMPUTER LITERACY DEFINED

Computer literacy is a term that has been defined by literally thousands of authorities, organizations, and associations. Definitions of computer literacy are frequently discussed, but rarely agreed upon. Barger (1983, October) analyzes 12 definitions of computer literacy and notes that (a) computer structure and operation and (b) computer applications and limitations appear to be accepted components of these definitions. He indicates that (c) computer programming is a third element which needs to be negotiated into some of the definitions. Barger suggests using the term "computer awareness" when only components (a) and (b) are intended and reserving the term "computer literate" for definitions that include a standard of minimal understanding of and ability in programming. Moursund (1983) concludes that computer literacy is a functional knowledge of computers and their effects on students and the rest of society. He indicates that approaches to computer literacy will constantly change as computers become more readily available and easier to use; as we learn more about computers and integrate this knowledge into curricula; and as the use of computers becomes commonplace in homes, businesses, government, and schools. Naisbitt (1984) compares individuals without computer skills to persons wandering around a book collection the size of the Library of Congress with all the books arranged at random with no Dewey Decimal system, no card catalogue, and no librarian to assist them.

The scope of this project requires a broad encompassing definition. Instructors in vocational education have to operate within the confines of a definition of computer literacy that will not inhibit professional growth, development, and creativity. This broad definition of computer literacy is critical to prepare professionals in vocational education to meet the multitude of job-specific requirements across vocational disciplines, as well as to adapt the computer as an educational tool in their environment.

The Advisory Panel that assisted Lockheed (1983) in the ETS computer literacy assessment project consisted of 10 experts in the application of computers in education. Each of these experts had previously developed individual definitions of computer literacy. However, they were able to agree on a common definition:

"Computer literacy may be defined as whatever a person needs to know and do with computers in order to function competently in our information-based society.

Computer literacy includes three kinds of competence: skills, knowledge, and understanding. It includes:

1. the ability to use and instruct computers to aid in learning, solving problems, and managing information;

2. knowledge of functions, applications, capabilities, limitations, and social implications of computers and related technology; and
3. understanding needed to learn and evaluate new applications and social issues as they arise." (pp. 8-9)

This broad definition allows teachers to express their individuality regardless of the vocational discipline that they represent. It permits tremendous variance from person-to-person, job-to-job, and time-to-time. The parameters of this definition do not include specialized skills and knowledge for careers in computer-related fields such as computer science, data processing, or systems engineering.

A CONCEPTUAL STRUCTURE FOR COMPUTER LITERACY

The definition of computer literacy was further refined by creating a conceptual structure or foundation of meaning. This structure was developed after a careful review of numerous course outlines, curriculum guides, and general goals for computer literacy. Lockheed (1983) states that this framework distinguished seven domains of computer literacy skills and knowledge:

Domain I — Administration

Administering computer-related policies and procedures for a school district or school. Includes such tasks as establishing computer literacy goals for students; establishing procedures for evaluating software; and assigning responsibility for teacher training. (p. 10)

Domain II — Teaching

Teaching with or about computers. Includes such tasks as teaching students how to use computer software; discussing social issues with students; assessing students' computer-related skills. (p. 10)

Domain III — Using Programs

Using suitably programmed computers as aids in learning, managing information, and solving problems. Includes such tasks as operating equipment; selecting the appropriate program for a given purpose; using a graphics program to graph data from a science experiment; using a word processor to aid in writing and editing a composition. (pp. 10-11)

Domain IV — Developing Programs

Developing procedures for solving a problem and writing the procedures in a form the computer can understand and carry out. Includes such tasks as defining a problem; giving a sequence of commands and instructions to the computer; testing and debugging a computer program. (p. 11)

Domain V — Analyzing Applications

Knowing capabilities and limitations of computers as they are used for various purposes. Includes such tasks as describing how people in the school district use computerized student records; deciding whether to use a computer to aid in a particular activity. (p. 11)

Domain VI — Social Issues

Understanding social issues related to computers and technology. Requires awareness of issues such as privacy, computer crime, job requirements, consumer concerns, sources, and effects of "computer errors." Involves identification of issues and parties in conflict. (p. 11)

Domain VII — Concepts and Terms

Understanding of the fundamental concepts and terms related to computers that are needed to use computers effectively and comfortably. Examples include understanding the concept of stored programs; and recognizing common ways of processing data, such as methods of searching, sorting, summarizing, and updating. (p. 11)

DEVELOPMENT OF A BATTERY OF COMPUTER LITERACY ASSESSMENT ITEMS

Experts serving on Lockheed's (1983) Advisory Panel developed 250 task statements for these seven domains. The Panel also carefully reviewed many instruments designed to assess the status of computer literacy. From information acquired through the review and the draft task statements, the Panel prepared draft versions of over 200 items. These experts raised substantive questions about the draft items and developed a second set of specifications. Finally, the Panel developed a comprehensive set of survey and resource items, intended to be used in computer literacy surveys.

A SELF-REPORT MEASURE OF COMPUTER LITERACY

Vocational educators can assess their personal and institutional level of competence in the seven domains of computer literacy. The self-report items included in the seven domains of this diagnostic-prescriptive instrument will enhance respondents' general understanding of computer awareness and enable them to quantify and qualify their computer literacy competency, as well as the basic capability of their institutions. This instrument, because it serves as a self-assessment, requires a realistic self-appraisal of each respondent's skills and knowledge.

Directions: As you read each item, place a checkmark in the space to the left of each response which is true for you, your school, or your program. Then sub-total the number of points which are recorded in each item and place the sub-total score in the appropriate blank on the right side of the page. Upon completing all items in a domain, add the item sub-totals together for a Domain Score.

Domain I — Administering Computer-Related Policies

I.1. Does your school have written goals for students' computer literacy? (Maximum = +2)

_________ Yes, in place (+2) I.1. Sub-Total _______
_________ Yes, in progress (+1)
_________ No (0)

I.2. How are computers used to support instruction in your school? Check all that apply: (Maximum = +4)

_________ Used for teaching and learning (+1) I.2. Sub-Total _______
_________ Used for instruction in programming (+1)
_________ Used as a tool in various subjects and courses (+1)
_________ Used for computer-managed instruction (+1)

I.3. How are computers used to support instruction in your program? Check all that apply: (Maximum = +8)

_________ Used for teaching and learning (+2) I.3. Sub-Total _______
_________ Used for instruction in programming (+2)
_________ Used as a tool in various subjects and courses (+2)
_________ Used for computer-managed instruction (+2)

I.4. In your school are there **specific rules** that govern any of the following? Check all that apply: (Maximum = +8)

_________ Protecting equipment from damage (+1) I.4. Sub-Total _______
_________ Protecting equipment from loss (+1)
_________ Destroying another person's data (+1)
_________ Disrupting the operation of the computer (+1)
_________ Scheduling or sharing equipment (+1)
_________ Scheduling or sharing programs (+1)
_________ Copying copyrighted programs (+1)
_________ Copying other students' graded computer work (+1)

I.5. Which of the following are methods or techniques used in your school to assess students' skills and knowledge of computer-related topics? Check all that apply: (Maximum = +6)

_________ Standardized tests (+1) I.5. Sub-Total _______
_________ Teacher-made tests (+1)
_________ Questionnaires (+1)
_________ Project evaluations (+1)
_________ Teachers' observations (+1)
_________ Others' observations (+1)

Domain I = I.1. + I.2. + I.3. + I.4. + I.5 = Domain Score (Maximum = 28)
___ + ___ + ___ + ___ + ___ = _____

Domain II — Teaching with or about Computers

II.1. Do you teach basic concepts about computers and information systems, such as the relationship between memory, central processing units, and input and output? (Maximum = +1)

_________ Yes (+1) II.1. Sub-Total _______
_________ No (0)

II.2. Do you teach how to develop computer-oriented algorithms and procedures? (Maximum = +1)

_________ Yes (+1) II.2. Sub-Total _______
_________ No (0)

II.3. Do you teach about the social implications of computer use, such as a job displacement or new job opportunities, dehumanization or better communications, dependency or increased productivity? (Maximum = +1)

_________ Yes (+1) II.3. Sub-Total _______
_________ No (0)

II.4. Do you teach about ethical issues related to computer use, such as privacy of data, copyright infractions, or electronic theft? (Maximum = +1)

_________ Yes (+1) II.4. Sub-Total _______
_________ No (0)

II.5. Do you teach about the general capabilities and limitations of computer use? (Maximum = +1)

_________ Yes (+1) II.5. Sub-Total _______
_________ No (0)

II.6. Do you teach about the capabilities and limitations of the particular computer applications you use in class? (Maximum = +1)

_________ Yes (+1) II.6. Sub-Total _______
_________ No (0)

II.7. In which of the following computer languages do you teach programming skills? Check all that apply: (Maximum = +10)

_________ APL (+1) II.7. Sub-Total _______
_________ Assembly Language (+1)
_________ BASIC (+1)
_________ COBOL (+1)
_________ FORTRAN (+1)
_________ LOGO (+1)
_________ PASCAL (+1)
_________ PILOT (+1)
_________ RPG (+1)
_________ Other ____________________ (+1)

II.8. How often do you use a computer as an aid when you are presenting or demonstrating concepts? (Maximum = +4)

_________ Never (0) II.8. Sub-Total _______
_________ Rarely (+1)
_________ Monthly (+2)
_________ Weekly (+3)
_________ Daily (+4)

II.9. For which of the following classroom *recordkeeping* activities do you use a computer as an aid? Check all that apply: (Maximum = +7)

_________ Attendance (+1) II.9. Sub-Total _______
_________ Grades (+1)
_________ Schedules (+1)
_________ Monitoring instructional progress (+1)
_________ Individual Educational Plans (IEPs) (+1)
_________ Standardized test scores (+1)
_________ Other ____________________ (+1)

II.10. Listed below are some computer activities that teachers can use to perform their jobs. Check all that apply: (Maximum = +16)

II.10. Sub-Total ______

______ For numerical calculations (+1)
______ To run simulations (+1)
______ For instructional games (+1)
______ As leisure time activity and reward (+1)
______ For student problem-solving (+1)
______ For drill-and-practice (+1)
______ As a tutor (teach content) (+1)
______ To demonstrate concepts (+1)
______ To score tests (+1)
______ As an instructional management aid (+1)
______ As a material generator (tests or worksheets) (+1)
______ For information retrieval (+1)
______ For student analysis of data (+1)
______ For word processing (+1)
______ For special needs students (+1)
______ To control laboratory equipment (+1)

II.11. Listed below are some computer activities that teachers can use to teach students about computers. Check all that apply: (Maximum = +9)

II.11. Sub-Total ______

______ To teach programming (+1)
______ To teach computer operation (+1)
______ To teach data processing (+1)
______ To teach hardware & software procedures (+1)
______ To teach history of computers (+1)
______ To teach how computers are applied (+1)
______ To teach about computer careers (+1)
______ To teach about the role and impact of computers in society (+1)
______ To teach problem solving (+1)

II.12. Which of the following sources of information about computing do you use at least once a month? Check all that apply: (Maximum = +14)

II.12. Sub-Total ______

______ Newspaper articles (+1)
______ Weekly computer periodicals (such as *Infoworld*) (+1)
______ General computer periodicals (such as *Popular Computing, BYTE Magazine, Consumer Report*) (+1)
______ Educational computing periodicals (such as *Electronic Learning, Classroom Computer Learning, The Computing Teacher, T.H.E. Journal*) (+1)
______ Professional periodicals (such as *Math Teacher, AEDS Monitor*) (+1)
______ Software catalogs (+1)
______ Regional teacher training centers (+1)
______ Colleagues and friends (+1)
______ Formal classes or workshops, including in-service (+1)
______ "User" or other professional groups (+1)
______ Electronic data services (such as The Source, Compuserve, EDUNET) (+1)
______ Magazines delivered on electronic media (+1)
______ Television/radio (+1)
______ Other______________________ (+1)

II.13. There are numerous types of computer teacher organizations that share resources. Which of the following organizations do you belong to? Check all that apply: (Maximum = +7)

II.13. Sub-Total ______

______ National organization of teachers whose major purpose is using computers (+1)
______ State organization of teachers whose major purpose is using computers (+1)
______ Local organization of teachers whose major purpose is using computers (+1)

_________ Local informal network or user group (+1)
_________ Computer special interest group in educational organization (+1)
_________ Education special interest group in computer organization (+1)
_________ Other_________________________ (+1)

Domain II = II.1. + II.2. + II.3. + II.4. + II.5. + II.6. + II.7 +
___ + ___ + ___ + ___ + ___ + ___ + ___ +

II.8. + II.9. + II.10. + II.11. + II.12. + II.13. = Domain Score (Maximum = 73)
___ + ___ + ___ + ___ + ___ + ___ =

Domain III — Using Computer Programs

III.1. Where have you received any training? Check all that apply:
(Maximum = +12) III.1. Sub-Total _______

_________ University or college (+1)
_________ Vocational-technical school (+1)
_________ Community college or junior college (+1)
_________ Community education program (+1)
_________ District in-service program (+1)
_________ Educational computer consortium (+1)
_________ Regional support or training center (+1)
_________ Computer store (+1)
_________ Computer camp (+1)
_________ Industry (+1)
_________ My training has been self-taught (+1)
_________ Other_________________________ (+1)

III.2. What types of computer-related courses or workshops have you taken since September, 1981? Check all that apply: (Maximum = +11)

_________ Learning a programming language (such as PASCAL, LOGO, or BASIC) (+1) III.2. Sub-Total _______
_________ Learning word processing (+1)
_________ Learning research applications (+1)
_________ Learning data processing (+1)
_________ Learning business applications (+1)
_________ A general introduction to computing course (+1)
_________ Learning about computer software and evaluation techniques (+1)
_________ Learning about computer hardware and evaluation techniques (+1)
_________ Learning authoring languages and courseware developments (+1)
_________ Learning about computer managed instruction (+1)
_________ Other, please specify_________________________ (+1)

III.3. What types of computer science courses or workshops have you taken? Check all that apply: (Maximum = +8)

_________ Introduction to Computer Science (+1) III.3. Sub-Total _______
_________ Modeling and simulation (+1)
_________ Survey of programming languages (+1)
_________ Advanced programming (+1)
_________ Artificial intelligence (+1)
_________ Data structures and algorithms (+1)
_________ File processing (+1)
_________ Information retrieval (+1)

III.4. Have you participated in any courses or workshops that included the following computer software packages in the content? Check all that apply: (Maximum = +10)

_________ Accounting (+1) III.4. Sub-Total _______
_________ Communications (+1)
_________ Data bases (+1)
_________ Gradebooks (+1)

_________ Graphics (+1)
_________ Simulations (+1)
_________ Spreadsheets (+1)
_________ Statistical analysis (+1)
_________ Word processing (+1)
_________ Other (+1)

III.5. Which of the following computer resources are available in your school? Check all that apply: (Maximum = +27)

III.5. Sub-Total _______

_________ Card punch (+1)
_________ Card reader (+1)
_________ Card monitor (+1)
_________ CRT or other video monitor (+1)
_________ Floppy disk drive (+1)
_________ Graphics plotter (+1)
_________ Graphics tablet (+1)
_________ Hard disk drive (+1)
_________ Joystick or game paddle (+1)
_________ Light pen (+1)
_________ Magazines (+1)
_________ Magnetic tape drive, including cassette (+1)
_________ Mainframe computer (+1)
_________ Microcomputer (+1)
_________ "Mouse" (+1)
_________ Music board (+1)
_________ Optical scanner (+1)
_________ Paper tape punch (+1)
_________ Paper tape reader (+1)
_________ Parallel or serial interface (+1)
_________ Persons to assist (+1)
_________ Printer (+1)
_________ Computer reference books and manuals (+1)
_________ Telephone modem (+1)
_________ Computer textbooks (+1)
_________ Voice synthesizer (+1)
_________ Other_____________________ (+1)

III.6. Which of the following computer devices have you personally used or operated? Check all that apply: (Maximum = +23)

III.6. Sub-Total _______

_________ Card punch (+1)
_________ Card reader (+1)
_________ Color monitor (+1)
_________ CRT or other video monitor (+1)
_________ Floppy disk drive (+1)
_________ Graphics plotter (+1)
_________ Graphics tablet (+1)
_________ Hard disk drive (+1)
_________ Joystick or game paddle (+1)
_________ Light pen (+1)
_________ Magnetic tape drive, including cassette (+1)
_________ Mainframe computer (+1)
_________ Microcomputer (+1)
_________ "Mouse" (+1)
_________ Music board (+1)
_________ Optical scanner (+1)
_________ Paper tape punch (+1)
_________ Paper tape reader (+1)
_________ Parallel or serial interface (+1)
_________ Printer (+1)
_________ Telephone modem (+1)

_________ Voice synthesizer (+1)
_________ Other_________________ (+1)

III.7. Which of the following kinds of programs are available for use in your program? Check all that apply: (Maximum = +14)

III.7. Sub-Total _______

_________ Simulations (+1)
_________ Business programs (e.g., spreadsheets) (+1)
_________ Math or statistics computation (+1)
_________ Text editing or word processing (+1)
_________ Tutorial programs (+1)
_________ Drill-and-practice programs (+1)
_________ Data base or file management programs (+1)
_________ Graphics programs (+1)
_________ Authoring language programs (+1)
_________ Telecommunication programs (+1)
_________ Compilers (+1)
_________ Recreational programs (+1)
_________ System utilities (+1)
_________ Other_________________ (+1)

III.8. How many single-user microcomputers or computer terminals do you have in your classroom or do your students have access to in your school? (Maximum = +10)

III.8. Sub-Total _______

_________ Number of single-user microcomputers
_________ Number of terminals
_________ Total (Maximum = +10)

III.9. Where do you have access to a computer outside of school? Check all that apply: (Maximum = +6)

III.9. Sub-Total _______

_________ At home (+1)
_________ At a friend's home (+1)
_________ At someone's place of work (+1)
_________ At a college or university (+1)
_________ At a library (+1)
_________ Other, please specify _________________ (+1)

III.10. Which of the following changes have occurred as a result of your use of computers in class? Check all that apply: (Maximum = +12)

III.10. Sub-Total _______

_________ Content of courses (+2)
_________ Grouping of students (+2)
_________ Pacing of instruction (+2)
_________ Pedagogical technique (+2)
_________ Time for individual attention (+2)
_________ Other_________________ (+2)

III.11. Which of the following sets of keys on a keyboard can you personally operate by "touch" typing? Check all that apply: (Maximum = +6)

III.11. Sub-Total _______

_________ Alphabet (+2)
_________ Numeric (+2)
_________ Function (For example, "enter" or "return") (+2)

III.12. How often do you personally use a word processing program or a computer dedicated to word processing? (Maximum = +4)

III.12. Sub-Total _______

_________ Never (0)
_________ Rarely (+1)
_________ Monthly (+2)
_________ Weekly (+3)
_________ Daily (+4)

III.13. How long have you personally been using a word processing program or a dedicated word processor (not necessarily the same program or computer)? (Maximum = +5)

III.13. Sub-Total _______

_________ I have not used a word processing program (0)

_________ Less than one month (+1)
_________ Two to four months (+2)
_________ Five months to a year (+3)
_________ 13-24 months (+4)
_________ More than 2 years (+5)

III.14. For which of the following types of documents do you personally use a word processing program or a computer dedicated to word processing? Check all that apply: (Maximum = +5)

III.14. Sub-Total _______

_________ Memoranda (+1)
_________ Letters (+1)
_________ Short reports or compositions (up to 19 pages) (+1)
_________ Long reports or compositions (20 or more pages) (+1)
_________ Other_________________________ (+1)

III.15. Which of the following outputs from a computer program have you produced or had produced for making decisions or solving problems? Check all that apply: (Maximum = +5)

III.15. Sub-Total _______

_________ Spreadsheets (+1)
_________ Charts and tables (+1)
_________ Graphs (+1)
_________ Drawings (+1)
_________ Other (+1)

III.16. Computers are frequently used to access data bases. Which of the following types of data bases have you personally accessed? Check all that apply: (Maximum = +10)

III.16. Sub-Total _______

_________ Career information (+1)
_________ Bibliographical citations (library) (+1)
_________ Stock market (+1)
_________ School or district data (Personnel, budget, inventory, etc.) (+1)
_________ Student records (+1)
_________ National press wire service (+1)
_________ Electronic bulletin board (+1)
_________ Computer courseware or other educational resources (+1)
_________ Recreational programs (+1)
_________ Other_________________________ (+1)

III.17. How often do you personally use commercially produced software (courseware) for teaching and learning in your program? (Maximum = +10)

III.17. Sub-Total _______

_________ Never (0)
_________ Rarely (+1)
_________ Monthly (+2)
_________ Weekly (+5)
_________ Daily (+10)

III.18. How often do you personally use software (courseware) that you developed for teaching and learning in your program? (Maximum = +10)

III.18. Sub-Total _______

_________ Never (0)
_________ Rarely (+1)
_________ Monthly (+2)
_________ Weekly (+5)
_________ Daily (+10)

Domain III = III.1. + III.2. + III.3. + III.4. + III.5. + III.6. +
___ + ___ + ___ + ___ + ___ + ___ +

III.7. + III.8. + III.9. + III.10. + III.11. + III.12. +
____ + ___ + ___ + ____ + ____ + ____ +

III.13. + III.14. + III.15. + III.16. + III.17. +
____ + ____ + ____ + ____ + ____ +

III.18. = Domain Score (Maximum = 188)
____ = _____

Domain IV — Developing Computer Programs

IV.1. Which of the following activities have you, yourself, performed with a computer? Check all that apply: (Maximum = +11)

IV.1. Sub-Total ______

- ________ Loaded a program into memory (+1)
- ________ Saved a program on a disk, tape, or cards (+1)
- ________ Name or renamed a program file (+1)
- ________ Listed a program (+1)
- ________ Backed up a copy of a program or file (+1)
- ________ Deleted a program from disk or tape (+1)
- ________ Erased computer memory (+1)
- ________ Accessed a catalog or menu or saved programs (+1)
- ________ Run a program (+1)
- ________ Tested and debugged a program (+1)
- ________ Other ____________________ (+1)

IV.2. In which of the following languages have you written a program? Check all that apply: (Maximum = +10)

IV.2. Sub-Total ______

- ________ APL (+1)
- ________ Assembly Language (+1)
- ________ BASIC (+1)
- ________ COBOL (+1)
- ________ FORTRAN (+1)
- ________ LOGO (+1)
- ________ PASCAL (+1)
- ________ PILOT (+1)
- ________ RPG (+1)
- ________ Other ____________________ (+1)

IV.3. What was the length, in lines, of the longest program you have written? (Maximum = +5)

IV.3. Sub-Total ______

- ________ 0, I have not written a program (0)
- ________ 1-10 lines or 1 procedure (+1)
- ________ 11-25 lines or 2-3 procedures (+2)
- ________ 26-50 lines or 4-10 procedures (+3)
- ________ 51-100 lines or 11-20 procedures (+4)
- ________ 101 or more lines or 21 or more procedures (+5)

IV.4. What is the longest program — written by someone else — that you have personally modified, edited, or changed in some way so that it would perform a different task? (Maximum = +3)

IV.4. Sub-Total ______

- ________ I have never changed a program (0)
- ________ 1-20 lines (approximately 1 screen) (+1)
- ________ 21-40 lines (approximately 2 screens) (+2)
- ________ 40 or more lines (+3)

IV.5. Have you, yourself, written a computer program containing any of the following elements? Check all that apply: (Maximum = +12)

IV.5. Sub-Total ______

- ________ Repetition or iteration (+1)
- ________ Conditional decisions ("if, then") (+1)
- ________ Use of variables (+1)
- ________ Logical operations (+1)
- ________ Arithmetic operations (+1)
- ________ Sound output (+1)
- ________ Graphical output (+1)
- ________ Using arrays (+1)
- ________ Using data files (+1)
- ________ Statements for accepting input from keyboard or other peripheral device (+1)
- ________ Format statements or image strings for outputting information on video display, printer, or other peripheral device (+1)
- ________ Other, please specify____________________ (+1)

IV.6. Which of the following sources of inaccuracies in program output have you experienced? Check all that apply: (Maximum = +6)

_________ The input data was inaccurate ("Garbage in/garbage out") (+1)

IV.6. Sub-Total _______

_________ The program "rounded off" inappropriately (+1)
_________ There was a logical error in the program (+1)
_________ The input data was called from the wrong memory location (wrong field, wrong variable, etc.) (+1)
_________ The program was inappropriate for the problem (+1)
_________ Other, please specify_______________________ (+1)

IV.7. Have you worked with a problem that required organizing a large amount of data? (Maximum = +5)

_________ Yes (+5)
_________ No (0)

IV.7. Sub-Total _______

IV.8. Which of the following aspects of algorithm development do you teach? Check all that apply: (Maximum = +6)

_________ I do not teach any of these (0)

IV.8. Sub-Total _______

_________ Hand simulation of an algorithm (+1)
_________ Ability to recognize basic algorithms (e.g., sorting, searching, making lists of things, repeating a task until a goal is reached) (+1)
_________ Algorithm testing by "Worst Case" inputs (+1)
_________ Design of a set of test data (+1)
_________ Determine how many arithmetic computations it will take to complete the algorithm (+1)
_________ Relative efficiency of different algorithms to solve the same problem (+1)

IV.9. Which of the following aspects of algorithm designs do you teach? Check all that apply: (Maximum = +5)

_________ I do not teach any of these (0)

IV.9. Sub-Total _______

_________ Flowcharts or other diagrams or algorithms (+1)
_________ English (or other) "pseudocode" for planning (+1)
_________ The concept of subtasks or procedures (+1)
_________ Top down design ("Consider the whole first, then details.") (+1)
_________ Treatment of error conditions (e.g., bad input data) (+1)

IV.10. Do you use a textbook that shows how to develop algorithms? (Maximum = +2)

_________ Yes (+2)
_________ No (0)

IV.10. Sub-Total _______

IV.11. Do you teach students to use a text or reference book to look up algorithms? (Maximum = +2)

_________ Yes (+2)
_________ No (0)

IV.11. Sub-Total _______

IV.12. Do a majority of your computer programming students write at least one complete user's guide (of any kind) during their school careers? (Maximum = +2)

_________ Yes (+2)
_________ No (0)

IV.12. Sub-Total _______

IV.13. Which of the following aspects of documentation and technical writing do you teach? Check all that apply: (Maximum = +6)

_________ Preparation of outlines before writing (+1)

IV.13. Sub-Total _______

_________ Teacher approval of outlines before writing (+1)
_________ Standard components of reference material (tutorial, component, summaries, errors, glossary, index, etc.) (+1)
_________ Use of word processing system to prepare drafts of a document (+1)
_________ Peer review of documents (+1)
_________ Rewriting and second review by teacher or peers (+1)
_________ Not applicable (0)

IV.14. Which of the following practices for debugging and testing of programs do you teach? Check all that apply: (Maximum = +5)

_________ Testing of small pieces of a program before it is all put together and tried (+1)

IV.14. Sub-Total _______

_________ Testing a program by putting in the largest, smallest, and most troublesome inputs (+1)

_________ Using "debugging" PRINT or output commands in your programs to see where execution is proceeding and what values are in the variables (+1)

_________ When a real mystery occurs, dividing the program in pieces with output commands, and successfully narrowing the problem location until the error is found ("Divide and conquer")(+1)

_________ Performance testing of programs: Measure the time or memory required to process various amounts of data (+1)

Domain IV = IV.1. + IV.2. + IV.3. + IV.4. + IV.5. + IV.6. +
___ + ___ + ___ + ___ + ___ + ___ +

IV.7. + IV.8. + IV.9. + IV.10. + IV.11. + IV.12. +
___ + ___ + ___ + ___ + ___ + ___ +

IV.13. + IV.14. = Domain Score (Maximum = 80)
___ + ___ = _____

Domain V — Analyzing Computer Applications

V.1. Many schools use computers for recording and accessing data about students and staff. Check all that apply: (Maximum = +7)

Who uses the computer:

V.1. Sub-Total _______

_________ Principal (+1)
_________ Teachers (+1)
_________ Special computer personnel (+1)
_________ Guidance counselors (+1)
_________ Secretaries, clerks (+1)
_________ Students (+1)
_________ Other_____________________ (+1)

V.2. What types of information are maintained in the computer system about students? Check all that apply: (Maximum = +14)

V.2. Sub-Total _______

_________ Classes requested (+1)
_________ Classes enrolled (+1)
_________ Grades received (+1)
_________ Homeroom assignment (+1)
_________ Standard test scores (+1)
_________ Honors (+1)
_________ School enrolled (+1)
_________ Personal profile (+1)
_________ Attendance (+1)
_________ Class schedule (+1)
_________ Residence (+1)
_________ Age (birth date) (+1)
_________ Telephone number (+1)
_________ Other_____________________ (+1)

V.3. What types of information are maintained in the computer system about staff? Check all that apply: (Maximum = +9)

V.3. Sub-Total _______

_________ Salary (+1)
_________ Residence (+1)
_________ Years of service (+1)
_________ Educational attainment (+1)
_________ Current grade level of classes (+1)
_________ Subject areas of current classes (+1)
_________ School (+1)
_________ Certification status (+1)
_________ Other_____________________ (+1)

V.4. What sorts of summary information do you retrieve or generate from the student record system at your school? Check all that apply: (Maximum = +9)

V.4. Sub-Total ______

______ Course enrollments (+1)
______ Student schedules (+1)
______ School or district standardized test score summaries (+1)
______ Busing schedules and routes (+1)
______ Attendance records (+1)
______ Room/building utilization (+1)
______ Grade point averages (+1)
______ Class ranks (+1)
______ Other______________________ (+1)

V.5. Which of the following groups utilize computer generated reports in your school? Check all that apply: (Maximum = +6)

V.5. Sub-Total ______

______ Administrative personnel (+1)
______ Guidance personnel (+1)
______ Instructional personnel (+1)
______ Students (+1)
______ Parents (+1)
______ Others______________________ (+1)

V.6. Before deciding to use or not to use computers, the following factors are often analyzed. Which of the following have you considered? Check all that apply: (Maximum = +17)

V.6. Sub-Total ______

______ Equipment acquisition costs (+1)
______ Equipment-related costs (+1)
______ Equipment availability (accessibility) (+1)
______ Hardware maintenance (+1)
______ Software maintenance (+1)
______ Software acquisition costs (+1)
______ Software-related costs (+1)
______ Software availability/accessibility/quality (+1)
______ Equipment capacity (memory) (+1)
______ Equipment capacity (CPU) (+1)
______ Textbook availability (+1)
______ Data gathering costs (+1)
______ Data storage costs (+1)
______ Data entry costs (+1)
______ Programming costs (+1)
______ Output capabilities (+1)
______ Other______________________ (+1)

Domain V = V.1. + V.2. + V.3. + V.4. + V.5. + V.6. = Domain Score (Maximum = 62)
___ + ___ + ___ + ___ + ___ + ___ = ______

Domain VI — Social Issues Related to Computers

VI.1. Which of the following data quality assurance activities have you done or directed someone else to do? Check all that apply: (Maximum = +9)

VI.1. Sub-Total ______

______ Established categories of data to be collected (+1)
______ Identified indicators or measures for data categories (+1)
______ Obtained data (+1)
______ Dealt with missing data (+1)
______ Changed data into a machine-readable form (+1)
______ Verified machine data against raw data (+1)
______ Conducted range check (+1)
______ Examined summary statistics, such as totals, means, and standard deviations (+1)
______ Other______________________ (+1)

VI.2. In your program, how often have you had intentional damage to computer equipment during the past year? (Maximum = +3)

VI.2. Sub-Total ______

______ 6+ times (0)
______ 3-5 times (+1)
______ 1-2 times (+2)
______ Never (+3)

VI.3. In your program, how often have you had computer equipment stolen during the past year? (Maximum = +3)

VI.3. Sub-Total ______

______ 6+ times (0)
______ 3-5 times (+1)
______ 1-2 times (+2)
______ Never (+3)

VI.4. In your program, how often have you had unauthorized changes of data during the past year? (Maximum = +3)

VI.4. Sub-Total ______

______ 6+ times (0)
______ 3-5 times (+1)
______ 1-2 times (+2)
______ Never (+3)

VI.5. In your program, how often have you had data stolen during the past year? (Maximum = +3)

VI.5. Sub-Total ______

______ 6+ times (0)
______ 3-5 times (+1)
______ 1-2 times (+2)
______ Never (+3)

VI.6. In your program, how often have you had copyrighted programs copied during the past year? (Maximum = +3)

VI.6. Sub-Total ______

______ 6+ times (0)
______ 3-5 times (+1)
______ 1-2 times (+2)
______ Never (+3)

VI.7. In your program, how often have you had passwords stolen during the past year? (Maximum = +3)

VI.7. Sub-Total ______

______ 6+ times (0)
______ 3-5 times (+1)
______ 1-2 times (+2)
______ Never (+3)

VI.8. In your program, how often have you had an operating computer system intentionally disrupted during the past year? (Maximum = +3)

VI.8. Sub-Total ______

______ 6+ times (0)
______ 3-5 times (+1)
______ 1-2 times (+2)
______ Never (+3)

VI.9. In your program, how often have you had students cheat on computer projects during the past year? (Maximum = +3)

VI.9. Sub-Total ______

______ 6+ times (0)
______ 3-5 times (+1)
______ 1-2 times (+2)
______ Never (+3)

VI.10. In the past year, have you been affected by a "computer error" in your school? (Maximum = +3)

VI.10. Sub-Total ______

______ Yes (0)
______ No (+3)

VI.11. If you were affected by a "computer error," how quickly was the error corrected? If you were not affected by a "computer error," think of an instance where someone else in your work environment was affected by a "computer error?" (Maximum = +5)

VI.11. Sub-Total ______

- ________ It has not been fixed (0)
- ________ In 3-4 weeks (+1)
- ________ In 1-2 weeks (+2)
- ________ Within one week (+3)
- ________ Within one day (+4)
- ________ Immediately upon being noticed (+5)

VI.12. In the past month, have you heard any complaints from students or parents about loss of jobs or curtailment of jobs due to the introduction of computers? (Maximum = +3)

VI.12. Sub-Total ______

- ________ Yes (0)
- ________ No (+3)

VI.13. In the past month, have you heard any students or parents tell you that they are using a computer in their job? (Maximum = +3)

VI.13. Sub-Total ______

- ________ Yes (+3)
- ________ No (0)

VI.14. Have you ever been required to interact with a computer when you would have preferred to interact with a person (for example, a bank machine teller instead of a human teller)? (Maximum = +3)

VI.14. Sub-Total ______

- ________ Yes (+3)
- ________ No (0)

VI.15. In the past month, how many complaints have you received from parents or students regarding computer-related invasion of privacy? (Maximum = +3)

VI.15. Sub-Total ______

- ________ 11-20 (0)
- ________ 4-10 (+1)
- ________ 1-3 complaints (+2)
- ________ None (+3)

VI.16. Which of the following actions have you never thought abo... with regard to having your personal privacy invaded by a computer? Check all that apply: (Maximum = +6)

VI.16. Sub-Total ______

- ________ Omitting certain information when filling out forms or applications (+1)
- ________ Requesting your name be removed from a list (+1)
- ________ Declining to provide your social security number (+1)
- ________ Complaining to government agencies (+1)
- ________ Writing to a legislator (+1)
- ________ Writing to the editor of a newspaper or magazine (+1)

VI.17. Which of the following actions have you taken in your school to protect the privacy of entries on a computerized data base? Check all that apply: (Maximum = +9)

VI.17. Sub-Total ______

- ________ Restricted or limited the data that was collected or entered into the data base (+1)
- ________ Identified individuals by identification number instead of names (+1)
- ________ Stored information necessary to link names with ID numbers in a separate location (+1)
- ________ Periodically purged data (+1)
- ________ Encoded all data (+1)
- ________ Restricted physical access to terminals (+1)
- ________ Assigned user "log on" ID to restrict access to data (+1)
- ________ Encrypted data when transferring from one location to another (+1)
- ________ Restricted physical access to data cards, tapes, or disks (+1)

VI.18. Do you (or any member of your family) have a computer at home? (Maximum = +3)

VI.18. Sub-Total ______

- ________ Yes (+3)
- ________ No (0)

Domain VI = VI.1. + VI.2. + VI.3. + VI.4. + VI.5. + VI.6. + VI.7. +
____ + ____ + ____ + ____ + ____ + ____ + ____ +

VI.8. + VI.9. + VI.10. + VI.11. + VI.12. + VI.13. +
____ + ____ + ____ + ____ + ____ + ____ +

VI.14. + VI.15. + VI.16 + VI.17. + VI.18. = Domain Score (Maximum = 71)
____ + ____ + ____ + ____ + ____ = ____

Domain VII — Computer-Related Concepts and Terms

VII.1. Which of the following operating systems have you personally used? (Maximum = +10)

VII.1. Sub-Total ____

____ CP/M (+1)
____ Apple DOS3.3 (+1)
____ TRSDOS (+1)
____ MS-DOS or PC-DOS (+1)
____ Unix (+1)
____ UCSD-p-system (+1)
____ Zenix (+1)
____ VMS (+1)
____ TSO (+1)
____ Other________ (+1)

VII.2. Which of the following data communication equipment or data terminal equipment have you used? (Maximum = +4)

VII.2. Sub-Total ____

____ Modem (+1)
____ Serial (RS232) or Parallel Interface (+1)
____ Port (+1)
____ Protocol Emulator or Converter (+1)

VII.3. Do you teach about how computers' speeds compare to non-computer methods for the same jobs? (Maximum = +2)

VII.3. Sub-Total ____

____ Yes (+2)
____ No (0)

VII.4. Do you teach about approximately how long (a minute? an hour? a week?) it would take a personal computer (such as an Apple II) or a large business-type computer (such as an IBM 370) to sort a thousand names alphabetically? (Maximum = +2)

VII.4. Sub-Total ____

____ Yes (+2)
____ No (0)

VII.5. Do you teach about what things computer speed depends upon besides the choice of physical computing hardware (e.g., choice of sorting algorithm, language in which the algorithm is expressed)? (Maximum = +2)

VII.5. Sub-Total ____

____ Yes (+2)
____ No (0)

VII.6. Do you teach about the relationship among the internal memory, central processing unit, input/output devices, and mass storage devices, and describe the flow of information and control? (Maximum = +2)

VII.6. Sub-Total ____

____ Yes (+2)
____ No (0)

VII.7. Which of the following items do you teach students so thoroughly that they can produce a sentence or paragraph explaining the term in relation to other given terms? Check all that apply: (Maximum = +33)

VII.7. Sub-Total ____

____ Algorithm (+1)

_________ Artificial intelligence (+1)
_________ Assembler (+1)
_________ Batch processing (+1)
_________ Central processing unit (+1)
_________ Compiler (+1)
_________ Computer-aided design (+1)
_________ Computer-aided manufacturing (+1)
_________ Computer operator (+1)
_________ Computer programmer (+1)
_________ CRT terminal (+1)
_________ Data base (+1)
_________ Data entry clerk (+1)
_________ Data processing (+1)
_________ Disk drive (+1)
_________ Higher level language (+1)
_________ Information retrieval (+1)
_________ Internal memory (+1)
_________ Interpreter (+1)
_________ Machine language (+1)
_________ Merging files (+1)
_________ Modeling and simulation (+1)
_________ Modem (+1)
_________ Operation system (+1)
_________ Pattern recognition (+1)
_________ RAM (+1)
_________ ROM (+1)
_________ Searching files (+1)
_________ Sorting files (+1)
_________ System analyst (+1)
_________ Tape drive (+1)
_________ Time sharing (+1)
_________ Updating files (+1)

Domain VII = VII.1. + VII.2. + VII.3. + VII.4. + VII.5. + VII.6. +
____ + ____ + ____ + ____ + ____ + ____ +

VII.7. = *Domain Score (Maximum = 55)*
____ = ______

CONVERSION OF DOMAIN SCORES TO PERCENTAGES

The following example can provide assistance for converting a respondent's scores on Domains I through VII to percentages.

Example Conversion

Divide the Respondent's Score on any given Domain by the Maximum Possible Score to obtain the Percentage Conversion (145 divided by 188 = .7713).

Domain III	Respondent's Score	Maximum Possible Score	Percentage Conversion
	145	188	77.13%

Example Scoring Table

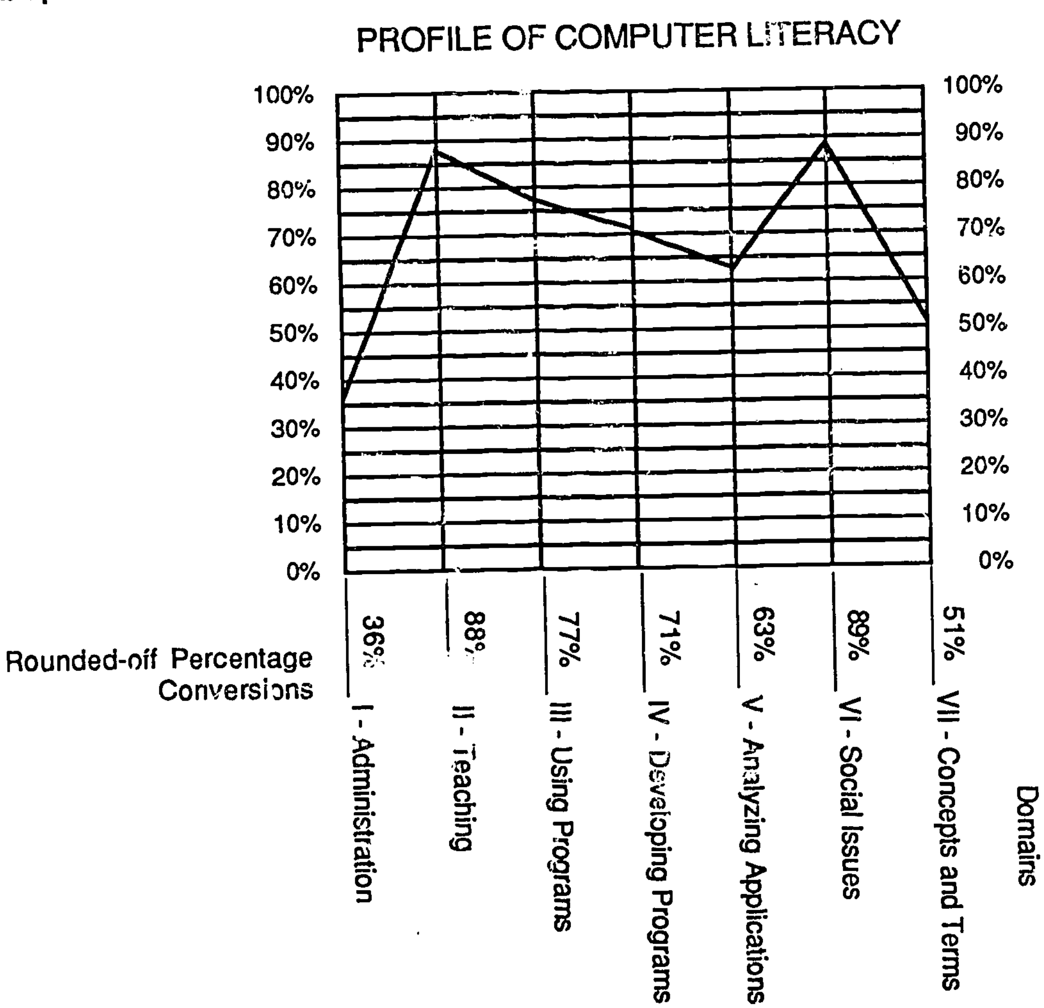
The respondent's scores and percentage conversions have been included on this example scoring table.

SCORING TABLE			
Domain	Respondent's Score	Maximum Possible Score	Percentage Conversion
I	10	28	35.71%
II	64	73	87.67%
III	145	188	77.13%
IV	57	80	71.25%
V	39	62	62.90%
VI	63	71	88.73%
VII	28	55	50.91%

GRAPHIC PROFILE OF SCORES ON DOMAINS I-VII

After converting Domain Scores to percentages, plot the percentage conversions on the Profile. Round off the percentages to the nearest whole number and plot these scores as near as possible to their exact location for the respective Domains. The following graph represents the scores and percentage conversions which are listed on the example scoring table.

Example Profile of Percentage Conversions



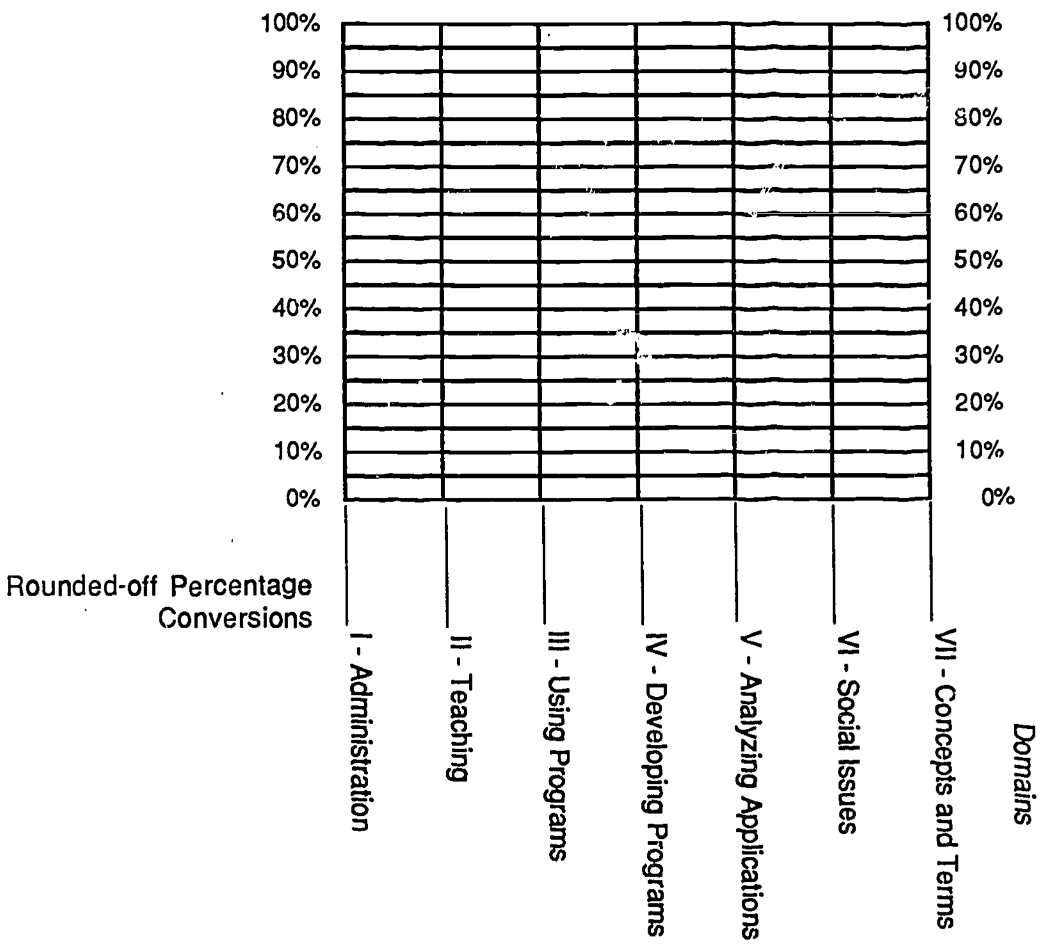
GRAPHING A PERSONAL PROFILE OF COMPUTER LITERACY

Record scores for the seven Domains in the Respondent's Score column. Then perform the necessary arithmetic to determine the percentages and record them in their respective space of the Percentage Conversion column.

SCORING TABLE			
Domain	Respondent's Score	Maximum Possible Score	Percentage Conversion
I		28	
II		73	
III		188	
IV		80	
V		62	
VI		71	
VII		55	

Round off the percentage conversions to the nearest whole number and record these percentages in the appropriate spaces on the Profile that follows. Then plot the percentages as near as possible to the exact location for each of the seven Domains. Next use a straight-edge to connect the points that have been plotted.

PROFILE OF COMPUTER LITERACY



SELF-IDENTIFICATION OF STRENGTHS AND WEAKNESSES

Based on a respondent's ratings and the profiled Percentage Conversions, the individual can determine his or her own strengths and weaknesses in the seven Domains of computer literacy. By analyzing one's own profile, each respondent can determine which Domains represent his or her strengths and weaknesses.

In the example profiled in this unit, the respondent's Percentage Conversions were 36%, 88%, 77%, 71%, 63%, 89%, and 51%, respectively, on Domains I through VII. An analysis of this example profile of computer literacy indicates that the strengths and weaknesses are represented as follows:

Example of Domain Strengths and Weaknesses

DOMAIN STRENGTHS		
Domain	Category	Percentage Conversion
II	Teaching	88%
VI	Social Issues	89%

DOMAIN WEAKNESSES		
Domain	Category	Percentage Conversion
I	Administration	36%
VII	Concepts and Terms	51%

Each respondent can identify his or her strengths and weaknesses on the following table:

DOMAIN STRENGTHS		
Domain	Category	Percentage Conversion

DOMAIN WEAKNESSES		
Domain	Category	Percentage Conversion

ACHIEVEMENT INDICATORS

1) Define the term computer literacy.
2) Discuss the conceptual structure, including the seven Domains, of computer literacy.
3) Respond to all items on the seven Domains of the self-assessment diagnostic-prescriptive computer literacy profile.
4) Record, convert, and profile the Domain scores on the self-assessment diagnostic-prescriptive computer literacy profile.
5) Identify individual strengths and weaknesses on the basis of percentage conversions on the seven Domains of the self-assessment diagnostic-prescriptive computer literacy profile.

PLANNING FOR MICROCOMPUTER COMPETENCY

The data available to respondents of this self-assessment diagnostic-prescriptive instrument can be utilized to achieve microcomputer competency or computer literacy. Following this unit of instruction, two units of instruction will assist individuals in achieving this competency. The following competencies are treated in these units:

Competency A.4 — Set Personal Goals for Microcomputer Competency

Competency A.5 — Construct a Personal Plan for Microcomputer Competency

Competency A.6 — Implement a Personal Plan for Microcomputer Competency

Competency A.7 — Evaluate Personal Plan Based on Computer Innovations

Competency A.8 — Modify Personal Plan as Needed

SUMMARY

This unit facilitates the process of conducting a personal and institutional assessment of microcomputer competency and computer literacy. The unit focuses on the impact of computer technology upon vocational education and provides a definition of computer literacy. The conceptual structure of the definition of computer literacy is described by seven Domains: I—Administration; II—Teaching; III—Using Programs; IV—Developing Programs; V—Analyzing Applications; VI—Social Issues; and VII—Concepts and Terms. These Domains, which represent the content of a self-assessment diagnostic-prescriptive profile, are presented in detail in the form of self-report items. Following the self-assessment instrument are examples and tables which enable participants to evaluate their personal levels of computer literacy or microcomputer competency, as well as the basic capability of their institutions. Finally, guidelines are presented which will enable individuals to plan for microcomputer competency.

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Unit 4

Setting Personal Goals and Constructing and Implementing a Personal Plan for Microcomputer Competency

UNIT OBJECTIVE

Upon completion of this unit, the learner will be able to establish a set of personal goals and to construct and implement a personal plan for microcomputer competency. The learner's ability to establish personal goals and construct and implement a personal plan for microcomputer competency will be demonstrated through the completion of the included activities and the unit achievement indicators.

SPECIFIC OBJECTIVES

Upon completion of this unit, the learner will:

1) Define the meaning of staff development.
2) Explain how individualized professional development is similar to staff development.
3) Discuss why professional development is important if an individual and/or his or her vocational program are going to grow.
4) List four features that characterize self-directed professional development.
5) Explain five principles that constitute "the foundation stones of modern adult learning theory."
6) Discuss the components of an Individual Computer Literacy Education Plan (ICLEP) and how it can facilitate the application of microcomputers in vocational programs.
7) List at least four reasons why teachers and administrators believe most in-service staff development activities are less than satisfactory.
8) Describe six met[illegible]s of improving in-service staff development activities.
9) Discuss the research that summarizes effective staff development programs.
10) List at least six of the recommended suggestions that might be of assistance in completing a Professional Development Plan (PDP).
11) Explain the eight components of PDP.
12) Record domain strengths and weaknesses from the self-assessment diagnostic-prescriptive computer literacy profile.
13) Record long-range goals that evolved from predetermined strengths and weaknesses on the computer literacy profile on the PDP.
14) Record short-term objectives that will facilitate the accomplishment of long-range goals on the PDP.
15) Record initial "Strategies, Techniques, or Methods" and "Materials or Resources" on the PDP.
16) Record dates when learning activities will be initiated to accomplish long-range goals and short-term objectives on the PDP.

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Utilizing Professional Development Plans to Enhance Vocational Educators' Abilities to Apply Microcomputers in Their Programs

BY: DR. DENNIS G. TESOLOWSKI

Professional development and staff development are similar processes with regard to their primary goal of providing learning or growth opportunities for involved participants. Both types of development must be based upon predetermined needs and a systematic approach to the intended growth areas. As B. D. Peterson (1981) stated:

> Staff development is a process designed to foster personal and professional growth for individuals within a respectful, supportive, positive organizational climate having as its ultimate aim better learning for students and continuous, responsible self-renewal for educators and schools. (p.3)

Rarely are individual development and institutional or programmatic development viewed as separate entities. However, in this case, from a professional development perspective, intended or planned individual growth may or may not represent programmatic growth or change. Each vocational teacher has the opportunity to develop a Professional Development Plan (PDP) that best serves his or her individual and/or programmatic needs.

The overall professional or staff development process must involve vocational teachers and administrators as students of teaching in a public, cumulative fashion. Regardless of how competent these professionals are, like actors, they need to continually study their profession. They must seek new options, polish the skills they possess, develop new skills, rethink their curricula, and make learning environments of schools more powerful (Joyce & Weil, 1980). The most effective professional or staff development activities combine theory, modeling, practice, feedback, and coaching to application (Joyce & Showers, 1980). If powerful training options are to be implemented, vocational teachers must become trainers of one another. Vocational educators must assist each other in learning to study theory, to demonstrate, to organize and practice, to give feedback, and, of critical importance, to coach one another in the classroom. Vocational teachers' capabilities to coach each other are vital to the overall productivity of any professional or staff development system (Joyce, 1981).

OVERVIEW OF SELF-DIRECTED DEVELOPMENT

Self-directed development is a process by which vocational teachers can systematically plan for their own professional growth (Glatthorn, 1984). Through the use of an individualized Professional Development Plan, vocational educators can conscientiously implement their personal plan over a predetermined period of time. This approach to professional or staff development works most effectively with vocational instructors who are experienced and competent teachers, skilled in self-analysis and self-direction, and enjoy working on their own or with colleagues. The value of self-directed development is that it appears to increase teachers' insight about and ability to achieve professional growth. Ideally, vocational teachers will discuss their PDPs with some other professional(s), such as a colleague, department chairman, or principal, after it has been written. Ultimately, the successful use of a PDP will rest upon the creation of meaningful and achievable goals and objectives. Vocational teachers' goals may or may not be directly related to the goals of their program or local educational agency (LEA). It should be noted that a written plan will probably facilitate self-directed growth.

Self-directed development is a process of professional growth characterized by the following four features:

1. The individual works independently on a program of professional growth ....
2. The individual develops and follows a goal-oriented program of professional improvement ....
3. The individual has access to a variety of resources in working toward those goals ....
4. The results of the self-directed program are not used in evaluating teacher performance. (Glatthorn, 1984, pp. 49-50)

Advocates of the self-directed development model primarily base their argument on the individualized needs of teachers, the nature of adult education, and the professionalism of teaching. Similar to other educators, vocational teachers have distinct individualized needs and learning styles. If vocational instructors prefer organized and systematic staff development programs, then they must identify workshops or courses that are available and include them as activities in their PDP.

Some principles for facilitating adult learning are generally accepted regardless of one's stage of development. These principles have broad-based endorsement and some empirical support (Bents & Howey, 1981). According to Knowles (1978), these five principles constitute "the foundation stones of modern adult learning theory":

1. Adults are motivated to learn as they experience needs and interests that learning will satisfy; therefore, these needs and interests are appropriate starting points for organizing adult learning activities.
2. Adult orientation to learning is life-centered; therefore, the appropriate units for organizing adult learning are life situations, not subjects.
3. Experience is the richest resource for adult learning; therefore, the core methodology of adult education is the analysis of experience.
4. Adults have a deep need to be self-directing; therefore, the role of the teacher is to engage in a process of mutual inquiry rather than to transmit knowledge to them and then evaluate their conformity to it.
5. Individual differences among people increase with age; therefore, adult education must make optimal provision for differences in style, time, place, and pace of learning. (p. 31)

Vocational teachers vary in the degree to which they can and want to participate in self-directedness, in their ability and desire to work collaboratively, and in their competence to deal with conceptual problems and universal principles as well as practical concerns. These differences are often related to developmental stages. Teachers need to possess a clear understanding of others' expectations of their role. The adoption of a simple system which assists vocational educators in understanding what it is that they are expected to learn and do can increase their self-awareness and role awareness. This understanding is necessary in order to grow professionally. Therefore, professional development in the form of adult learning must take into account the **professional performance** of teachers and **how this performance is determined** by such factors as personal goals, strengths, needs, and beliefs (Bents & Howey, 1981).

THE NEED FOR AN INDIVIDUALIZED "PROFESSIONAL DEVELOPMENT PLAN"

The need for vocational educators to be involved with a "Professional Development Plan" has been clearly called for by David Moursund, editor-in-chief of *The Computing Teacher.* Moursund (1983) indicates that a contemporary need has arisen for educators: Educators need a modern, realistic awareness of the current and potential capabilities of computers as well as of their limitations. This awareness can be acquired through reading, hands-on experiences, talking to others, thinking about computers, and attending conferences and workshops. But what follows after vocational educators have achieved computer awareness? Moursund (1983) indicates that educators must make a new commitment to their students and themselves through an Individual Computer Literacy Education Plan (ICLEP).

The concept of the ICLEP is relatively simple. It requires each educator to assume the responsibility for his or her own computers-in-education literacy by developing a plan to acquire a professional level of computer competency. Moursund states that each instructor is the most qualified person to determine his or her specific professional and programmatic needs for computer literacy, knowledge, and skills. Although outside assistance may be desirable in gaining initial computer awareness, an ICLEP can aid educators in focusing on general computer literacy and specific needs associated with their professional responsibilities. The latter will certainly change along with state-of-the-art computer technology. ICLEPs should include short-term goals, long-term goals, specific objectives, and methods of measuring progress toward these objectives. In addition, each plan must have a timeline which permits individuals to review their progress on goals and objectives. As Moursund implies, the key to success is professionalism: Each vocational educator must accept the responsibility for applying microcomputers in his or her personal life and vocational program. This powerful idea has the potential to dramatically improve vocational education programs (Tesolowski, Wallin, Roth, & Rankin, 1984).

DEVELOPING AN EFFECTIVE PROFESSIONAL OR STAFF DEVELOPMENT PROGRAM

Traditionally, educators have had negative attitudes toward in-service staff development activities. Studies conducted at state and national levels during the past ten years have consistently suggested that the majority of teachers, administrators, and college personnel are not satisfied with staff development programs (Arnsworth, 1976; Brimm & Tollett, 1974; Zigarmi, Betz, & Jensen, 1977).

Problems that have been identified related to in-service programs include: poor planning and organization; lack of participant involvement in the planning and implementation of the in-service; utilization of activities that are impersonal and unrelated to the day-to-day problems of participants; inadequate needs assessment; unclear objectives; and the lack of follow-up in the classroom or job setting after training has been concluded. When these problems are coupled with what is known about adult learning and motivation, it becomes apparent that in-service educators and trainers could benefit from a set of guidelines. Wood and Thompson (1980) suggest the following six recommendations:

1. Include more participant control over the "what" and "how" of learning;
2. Focus on job related tasks that the participants consider real and important;
3. Provide choices and alternatives that accommodate the differences among participants;
4. Include opportunities for participants in in-service training to practice what they are to learn in simulated and real work settings as part of their training;
5. Encourage the learners to work in small groups and to learn from each other; and
6. Reduce the use and threat of external judgments from one's superior by allowing peer-participants to give each other feedback concerning performance and areas of needed improvement. (p.376)

A synthesis of research on staff development tends to support these six recommendations. The ERIC Clearinghouse on Education Management (1980) summarized numerous research studies and stated that effective staff development programs:

* are concrete and aimed at specific skills
* emphasize demonstrations and opportunities for staff to practice the new skills and receive feedback
* are individualized to address the requirements of each participant and to relate to on-the-job needs
* are ongoing—stretching throughout the school year
* are held at school rather than elsewhere
* include opportunities to observe other teachers who have mastered and are practicing the skills being taught. (p.184)

As vocational educators begin to think about creating their own Professional Development Plan, hopefully they will reflect upon the recommendations and summary of research that have been presented. Vocational teachers should develop their own PDPs with the same intensity that they would exhibit while preparing a course for their vocational programs. Some additional suggestions that might be of assistance in completing a PDP include:

1. Conduct a needs assessment in order to focus the plan. Remember the importance of not trying to do too much (see Unit of Instruction of Competency A.3).
2. Set specific, practical objectives for the plan.
3. Consult with other individuals who have expertise related to computers. Do not allow anyone else to dictate what should be included on a plan.
4. Work on the plan as well as the implementation of it at convenient times.
5. Build a variety of learning opportunities into the plan. Be sure to include many hands-on experiences.
6. Include at least one immediately useful computer application in the plan.
7. Plan to spend at least one day, as soon as possible, making friends with the computer.
8. Do not focus on computer programming unless it will serve as a positive benefit and experience.
9. Build some type of a follow-up system into the plan. ("Home-Grown Computer Instruction Deemed Best," 1984, June 6)

PREPARING TO DEVELOP A PROFESSIONAL DEVELOPMENT PLAN

Successful developmental activities must be based upon predetermined needs. Three forms of needs assessments are commonly used:

1. Individuals in supervisory positions determine needs from their assessment of the quality of work being performed by people who work under their supervision.
2. Persons are asked to state their own perceived needs or to respond to a rating instrument or checklist.

3. Groups of professionals from schools, divisions, departments, or teams respond to various external or internal pressures by planning collaboratively to create specific changes. (Peterson, 1981)

Within a local educational agency (LEA), all three processes may operate simultaneously. This Unit of Instruction on Competencies A.4, A.5, and A.6 is primarily concerned with self-assessment or the individualized approach to planning, developing, and implementing professional growth activities (Roth, Tesolowski, Rankin, & Blackman, 1984). The greatest advantage of this approach toward professional or staff development is that it permits almost complete autonomy on the part of those for whom developmental activities are intended (Peterson, 1981).

All of the Units of Instruction included in this resource guide are intended to be utilized across the entire continuum of potential pre-service staff development activities. These Units of Instruction, which focus on the 47 competencies on the "Vocational Teacher Competency Profile for Microcomputer Applications," have been specifically developed so that they can be used by vocational educators as self-instructional materials or as instructional materials in formal staff development activities or university courses.

In particular, these materials can be utilized to facilitate professional growth on the part of vocational educators. Units of Instruction can be used to individualize professional development regardless of whether these learning activities are formal or informal. Research has demonstrated that individualized staff development activities tend to be more effective than those that present uniform experiences to all participants (Lawrence, 1974). Hopefully, these materials, including the use of a PDP, will lend themselves to a relatively individualized staff development format. Research has also documented the fact that teachers can learn from self-instructional materials as well as they can learn from trainers or course instructors (Edwards, 1975; Glatthorn, 1984; Kulik, Kulik, & Cohen, 1980).

CONSTRUCTING AND IMPLEMENTING A PDP

A properly developed Professional Development Plan can serve as the critical link between vocational teachers and the appropriate application of microcomputers in their programs. The PDP should serve as a management tool. Essentially, the plan should permit any vocational educator to determine and understand what it is that he or she really wants to know about and do with microcomputers. The process of constructing and implementing a PDP should assist vocational educators in:

1. Acquiring responsibility for their own learning.
2. Developing a positive attitude toward learning about computer technology through success oriented activities.
3. Being active learners, rather than passive learners.
4. Experiencing learning activities that are consistent with their own individual needs, interests, and abilities. (Bishop, 1976)

Components of the PDP

The Professional Development Plan can serve as a vehicle for vocational educators to make an individualized commitment toward learning more about computer technology. A PDP can assist vocational teachers in expanding their personal level of computer awareness or computer literacy. Furthermore, it can be used to increase an individual's ability to apply microcomputers in his or her vocational program.

Components that must be addressed in an individualized PDP include:

1. A review of each vocational educator's personal level of performance and knowledge related to computer literacy or the application of microcomputers in his or her program (see the Unit of Instruction entitled "Conduct A Personal Assessment of Microcomputer Competency" — Competency A.3).
2. A statement of long-range goals based on identified strengths and weaknesses from the self-assessment diagnostic-prescriptive computer literacy profile (see Competency A.3). These goals must also be based upon other self-identified needs.
3. A statement of short-term objectives that evolve from the needs created by the identified long-range goals.
4. A statement of strategies, methods, or techniques that can be utilized to accomplish the short-term objectives.
5. A statement of materials and resources that can be used to facilitate the accomplishment of short-term objectives through the identified strategies, methods, or techniques.

6. A statement of the date on which any activities related to a specific short-term objective were initiated.
7. A statement of the date on which all activities related to a specific short-term objective have been terminated.
8. A statement that indicates whether or not a specific short-term objective has been mastered.

These eight components comprise the integral parts of the Professional Development Plan. It must be remembered that successful use of the PDP hinges upon an honest self-appraisal and the ultimate establishment of important and realistic long-range goals and short-term objectives.

Assessing personal needs. By this time, vocational educators who are using this Unit of Instruction should have completed the self-assessment diagnostic-prescriptive computer literacy profile that was included in the Unit of Instruction for Competency A.3. This profile can be used to address a vocational educator's individualized level of competence in relationship to the seven domains of computer literacy. As a result of completing this profile, vocational educators should have a better general understanding of computer awareness. Furthermore, the profile should enable vocational teachers to quantify and qualify their personal levels of computer literacy or microcomputer competency as well as the basic capabilities of their institutions. This instrument is intended to serve as a self-assessment. In order for the results to have any validity, realistic self-appraisals of respondents' skills and knowledges are necessary.

Vocational instructors who have already responded to the profile should have tabled their domain scores and percentage conversions. In addition, they should have already plotted or graphed their percentage conversions for the seven domains on the Profile of Computer Literacy. Finally, each vocational educator should have recorded his or her domain strengths and weaknesses on the appropriate table. At this time, transfer the domain strengths and weaknesses and percentage conversions to the following table.

DOMAIN STRENGTHS		
Domain	Category	Percentage Conversion

DOMAIN WEAKNESSES		
Domain	Category	Percentage Conversion

The next step in the process of developing a PDP is to carefully analyze the information that has been recorded on this table. If necessary, return to the Unit of Instruction on Competency A.3 and review the definitions for each domain as well as the respective items in each domain. This information, coupled with any other self-identified needs, should be used to write corresponding long-range goals. As an example, long-range goals will be developed for the following domain strengths and weaknesses that were tabled.

DOMAIN STRENGTHS		
Domain	Category	Percentage Conversion
II	Teaching	88%
VI	Social Issues	89%

DOMAIN WEAKNESSES		
Domain	Category	Percentage Conversion
I	Administration	36%
VII	Concepts and Terms	51%

Setting long-range goals. The formulation of long-range goals and the resulting short-term objectives constitutes the plan by which a given vocational teacher intends to develop his or her microcomputer competency. If careful thought is put into developing long-range goals, anticipated professional growth can be planned for up to one year. Vocational educators must remember that it is unreasonable to establish more than four long-range goals. Furthermore, it should be noted that long-range goals can be drawn from strengths or weaknesses.

The establishment of goals should be based primarily upon each vocational teacher's self-identified needs, either personal needs or programmatic needs. An attempt should be made to incorporate identified strengths that will facilitate the accomplishment of determined needs. Preferably, goals should be tied to performance whenever possible. The more specific goals are, the easier it will be to determine when they have been accomplished. While goals need not be quantifiable, they should be clear and unambiguous (Glatthorn, 1984). The completed PDP that has been included in this Unit of Instruction includes goals that have been developed in conjunction with the domain strengths and weaknesses that were presented prior to this section.

Creating short-term objectives. The model upon which the PDP has been established requires vocational educators to focus on identifying the learning task. Vocational teachers are well aware of the fact that performance or behavioral objectives are commonly characterized by three qualities:

1. The performance to be attained is identified.
2. Conditions under which the behavior is to occur is stated.
3. Criteria or standards for judging the performance are included. (Bishop, 1976; Mager,1975)

In creating a PDP, vocational educators must record their expected performances in the form of short-term objectives. Hopefully, objectives will be written in as specific behavioral terms as possible. Essentially, these short-term objectives should be written in terms of what the vocational instructor wishes to accomplish as a result of various learning activities. The completion of a short-term objective should facilitate the accomplishment of a portion of the corresponding long-range goal.

If short-term objectives are properly stated, they can make it easier to determine when they have been accomplished, even though criteria or standards may not be included. As long-range goals or short-term objectives are initiated or concluded, the corresponding dates should be recorded on the PDP. Furthermore, whether or not the goals or objectives have been successfully accomplished should be indicated.

Remember that it is extremely important to formulate small, achievable short-term objectives that will facilitate the accomplishment of long-range goals. Try to make each short-term objective one that can be accomplished in four weeks or less. In addition, attempt to sequence the objectives in a fashion that will permit a broad-base of knowledge and skills to be developed. Initially, attempt to write at least two short-term objectives for each long-range goal. At a later date, as progress is made on the PDP, additional short-term objectives can be developed.

Completing the final components of the PDP. As long-range goals and short-term objectives are developed, it is important to begin thinking about how the objectives can be accomplished. The second and third components of the PDP deal with (a) strategies, techniques, or methods and (b) materials or resources. These components can be used either in conjunction with each other or independently to facilitate the accomplishment of the goals and objectives.

When addressing the PDP component on "Strategies, Techniques, or Methods," it is necessary to begin thinking about what learning activities are available in one's local community that will be of assistance in mastering a specific objective(s). Vocational teachers should explore the availability of staff development activities with universities, state departments of education, community colleges, and post-secondary vocational-technical institutions, as well as their own local educational agencies. Simultaneously, while exploring these opportunities, vocational teachers must quickly review the overall content of all of the Units of Instruction in this entire Resource Guide. Note that the use of this Resource Guide is only one of many strategies, techniques, or methods that can be used to facilitate the accomplishment of specific objectives.

As Units of Instruction are identified in relationship to specific short-term objectives, it is important to indicate the unit itself and/or selected pages on the PDP component entitled "Materials or Resources." Subsequently, the use of a Unit of Instruction, in whole or part, should be indicated on both of these components of the Professional Development Plan.

Participants should indicate the dates on which they initiated learning activities to facilitate the accomplishment of a specific short-term objective(s). They should also record the dates on which they have completed or terminated various learning activities. Finally, it is important that vocational educators indicate whether or not they have accomplished their long-range goals and short-term objectives.

A Sample PDP

A Professional Development Plan based on strengths and weaknesses, which were presented earlier, follows this section. Vocational teachers may desire to develop more comprehensive PDPs than this plan. Following the sample PDP is a blank form that can be reproduced and used for writing individualized plans. Only one long-range goal should be written and developed on a single page of the PDP. It is important to remember that most vocational educators should not work on more than four long-range goals during any specific period of time. PDPs are dynamic and they will need to be modified as individuals' needs and the state-of-the-art of computer technology changes.

PROFESSIONAL DEVELOPMENT PLAN (PDP)

Stanislaw Zabrowski

Date Goal was Initiated September 1,

Date Goal was Concluded May 12, 198

Range Goal - 1) To become familiar with and know how to operate several different types or brands of microcomputers.

erm Objectives	Strategies, Techniques, or Materials	Materials or Resources	Date Initiated	Date Concluded	Accomplish YES
Stanislaw has pertise operating e IIe.					
ate an Apple ntosh	1. Operate an Apple MacIntosh for at least 8 hours with some assistance from a colleague.	1. Software recommended by colleague	9/01/84	9/12/84	X
ate an IBM PC	2. Enroll in a University course.	2. Reference Text Book	1/10/85	5/12/85	X
ate a TRS 80	3. Participate in a workshop through the LEA.	3. Workshop Handouts	11/02/84	11/3/84	X
ect simple ating errors pple MacIntosh BM PC RS 80	4. Actual hands-on performance	4. Assorted software	9/01/84	5/12/85	a.X b.X
ire knowledge computer-related epts and terms	5a. Study a beginning level computer book		9/15/84	12/15/84	X
	5b. Enroll in a University course	5b. Reference text book	1/10/85	5/12/85	X
	5c. Participate in a LEA Workshop	5c. Workshop Handouts	9/27/85	9/27/85	X

PROFESSIONAL DEVELOPMENT PLAN (PDP)

Stanislaw Zabrowski

Date Goal was Initiated October 14, 19

Date Goal was Concluded May 15, 1985

ange Goal -2) To become familiar with computer software that is appropriate for my vocational program.

rm Objectives	Strategies, Techniques, or Materials	Materials or Resources	Date Initiated	Date Concluded	Accomplishe YES	
t appropriate are for specific uctional ses	1. Read Resource Guide	1. Competency C.4	10/15/84	10/30/84	X	
ify sources of rcially ced software	2a. Review assorted computer periodicals		10/15/84	5/15/85	X	
	2b. Participated in LEA Workshop	2b. Workshop Handouts	4/02/85	4/04/85	X	
re uctional ials to pany software	3. Read Resource Guide	3. Competency C.7	12/15/84	12/30/84	X	
t software for room manage- activities	4. Read Resource Guide	4. Competency E.2	1/01/85	1/15/85	X	
strate an ness of micro- ter software eveloping ter based ional culum	5. Read Resource Guide	5. Competency B.4	5/01/85	5/15/85	X	

PROFESSIONAL DEVELOPMENT PLAN (PDP)

Stanislaw Zabrowski

Date Goal was Initiated January 16, 1

Date Goal was Concluded May 15, 1985

ange Goal -3) To increase my knowledge of the ethical and legal problems involved in the use of the microcomputer.

m Objectives	Strategies, Techniques, or Materials	Materials or Resources	Date Initiated	Date Concluded	Accomplishe YES
y simple soft- for specific uctional ses	1. Read Resource Guide	1. Competency C.5	1/16/85	1/30/85	X
y software entation for fic instruc- l purposes	2. Read Resource Guide	2. Competency C.8	2/01/85	2/15/85	X
lish micro- ter user ity	3. Read Resource Guide	3. Competency D.5	2/16/85	2/28/85	X
lish micro- ter hardware/ are security	4. Read Resource Guide	4. Competency D.6	3/01/85	3/15/84	X
e authorized up copies of computer are	5. Read Resource Guide	5. Competency D.7	3/16/85	3/31/85	X

PROFESSIONAL DEVELOPMENT PLAN (PDP)

Stanislaw Zabrowski

Date Goal was Initiated April 1, 198

Date Goal was Concluded May 15, 1985

ange Goal - 4) To integrate microcomputers into my existing vocational curriculum.

rm Objectives	Strategies, Techniques, or Materials	Materials or Resources	Date Initiated	Date Concluded	Accomplishe YES
ify job-specific cations of the computer for sion in the ional curriculum	1. Read Resource Guide	1. Competency B.1	4/01/85	4/15/85	X
ify educational cations of the computer for sion in the ional curriculum	2. Read Resource Guide	2. Competency B.2	4/16/85	4/30/85	X
op a plan to CBI to the ional curriculum	3. Read Resource Guide	3. Competency B.3	5/01/85	5/15/85	X

PROFESSIONAL DEVELOPMENT PLAN (PDP)

Stanislaw Zabrowski

Date Goal was Initiated June 1, 1985
Date Goal was Concluded September 1,

Range Goal -5) To increase my knowledge and ability to use microcomputers for time-saving classroom management functions.

erm Objectives	Strategies, Techniques, or Materials	Materials or Resources	Date Initiated	Date Concluded	Accomplish YES
tanislaw is ly ambitious has elected to the rule about ating more than ng-range goals.					
rmine classroom gement activities	1. Read Resource Guide	1. Competency E.1	6/01/85	6/15/85	X
	1b. Enroll in University course	1b. Reference Text books	6/15/85	7/30/85	X
ew what class- management vities can be mplished with ocomputers	2. Read Resource Guide	2. Competencies E.4, E.5, E.6, E.7, E.8, E.9, and E.10	7/01/85	9/01/85	X
are Software for sroom manage- activities	3. Read Resource Guide	3. Competency E.3	8/01/85	8/30/85	X

PROFESSIONAL DEVELOPMENT PLAN (PDP)

Date Goal was Initiated ____________

Date Goal was Concluded ____________

Range Goal - ____

____

erm Objectives	Strategies, Techniques, or Materials	Materials or Resources	Date Initiated	Date Concluded	Accomplish YES

SUMMARY

This Unit of Instruction explains the process of setting personal goals and constructing and implementing a Professional Development Plan for microcomputer competency. The unit is designed to be used in conjunction with the Units of Instruction on Competencies A.1, A.2, and A.3. Preferably, all four of these units should be thoroughly utilized prior to reading the remaining Units of Instruction in Categories B, C, D, and E in this Resource Guide.

Prior to actually developing a PDP, this unit defined for vocational educators the meaning and value of both staff development and individualized self-directed professional development. The reasons for most staff development activities being perceived as being unsuccessful were explained. Then, research describing effective staff development activities and methods of improving in-service staff development were discussed.

The need for developing a PDP is discussed in relationship to the component parts of an Individual Computer Literacy Education Plan. Suggestions are then made for completing a PDP and the component parts of a PDP were discussed. Finally, a sample Professional Development Plan and one blank PDP is included.

ACHIEVEMENT INDICATORS

1. Define the meaning of staff development.
2. Explain how individualized professional development is similar to staff development.
3. Discuss why professional development is important if an individual and/or his or her vocational program are going to grow.
4. List four features that characterize self-directed professional development.
5. Explain five principles that constitute "the foundation stones of modern adult learning theory."
6. Discuss the components of an Individual Computer Literacy Education Plan (ICLEP) and how it can facilitate the application of microcomputers in vocational programs.
7. List at least four reasons why teachers and administrators believe most in-service staff development activities are less than satisfactory.
8. Describe six methods of improving in-service staff development actiities.
9. Discuss the research that summarizes effective staff development programs.
10. List at least six of the recommended suggestions that might be of assistance in completing a Professional Development Plan (PDP).
11. Explain the eight components of a PDP.
12. Record domain strengths and weaknesses from the self-assessment diagnostic-prescriptive computer literacy profile.
13. Record long-range goals that evolve from predetermined strengths and weaknesses on the computer literacy profile on the PDP.
14. Record short-term objectives that will facilitate the accomplishment of long-range goals on the PDP.
15. Record initial "Strategies, Techniques, or Methods" and "Materials or Resources" on the PDP.
16. Record dates when learning activities will be initiated to accomplish long-range goals and short-term objectives on the PDP.

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Unit 5

Evaluating and Modifying a Personal Plan for Microcomputer Competency

UNIT OBJECTIVE

Upon completion of this unit, the learner will be able to evaluate his or her personal plan based on computer innovations and modify the plan as needed. The learner's ability to evaluate and modify his or her personal plan for microcomputer competency will be documented through the completion of the unit activities and self-achievement indicators.

SPECIFIC OBJECTIVES

Upon completion of this unit, the learner will:

1) List at least three suggestions for assisting vocational teachers in staying abreast of this expanding technology.
2) Discuss at least three positive benefit outcomes that can evolve from creating and implementing a Professional Development Plan (PDP).
3) List at least two positive and two negative aspects of having vocational educators conduct a self-evaluation process in conjunction with their PDPs.
4) Discuss basic considerations for evaluating whether or not long-range goals and short-term objectives have been accomplished.
5) Explain the ultimate benefit of utilizing a self-evaluation process in conjunction with the PDP.
6) Conduct a follow-up self-assessment of microcomputer competency using all seven domains of the computer literacy profile in the Unit of Instruction on Competency A.3.
7) Record domain scores, calculate percentage conversions, and plot percentage conversions from this second phase self-assessment using the computer literacy profile on their respective tables.
8) Identify domain strengths and weaknesses on the basis of the results on this second phase self-assessment using the computer literacy profile.
9) Develop a revised Professional Development Plan on the basis of this second phase self-assessment using the computer literacy profile as well as the professional growth that has been achieved as a result of the initial PDP.
10) Explain why educational computing will continue to expand.

Evaluating and Modifying Professional Development Plans to Further Enhance Vocational Educators' Abilities to Apply Microcomputer in Their Programs

BY: DR. DENNIS G. TESOLOWSKI

Vocational educators who have thoroughly read the Units of Instruction for Competencies "A.3" and "A.4, A.5, and A.6" have built the foundation for more effectively applying microcomputers in their programs. The integration of computer technology into vocational curricula can be thoroughly enhanced by completing the required tasks in these units. As vocational teachers implement their Professional Development Plans (PDPs), they will find it necessary to continually make revisions of various components of their plans. It must be remembered that such revisions are to be expected, since this is a dynamic process. As participants learn more about the application of microcomputers in their vocational disciplines and as the state-of-the-art in computer technology changes, vocational instructors' long-range goals and short-term objectives will have to be modified.

If vocational teachers do not make an on-going commitment to this process, then vocational education will not be able to meet the critical demands of this burgeoning technology. As indicated in the Unit of Instruction for Competencies B.7 and B.8, vocational instructors have a personal responsibility for developing their own computer skills as computer applications expand into new arenas of the home, school, and work. As computer technology continues to expand and develop in a relatively unpredictable manner, vocational educators will have to increase their commitment in order to stay abreast of the changes. The following suggestions may assist vocational teachers in meeting this challenge.

1. Develop a stronger commitment to personal learning as technological changes continue to affect an individual's personal and professional life. A positive attitude of inquiry and the ability to continually strive for personal growth will mean the ultimate difference between success and failure.
2. Examine personal values and beliefs about vocational curriculum and instruction from a new and developing perspective of what is being learned about the future and computer technology.
3. Develop computer skills that will make it easier to perform employment responsibilities in a more effective and efficient manner.
4. Modify vocational programs to go beyond the process of teaching the basics. Develop programs in a fashion that will provide educational opportunities for students that incorporate analysis, synthesis, and evaluation skill development procedures.
5. Maintain a positive attitude about the profession of vocational teaching and one's ability to cope with the technological changes that are occurring in that profession. (Berg & Bramble, 1983)

These suggestions should continually be reflected upon as assumptions that serve as the underlying structure for each vocational educator's PDP. The final benefits that can be accrued as a result of creating and implementing a PDP can only be determined by professionals who are actively involved with the process. In other words, the final evaluation of whether or not long-range goals or short-term objectives have been achieved must be determined by each individual vocational teacher who is participating in the professional growth process.

POSITIVE OUTCOMES OF A GOAL SETTING ORIENTED PDP

Vocational teachers and their programs can benefit positively from the overall nature of the PDP process. A well constructed Professional Development Plan can:

1. Promote professional growth by enhancing strengths and correcting weaknesses.
2. Foster developmental growth due to the fact that the evaluation component is performed by each participating vocational educator.
3. Focus on the unique professional growth needs of each vocational teacher.
4. Clarify performance expectations and allow each participant to randomly set criteria for self-evaluation.
5. Allow vocational instructors to determine the extent to which their goals and objectives should be compatible with those of their employing organization. (Iwanicki, 1981; McGreal, 1983)

It should be clearly evident that vocational educators have the sole responsibility for evaluating their performance in regards to the goals and objectives that are included on their PDPs. Many excellent reasons for utilizing a self-evaluation process exist, including the following:

1. Vocational teachers need to share the responsibility for improving their performance with their colleagues and administrators. Academic freedom and professional recognition require vocational educators to assume this responsibility.
2. Vocational instructors who aspire to enhance their professional status, regard self-evaluation as the most acceptable type of evaluation.
3. Self-evaluation is the ultimate goal of most teacher evaluation programs that seek to promote improved performance and to enhance professional status. Vocational educators, like other professionals, are most effectively motivated toward change from within.

However, some major problems are also associated with the use of this process. The primary problems associated with self-evaluation are that:

1. Some vocational teachers, particularly those who are marginal or insecure, tend to overrate themselves. They may seem to think that they are doing as well as they can under the circumstances.
2. Occasionally, emotionally secure vocational instructors may tend to underrate themselves.
3. Some professionals believe that few vocational educators are able to objectively assess their own performance. The result of this belief is that self-evaluation is inaccurate and unreliable. (Brighton, 1965; McGreal, 1983)

BASIC CONSIDERATIONS FOR THE EVALUATION PROCESS

Evaluation is a complex issue that can include aspects of research, testing, measurement, and statistics. In the PDP process, a simplified self-evaluation procedure must be performed by each participating vocational educator with regard to his or her long-range goals and respective short-term objectives. Even though the evaluation process has been reduced to a personalized subjective procedure, it is believed that the resulting information will enable vocational teachers to make decisions regarding their professional and programmatic growth.

The self-evaluation process must be initiated as soon as vocational instructors begin to record the required information in the various components of their PDPs. At this early stage, the PDP takes on an identity and becomes an organized activity. The following items represent some basic considerations that vocational teachers can reflect upon as they make decisions regarding whether or not they have accomplished various goals and objectives.

1. Objectives—What was the intent of the project or activity?
2. Environment—What facilities, what processes, what inputs (time, money, staff, etc.) were used? What were the circumstances that preceded and followed the activity? What were the limitations, the constraints, the context?
3. What actions were taken? What were the transactions? What elements and inputs were modified or impacted in order to achieve the objectives?
4. What happened? Where was change or modification evident—in what regard, at what point, how much? To what extent did a direct result occur? To what extent was a side effect or indirect result obtained?
5. How close to the objective did the activity come? What were the merits, the shortcomings? Against what baseline or standard can the progress or discrepancy be viewed? What unexpected or fortuitous [sic] results can be identified?
6. "So what?" How should subsequent planning, circumstances, and activities be modified? What alternatives should be attempted, what recommendations made; what should be recycled, what valued as satisfactory, and worthy of reinforcement. Who should do these things and under what changed circumstances? (Bishop, 1976, p. 146)

It is intended that the self-evaluation procedures, which are used in conjunction with the PDP, will take the overall process, ultimate outcomes, and each vocational educator's attitude into consideration. This process necessitates a commitment to change, as well as a personalized search for evidence that documents that change (Bishop, 1976). Self-evaluation is a follow-up activity that should encourage vocational teachers to evaluate their own professional growth. Increasing teachers' abilities to be **self-reflective** is a desired outcome of almost all effective teacher evaluation systems. Self-evaluation is and can be a naturally occurring event, especially if the experience allows it to happen spontaneously (McGreal, 1983).

A SYSTEMATIC APPROACH TO SELF-EVALUATION

The Professional Development Plan should allow vocational educators to participate in a dynamic, personalized growth experience. Upon establishing long-range goals and short-term objectives, each vocational teacher must identify and pursue learning activities that will foster his or her professional growth. When various learning activities have been completed or terminated, it is the vocational instructor's responsibility to indicate whether or not he or she has successfully achieved the corresponding short-term objective. This on-going evaluation process is a formative procedure. As the process progresses, a vocational teacher can gather information which will enable him or her to make a decision about whether or not a long-range goal has been accomplished. Prior to making a summarative decision with regard to any long-range goal, a vocational instructor has the option of modifying the PDP. New short-term objectives and respective learning activities can be added to the plan or the existing ones can be changed. The entire professional development process is in the hands of each participating vocational educator.

RE-EVALUATING MICROCOMPUTER COMPETENCY OR COMPUTER LITERACY

As has been suggested, the self-evaluation procedure must be an on-going process that is initiated with the creation and implementation of the PDP. The second phase of this overall evaluation process should involve each vocational educator in another self-assessment of his or her microcomputer competency or computer literacy. In the Unit of Instruction for Competency A.3, participating vocational teachers have already conducted an initial personal assessment of their microcomputer competency. The percentage conversions and profiled strengths and weaknesses that resulted from this initial self-assessment can serve as baseline data for the second phase of this overall professional development process.

This second self-assessment of microcomputer competency should be conducted either when a vocational teacher believes that he or she has fulfilled the intent of the PDP or approximately one year after the initial PDP was implemented. If this overall process is being utilized in conjunction with a standard 3-semester hour pre-service or in-service university course, the initial self-assessment and re-assessment could be conducted at the very beginning and conclusion of the course.

After vocational instructors have completed this second self-assessment of their microcomputer competency, they have the responsibility to record and profile the results on the tables that are included in this unit. Begin this evaluation phase by returning to the Unit of Instruction on Competency A.3. Participating vocational teachers should use a writing utensil that will permit them to record their new responses in a different color. Upon responding to the items in each domain, record the item sub-totals and respective domain scores in the following blanks:

Domain I - Administering Computer-Related Policies

=	I.1	+	I.2	+	I.3	+	I.4	+	I.5	=	Domain Score (Maximum = 28)
=		+		+		+		+		=	____________

Domain II - Teaching With or About Computers

=	II.1	+	II.2	+	II.3	+	II.4	+	II.5	+	II.6	+
=		+		+		+		+		+		+
	II.7	+	II.8	+	II.9	+	II.10	+	II.11	+	II.12	+
		+		+		+		+		+		+
	II.13	=	Domain Score (Maximum = 73)									
		=	____________									

Domain III - Using Computer Programs

=	III.1	+	III.2	+	III.3	+	III.4	+	III.5	+	III.6	+
=		+		+		+		+		+		+
	III.7	+	III.8	+	III.9	+	III.10	+	III.11	+	III.12	+
		+		+		+		+		+		+
	III.13	+	III.14	+	III.15	+	III.16	+	III.17	+		
		+		+		+		+		+		
	III.18	=	Domain Score (Maximum = 188)									
		=	____________									

Domain IV - Developing Computer Programs

=	IV.1	+	IV.2	+	IV.3	+	IV.4	+	IV.5	+	IV.6	+
=		+		+		+		+		+		+
	IV.7	+	IV.8	+	IV.9	+	IV.10	+	IV.11	+	IV.12	+
		+		+		+		+		+		+
	IV.13	+	IV.14	=	Domain Score (Maximum 80)							
		+		=	________							

Domain V - Analyzing Computer Applications

=	V.1	+	V.2	+	V.3	+	V.4	+	V.5	+
=		+		+		+		+		+
	V.6	=	Domain Score (Maximum = 62)							
		=	________							

Domain VI - Social Issues Related to Computers

=	VI.1	+	VI.2	+	VI.3	+	VI.4	+	VI.5	+	VI.6	+
=		+		+		+		+		+		+
	VI.7	+	VI.8	+	VI.9	+	VI.10	+	VI.11	+	VI.12	+
		+		+		+		+		+		+
	VI.13	+	VI.14	+	VI.15	+	VI.16	+	VI.17	+		
		+		+		+		+		+		
	VI.18	=	Domain Score (Maximum = 71)									
		=	________									

Domain VII - Computer-Related Concepts and Terms

=	VII.1	+	VII.2	+	VII.3	+	VII.4	+	VII.5	+	VII.6
=		+		+		+		+		+	
	VII.7	=	Domain Score (Maximum = 55)								
		=	________								

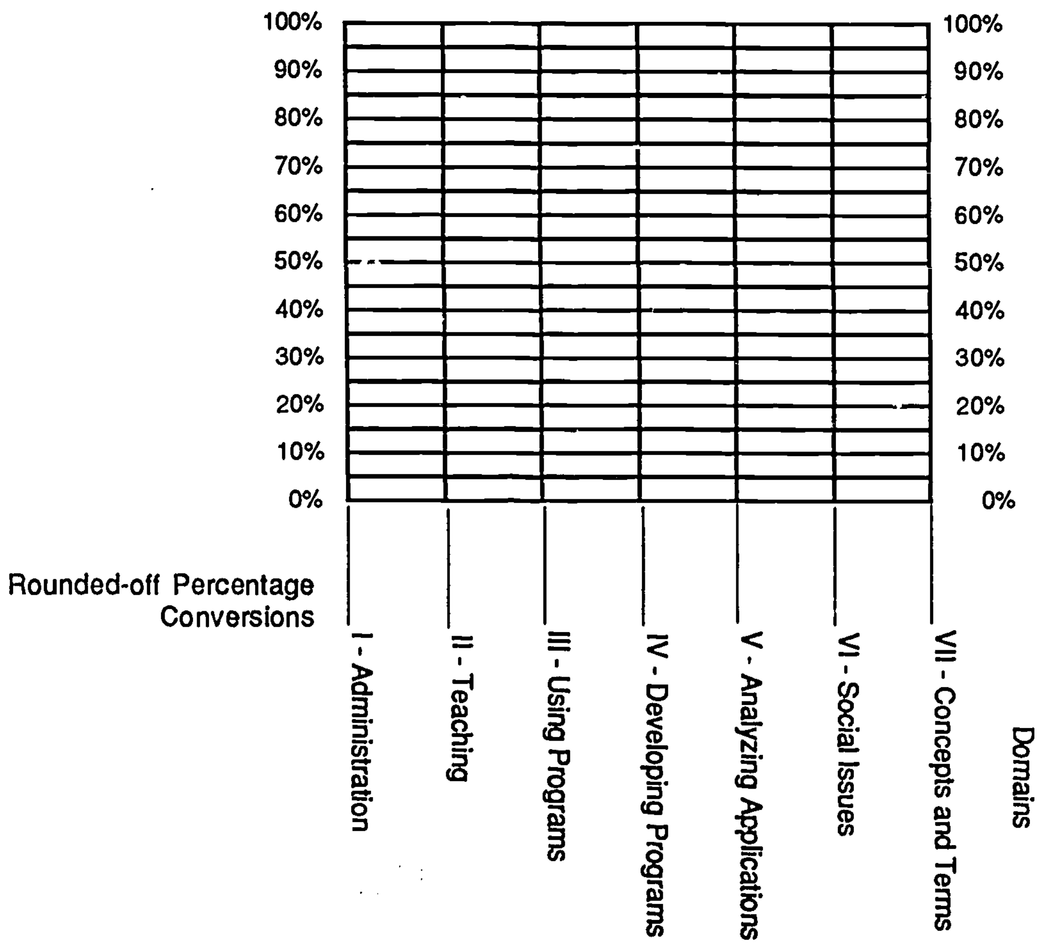
120

Once all of the domain scores have been retabulated, they can be converted to percentage scores. An example of how to convert these scores is provided in the Unit of Instruction on Competency A.3. Record each domain score and percentage conversion on the following table:

SCORING TABLE			
Domain	Respondent's Score	Maximum Possible Score	Percentage Conversion
I		28	
II		73	
III		188	
IV		80	
V		62	
VI		71	
VII		55	

The final stage of this second phase self-assessment is to profile the resulting percentage conversions on the following graph. Be sure to round off the percentages to the nearest whole number and plot these scores as near as possible to their exact location for the respective domains. Next, use a straight edge to connect the points that have been plotted.

PROFILE OF COMPUTER LITERACY



After the percentage conversions have been plotted, conduct a personalized re-assessment of domain strengths and weaknesses. Record the respective strengths and weaknesses on the following table:

DOMAIN STRENGTHS		
Domain	Category	Percentage Conversion

DOMAIN WEAKNESSES		
Domain	Category	Percentage Conversion

CREATING A NEW PROFESSIONAL DEVELOPMENT PLAN

At this stage it is necessary for each participating vocational educator to thoroughly re-assess all of the available information as well as this dynamic process. Vocational teachers must reflect upon the areas in which they have experienced professional growth and those areas in which they would like to experience additional growth. On the basis of this new information and the progress which has been made on the original PDP, it is now imperative to create a revised Professional Development Plan.

In order to accomplish the ultimate goal of this professional growth experience, vocational teachers must return to the Unit of Instruction on Competencies A.4, A.5, and A.6 and photocopy four or more clean copies of the PDP. Then they must create new long-range goals and short-term objectives that will enable them to fulfill their additional personal and professional needs. Furthermore, they must begin to identify new strategies, techniques, methods, materials, and resources that will facilitate their mastery of the newly identified goals and objectives. In addition to following through with these learning activities, it is necessary for vocational educators to continue the self-evaluation process.

STAYING ABREAST OF COMPUTER TECHNOLOGY

Do not forget that this professional growth experience is a dynamic process that will enable vocational teachers to develop professionally with the changing state-of-the-art in computer technology. One only has to reflect upon how rapidly this technology has changed during the past three decades in order to realize how radically this technology may develop by the twenty-first century. In approximately 30 years, our society has seen several generations of computers pass us by. Computer technology has evolved from mainframe computers to mini-computers to microcomputers, with microcomputers only being marketed since 1977.

These changes have been made possible by the miniaturization of parts, the demand for greater computer power, and the ingenuity of technicians. The contemporary status of computer technology is reviewed in the Unit of Instruction for Competencies B.7 and B.8. In the past, technological advances made by the computer industry have been swifter than our ability to comprehend and integrate them into educational systems. Education has not been able to keep pace with scientific, governmental and business applications of computer technology during the past several decades. However, with the continued development of microcomputers, educational computing should be able to progress with future technological changes. This growth in educational computing will continue to be spurred on by the development of microcomputers, high school interest, increased parental support, decreasing costs for computer power, expanded storage media, and cheaper peripherals (Friedman, 1982, November-December).

SUMMARY

This Unit of Instruction facilitates the process of evaluating and modifying a Professional Development Plan for microcomputer competency. The unit is designed to be used in conjunction with the Units of Instruction on Competencies A.1, A.2, A.3, A.4, A.5, and A.6. It was created with the intent to continue the professional development process that was implemented with the PDP.

Five suggestions for staying abreast of this rapidly expanding technology are presented. Then five positive benefit outcomes that can evolve from creating and implementing a PDP are discussed. This discussion leads into a presentation of three positive and three negative aspects of having vocational educators conduct a self-evaluation of their planned professional growth. Then six considerations are presented, which should be considered while evaluating whether or not long-range goals and short term objectives have been accomplished. These considerations precede a discussion about the ultimate benefit of using a self-evaluation process in conjunction with the PDP.

All of this explanatory information is followed by a series of activities that will enable participating vocational educators to evaluate and create revised PDPs. Vocational teachers are encouraged to conduct a follow-up self-assessment of microcomputer competency using the computer literacy profile that is included in the Unit of Instruction on Competency A.3. Following this second phase self-assessment, vocational instructors are charged with the responsibility of identifying their current strengths and weaknesses and creating a totally revised Professional Development Plan. Finally, there is a brief discussion about why educational computing will continue to expand.

ACHIEVEMENT INDICATORS

1) List at least three suggestions for assisting vocational teachers in staying abreast of this expanding technology.
2) Discuss at least three positive benefit outcomes that can evolve from creating and implementing a Professional Development Plan (PDP).
3) List at least two positive and two negative aspects of having vocational educators conduct a self-evaluation process in conjunction with their PDPs.
4) Discuss basic considerations for evaluating whether or not long-range goals and short-term objectives have been accomplished.
5) Explain the ultimate benefit of utilizing a self-evaluation process in conjunction with the PDP.
6) Conduct a follow-up self-assessment of microcomputer competency using all seven domains of the computer literacy profile in the Unit of Instruction on Competency A.3.
7) Record the domain scores, calculate percentage conversions, and plot the percentage conversions from this second phase self-assessment using the computer literacy profile on their respective tables.
8) Identify domain strengths and weaknesses on the basis of the results on this second phase self-assessment using the computer literacy profile.
9) Develop a revised Professional Development Plan on the basis of this second phase self-assessment using the computer literacy profile as well as the professional growth that has been achieved as a result of the initial PDP.
10) Explain why educational computing will continue to expand.

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A PROSE GLOSSARY

Glossaries of technical terms are very often of little use to the novice since their alphabetic order does not reflect the logical structure of the subject. This glossary is arranged in a more or less logical fashion. If the definition does not shed sufficient light, the context may. All important words and terminology can be located since they are all in capital letters throughout.

A COMPUTER is a machine for performing complex processes on information without manual intervention. ANALOG COMPUTERS perform this function by directly measuring and transforming continuous physical quantities such as electrical voltages. DIGITAL COMPUTERS represent numerical quantities by discreet electrical states that can be manipulated logically and hence arithmetically. Digital computers are sometimes referred to as ELECTRONIC DATA PROCESSING MACHINES (EDP), AUTOMATIC DATA PROCESSING MACHINES (ADP), or PROCESSORS. In order to distinguish the actual physical equipment from the programs which extend its usefulness, the former is called HARDWARE.

The CENTRAL PROCESSOR UNIT (CPU) or MAINFRAME is the portion of the computer that performs the calculations and decisions; it contains two logically separate entities: the CONTROL UNIT, which determines the sequences of operations of the computer, and the ARITHMETIC UNIT, which actually performs the individual logical and arithmetic operations. The MEMORY or STORAGE is the part of the computer in which the data and programs are stored. The CORE MEMORY is the main memory of most modern machines; it is normally the only memory directly accessible to the CPU. Its name derives from the composition: small ferrite rings called CORES. The computer may have additional memory devices. Information is transferred between these and the core memory. The most usual such memories are MAGNETIC TAPES, MAGNETIC DRUMS (spinning cylinders with a magnetizable recording surface), and MAGNETIC DISKS (flat spinning disks with magnetizable surfaces). DISK PACKS are disks that can be removed from the machine and stored elsewhere.

The capability of memory devices is measured in capacity and speed of access. The STORAGE CAPACITY of a memory is measured in WORDS, which are usually of fixed length, consisting of from 12 to 48 bits. This number is called the machine's WORD LENGTH. A BIT (binary digit) is the minimum unit of information storage and has only two possible values. Capacity can also be measured in BYTES, units of six or eight bits, each capable of representing one alphabetic or numeric symbol. Core memory is called RANDOM ACCESS MEMORY (RAM) when any word can be obtained at any time without regard to its serial order. Drum, tape, and disk memories are SERIAL ACCESS because the words pass one at a time as they move past the station where they may be accessed. Rotating serial access memories, drums, and disks, are called DIRECT ACCESS DEVICES because by using multiple access locations a word can be obtained without waiting for all the preceding words to pass.

The speed of a computer is measured in CYCLE TIME, the time required to reference a core memory word, get the data, and be ready to do it again, or ADD TIME, the time needed to perform a single addition of two words. ACCESS SPEED is the time it takes to locate a word in a memory; TRANSFER RATE is the rate at which words can be moved from or to the memory device in question. Speed is usually spoken of in terms of MILLISECONDS (m) (thousandths of seconds), MICROSECONDS (or u) (millionths of a second), or NANOSECONDS (n or v) (billionths of a second). One nanosecond is the time required for light to travel almost one foot. A thousandth of a nanosecond is a PICOSECOND; this word is beginning to be used.

The central processor and the memory constitute the computer per se; to get data and programs into the machine and the results out is the role of the INPUT/OUTPUT EQUIPMENT or (I/O).

INPUT DEVICES convert information to a form in which it can be stored in the computer's memory. The most common form of input, in the past, is the PUNCHED CARD or HOLLERITH CARD (named after its inventor). Input devices that accept cards are called CARD READERS, and the function they perform is commonly called READING, as is that of all input. Hollerith cards have 80 COLUMNS with 12 possible punch positions; normally, each column is used to represent one character. A set of cards is called a DECK. Another form of input is PUNCHED PAPER TAPE — continuous tape approximately one inch wide, with holes punched across its width to represent characters or numeric quantities. MAGNETIC INK CHARACTER READERS (MICR) have come to be used for input, particularly in banking; they can interpret characters printed with a special ink. More recently, OPTICAL SCANNERS have appeared that can read clearly printed or typed material of given fonts. With a DATA ENTRY device characters can be keyboarded directly into a computer.

OUTPUT DEVICES usually include a CARD PUNCH (which converts the characters stored in memory to punched holes in a card), a TAPE PUNCH (which performs the same function for punched paper tape), and a LINE PRINTER (which prints numerals, letters, and other characters of conventional design on continuous rolls or sheets

This Prose Glossary was adapted from *Computer Usage Fundamentals*, by Eric A. Weiss. Revisions were provided by H. D. Marvel, Data Processing Instructor, Quincy Area Vocational Technical Center, 219 Baldwin Drive, Quincy, Illinois 62301, November 1984.

of paper). Passing information to these devices, the computer is WRITING. The output family may also include DISPLAY devices that exhibit readable characters of graphic information on the face of a CATHODE RAY TUBE or CRT. These images must be read at once, of course, since they are not permanent. They may be photographed or rewritten later, of course. Information that can be taken away in permanent form (such as the output of a line printer) is called HARD COPY. A PLOTTER is an output device that, under computer control, can draw continuous lines or curves on paper, thus producing graphs, maps, and so forth in hard copy. Magnetic tape is widely used as a form of both memory and input/output. It can be stored conveniently away from the machine and can be read or written by the computer if it is put on a TAPE DRIVE attached to the computer. Tapes may be referred to as NINE-TRACK or SEVEN-TRACK, depending on the number of bits that are written parallel across the tape.

I/O devices connect to a computer by means of a CHANNEL; when several devices share the same channel, they are said to be MULTIPLEXED. When they are attached to the computer and are under its control, devices are ON-LINE. They are placed OFF-LINE when they are used to perform independent functions. Any device which is attached to the mainframe, other than the core storage unit, is called a PERIPHERAL device. The term may be limited to I/O devices used off-line.

ELECTROMECHANICAL ACCOUNTING MACHINES or EAM are independent of the computer and in fact antedate the use of computers by many years. The most common are the KEYPUNCH, used to punch cards; the REPRODUCER, which makes copies of decks of cards; and the SORTER, which places cards in different bins according to what holes are punched. In some systems, another on-line input/output device has been added: the CONSOLE or TERMINAL. This is intended for the user to interact directly with the computer, and usually consists of a typewriter-like keyboard with either a typewriter-like printing mechanism or another display device for output.

Information is stored in the computer's memory in the form of the presence or absence of a magnetic area or electrical charge. A collection of such "yes or no" physical states is usually thought of as a BINARY NUMBER (a number whose only possible digits are 0 and 1). Depending on the context, such numbers can have many meanings; in this sense, the numbers are CODED. They can be interpreted as numeric quantities, as CHARACTERS (letters, digits, punctuation marks), or as INSTRUCTIONS or COMMANDS that will direct the computer to perform its basic functions (add, compare, read, and so forth). In IBM computers, EBCDIC (Extended Binary Coded Decimal Interchange Code) is the code that relates binary numbers to decimal numbers and characters, while ASCII (American Standard Code for Information Interchange) is the standard code used chiefly in data communications.

Binary numbers in storage or transit often include a CHECK BIT or PARITY BIT which protect them against certain kinds of computer errors.

A set of instructions to perform a specific function or solve a complete program is called a PROGRAM. The computer performs such instructions sequentially. However, as it can modify the data in its memory, the computer can also modify its program. It is because of this distinctive feature that modern digital computers are sometimes called STORED PROGRAM (or INTERNALLY PROGRAMMED) computers. Parts of programs are sometimes called ROUTINES or SUBROUTINES. Subroutines that perform generally useful functions are sometimes combined into a subroutine LIBRARY, usually on magnetic tape. Copies of relevant subroutines will be added to a program automatically and hence need not be developed by hand. Single instructions in a program are sometimes called STEPS. When a sequence of program steps is operated again and again, the process is called a LOOP. Certain instructions compare two quantities, and select either of two program paths on the basis of the result: these are called BRANCH instructions. The data on which a program acts are usually structured into RECORDS or TABLES. Individual values that control the operation of programs or subroutines are PARAMETERS. An organized collection of information in the computer or on tape is called a FILE, like the organized set of papers in a file cabinet. A DATA BASE or DATA BANK is a large and complex set of files (such as a library catalog, a personnel file, or a budget).

A PROGRAMMER is a person who converts a problem into a set of directions to a computer to solve it. The function is sometimes broken down into several parts, particularly if the problem is very complex. The task of stating the problem in a clear and unambiguous form is performed by an ANALYST or SYSTEMS ANALYST. The technique of specifying methods of solution for mathematical problems is MATHEMATICAL ANALYSIS or NUMERICAL ANALYSIS. A specific procedure for solving a problem is an ALGORITHM. The process of writing the detailed step-by-step instructions for the computer to follow is CODING; it is done by a CODER. A person who actually runs the computer, pressing the buttons, flipping the switches, changing the tapes, loading the cards, inputting its work, and collecting the output to be returned to the user, is a COMPUTER OPERATOR.

After a program is written, it is tried out by letting it perform its function in the computer. This process is CHECKOUT, CODE CHECKING, or DEBUGGING. Programs to help the coder find errors or BUGS may include a TRACE to follow the course of a program in its operation, a SNAPSHOT to display the momentary content and state of the computer, or a POSTMORTEM DUMP to print the state of the machine after program operation. Once a program has been debugged so that it will run, it is TESTED with test data to which the proper solution is known.

The coder will also be expected to produce some descriptions of the programs and how it operates so that others may understand how it works in case at a future date it is necessary to modify it. This DOCUMENTATION may include a FLOWCHART or FLOW DIAGRAM: a graphic description or diagram of the various paths and branches followed by the program. A program which has been satisfactorily debugged, tested, and documented will be released for the PRODUCTION of useful results.

The repertory of instructions available to the programmer for a specific computer is that computer's MACHINE LANGUAGE. (Because this use of the word "language" is somewhat misleading, human languages such as English are distinguished as NATURAL LANGUAGES.) HIGHER-ORDER LANGUAGES have been developed to help the programmer by simplifying the tedious aspects of writing machine language; these are called PROCEDURE ORIENTED LANGUAGES or POL. Commonly used POLs are FORTRAN computation and the latter for business data processing. PL/1 is a more general POL. PROBLEM ORIENTED LANGUAGES are designed to be used only in certain limited kinds of applications. For example, TRANSIM is used for simulating transportation problems.

Because of greater flexibilities in dealing with data, LIST PROCESSING LANGUAGES are particularly useful in processing non-numerical symbols. Their particular virtues are most apparent in HEURISTIC PROCESSES: methods in which the precise method of solution is not spelled out, but is discovered as the program progresses and as it evaluates its progress toward an acceptable solution. The study of such processes is called ARTIFICIAL INTELLIGENCE.

Programs that convert higher-order languages into machine language are called COMPILERS; programs that perform similar functions at a much simpler level are ASSEMBLERS. The term TRANSLATOR is used sometimes for a compiler, but is used less frequently because of the possible confusion with programs that perform translations between natural languages. INTERPRETERS do not compile the entire program, but translate and perform one statement of the program at a time; effectively, they perform both functions—compiling and running a program.

SOFTWARE is the term used to refer to the totality of programs, documentation, and procedures required to use a computer; sometimes it is used more specifically to mean those programs of general usefulness (such as compilers) that are available to all users. These are sometimes called UTILITY PROGRAMS. All computers today have programs called OPERATING SYSTEMS to aid the user (and the operator) in sequencing jobs, accounting, and calling up other utility programs. Operating systems or programs are also called CONTROL PROGRAMS, SUPERVISORS, EXECUTIVES, MONITORS, or SYSTEMS SOFTWARE. APPLICATIONS are the problems to which a computer is applied; the names for the most common applications are self-explanatory, but some are not. DATA REDUCTION is the process of compressing, editing, smoothing, and formatting large quantities of information for human consumption. A SIMULATION is the representation of a real or hypothetical system by a computer process; its function is to indicate system performance under various conditions by program performance. STOCHASTIC simulations are based on an understanding of the probable behavior of systems. INFORMATION RETRIEVAL is the name applied to processes that recover or locate information in a large collection or data base. An INFORMATION MANAGEMENT SYSTEM supplies the data that the management of an organization requires to make decisions and exercise control. A REPORT GENERATOR is a program that allows the user to specify in some simple way the content and format of reports the computer is to produce. PROCESS CONTROL programs are used to monitor and guide machines, particularly those in continuous-process industries like oil refining or electronic circuit manufacturing.

To RUN a program is to cause it to be performed on the computer. Running a program to solve a problem or produce real results (as opposed to debugging) is called a PRODUCTION RUN. Installations in which the user runs his own job are called OPEN SHOPS. Computers are sometimes operated in BATCH PROCESSING mode: the operator assembles a batch of programs waiting to be run and puts them serially into the computer; output from all the programs is returned in one batch. TURNAROUND TIME is the time between the user's delivering his job to the center and the availability of his output. TIME SHARING is a method of operation by means of which several JOBS (programs being run) are interweaved, giving the appearance of simultaneous operation. A related concept is MULTIPROGRAMMING, which implies the interweaving of jobs, too. The intent in multiprogramming is more likely to be computer efficiency; in time sharing, it is user convenience. MULTIPROCESSING is a technique for increasing the effective speed of a computer by adding additional arithmetic units to the system. When several computers are linked together, the one responsible for control and scheduling of the others is the MASTER; the others are SLAVES. If the system has small computers responsible only for the control of input/output, these are usually called SATELLITES.

In many multiprogrammed systems, users have terminals that are on-line. Such terminals may be located far from the computer. This is REMOTE ACCESS. It allows users to interact with the computer on a time scale appropriate for human beings—on the order of a few seconds between responses. This capability is called operating in REAL TIME. Using the computer for frequent interaction with users in this way is called an INTERACTIVE mode of computing; if the communication is in words and sentences approaching natural language, It may properly be called CONVERSATIONAL. Sometimes, noninteractive work is done by a time shared computer during idle seconds; those jobs are called BACKGROUND.

The capacity of the main memory is always much smaller than the capacity of the additional drums and disks. If the computer and its operating system are so designed that some of the memory space on the drums and disks appears to be a direct extension of the main memory, the computer is said to have a VIRTUAL STORAGE capacity which will always be much larger than the real main memory. Virtual storage is usually divided into PAGES, each of which contains a number of words.

Like all electronic devices, computers sometimes break down. The prevention and correction of such situations is MAINTENANCE. PREVENTIVE MAINTENANCE finds failing components before they actually break down. RELIABILITY is the measure of the frequency of failure of the computer. During DOWNTIME the machine is being maintained or repaired; during UPTIME (or AVAILABLE TIME) it is available for normal productive use. Available time that is not used productively is IDLE TIME.

A computer which is small in physical size (about as big as a bread basket), small in price (below $20,000), small in word size (usually 16 bits), small in main-memory capacity, and small in the number of commands it can execute is called a MINICOMPUTER. It will have all the fundamental characteristics of the largest computer, but its limitations of commands, word size, memory, and peripheral attachments make it suitable for special purpose applications rather than the general purpose applications of its larger brothers.

Since about 1977 the MICROCOMPUTER has been readily available for the small business and home applications. Generally the prices have ranged from below $100 to a top dollar of about $10,000. Most microcomputers can be purchased directly from retail outlets which is known as OFF-THE-SHELF dealers. Modern TECHNOLOGY has produced MICROPROCESSORS which are made from SILICON (white sand). These are referred to as CHIPS. These chips include the central processing unit (CPU) and are quite small in size. The microcomputer today is capable of doing the same type of processing that the mainframe computer performed just a few years ago. This has led to tremendous growth in the usage of computers in education, business, and the home.

Glossary of Terms

BY: HORACE D. MARVEL

ACCESS TIME: The time required to gain access to and retrieve data from a disk.

ACOUSTIC COUPLER: A modem that is connected to a personal computer or terminal by a cable and allows a standard telephone headset to be placed into molded rubber cups on the modem. Also see MODEM.

ADDRESS: A label, name, or number that designates a register, a memory location, or a device.

ALGORITHM: A fixed step-by-step procedure for accomplishing a given result.

ALPHANUMERIC or ALPHAMERIC: Characters which are either letters of the alphabet, numerals, or special symbols.

ANALOG TO DIGITAL CONVERTER: A device that changes physical motion or electrical voltage into digital factors. See SPECIAL PURPOSE I/O DEVICES.

ANALYTICAL ENGINE: A mechanical computing device designed, but never completed by British scientist Charles Babbage in 1835. It was the forerunner of modern digital computers.

ANSI: American National Standards Institute. The authority for establishing industrial standards in the United States.

ANXIETY REACTIONS: Also known as computerphobia. A reaction often related to change. Technological advances within the computer industry have been swifter than our ability to comprehend.

APPLICATION PROGRAMS: See SOFTWARE APPLICATIONS.

ARITHMETIC OPERATIONS: The performing of calculations on data by the internal electronic circuitry in the central processing unit (CPU).

ARRAYS: A series of related data items and fields, also called a table, stored in rows and columns.

ARTIFICIAL INTELLIGENCE: A field of study that has traditionally included natural language processing and computer vision, and has made considerable progress in the use of computers to simulate the thought process of human experts in narrowly defined subjects.

ASCII: American Standard Code for Information Interchange. A coding system to represent data in main computer memory used on microcomputers and many minicomputers.

ASSEMBLER LANGUAGES: Programming languages, also called low-level or machine languages, that use symbolic notation to represent machine language instructions and are closely related to the internal architecture of the computer on which they are used.

BACKUP: A copy of programs or data that is kept in case the original is accidently destroyed.

BARCODE READER: A device used to translate a pattern of varying width bars into characters that can be processed by the computer.

BASIC: Beginner's All-purpose Symbolic Instruction Code. A programming language developed at Dartmouth University for use in academic computing, but now widely used on personal computers and small business systems.

BEACHHEAD APPROACH: The adoption of computer literacy for establishing a safe and secure base of operations for the diffusion throughout the school system.

BENCHMARKS: The testing of software and hardware to establish how fast the system can operate in relation to other systems.

BATCH PROCESSING: The accumulation and processing of data as a group.

BAUD RATE: Measurement of speed for information transmission. Common speeds include 300, 1200, and 2400 baud. Bits per second is a more technically correct term.

BINARY: Pertaining to a condition where there are only two possible alternatives; for example, the numbering system with a base of two using digits: zero (0) — off, and one (1) — on.

BOOLEAN ALGEBRA: An algebra named for George Boole. This algebra is similar in form to ordinary algebra, but with classes, propositions, yes/no criteria, etc., for variables rather than numeric quantities.

BOOT: The procedure used to start-up the system including hardware and software.

BRANCH or JUMP: An instruction which when executed may cause the arithmetic and control unit to obtain the next instruction from some location other than the next sequential location. It is one of two types, conditional and unconditional.

BUBBLE MEMORY: Computer memory composed of small magnetic domains, or bubbles, formed on a thin single-crystal film or synthetic garnet.

BUFFER: A device which stores information temporarily during data transfers. Sometimes, a power amplifier. Also see SPOOLING.

BUG: Any mistake in a computer program.

BUNDLED SOFTWARE: Programs sold (or given) that are included in the purchase of specific hardware.

BYTE: A unit usually made up of 8 bits. One byte represents one character on the computer keyboard.

CAD/CAM: Computer Assisted Design-Drafting/Computer Assisted Manufacturing. Special software programs purchased for specific hardware. Uses a plotting table and a plotter printer.

CAI: Computer Assisted Instruction. CAI is related to delivery of lessons and materials in the classroom.

CAL: Computer Assisted Learning. CAL is the proper definition of CAI in use in the classroom as there is feedback between the instructor and the student.

CBE: Competency Based Education. A systematic system approach to curriculum and instruction consisting of three basic steps: Establish student objectives; Develop appropriate instructional activities to mesh with the learner objectives; Monitor the progress toward achieving the educational objectives.

CBI: Computer Based Instruction. Encompasses all aspects of instructional utilization of computers and is subdivided into two categories: Computer Managed Instruction (CMI) and Computer Assisted Instruction (CAI). Characteristics include modes of delivery and interaction for students to obtain, review, apply, and/or create knowledge by actively communicating with computers.

CBVE: Competency Based Vocational Education.

CHIP: A very thin wafer of silicon containing thousands of integrated circuits. Chips are used in fourth generation computers.

CMI: Computer Managed Instruction. CMI is required in combining the use of CAI as all software must be managed by the instructor.

CPU: Central Processing Unit. The part of a computer system that processes information. Its two main parts are the arithmetic/logic unit and the control unit.

COBOL: An acronym for Common Business Oriented Language. The major language used for most business applications.

CODING: The process used in programming to write out the r ired codes used in the particular language.

COMMAND: A word which relates what the computer is to do next.

COMMUNICATION DEVICE: A device that links a particular computer to other remote computers through the use of MODEMS and telephone equipment.

COMPARING LOGICAL OPERATIONS: The ability of the computer to compare data and perform alternative actions based upon the results of the comparison.

COMPILER: A program that interprets computer statements written in a symbolic form and converts the statements to machine language instructions.

COMPILER LANGUAGE: A computer language, more powerful than an assembly language, which instructs a compiler in translating a source language into a machine language. The machine-language result (object) from the compiler is a translated and expanded version of the original.

CONCATENATE: A word that means "to link together." In programming, strings can be concatenated.

CRITICAL INCIDENT TECHNIQUE: A technique of observing students to determine what factors make the students feel positively and negatively about the use of microcomputers.

CRT: Cathode Ray Tube. Also known as VDT—Video Display Terminal. An output unit with a TV-like screen used to display information from a computer.

CURSOR: The symbol appearing on the video screen that shows where the next character to be typed will appear.

DACUM: Developing a Curriculum. The DACUM process is a curriculum development method that was originally used by the Experimental Projects Branch, Canada Department of Regional Economic Expansion and the General Learning Corporation of New York. The development of the attached handbook was funded by the Department of Vocational and Adult Education, State of Illinois.

DAISY WHEEL PRINTER: A printer which has a wheel mechanism, with characters on the perimeter of the wheel. The wheel rotates to place the appropriate character in print position. A "hammer" strikes the character, forcing it against a ribbon, thereby forming an impression on the paper. The daisy wheel printer has the reputation of great reliability, is relatively inexpensive, and forms solid characters. However, speed in printing is slower than the dot matrix printer.

DATA BANKS: A collection of data which is stored on auxiliary storage devices.

DATA BASE MANAGEMENT SYSTEM: A system can be viewed logically as a software package. It is not unusual for database management software on a minicomputer or mainframe computer to reside in several megabytes of memory. dBAS II is an illustration of a commercial software package available for the microcomputer.

DATA ENTRY: The process of entering information into the random access memory (RAM) through an input device such as the keyboard.

DEBUGGING: Also referred to as DEBUG. The process of determining the correctness of a computer routine, locating any errors, and correcting them. Also, the detection and correction of malfunctions in the computer itself.

DECOLLATING: The process of removing carbon and separating the multiple copies of a report (printed hardcopy output).

DELPHI TECHNIQUE: This perspective considers curriculum content to be established best through a process of achieving consensus of knowledgeable individuals.

DESK CHECK: The process used to check the pseudocode for logical errors. These are errors in the logical structure of the program, errors that the educational specialist should be able to identify more often than the computer programmer could see.

DIGIT: A single number from 0 through 9.

DIGIT PORTION of the BYTE: The rightmost four bits of an eight-bit byte.

DIGITAL COMPUTER: A general-purpose computer that uses letters, numbers, and symbols as input and converts this information into digits to be stored and processed.

DIGITIZER: A graphical input device that converts points, lines, and curves from a sketch, drawing, or photograph to digital impulses and transmits them to a computer.

DIP SWITCHES: Small switches, usually set at time of printer installation, that control printer options and compatibility.

DIRECTORY: A listing of software programs previously stored on the disk. Another name is sometimes referred to as CATALOG.

DISK DRIVE: An I/O device that loads a program or data stored on a disk into a computer.

DISKETTE or DISK: A thin, flexible platter, similar to a 45 rpm record, coated with magnetic material and used to store information; a floppy disk. The most popular size is the 5¼" disk. Another size is the 8". The newest trend is developing a 3½" disk that comes in a hard covering instead of the cardboard envelope used in the other sizes.

DOCUMENTATION: The group of techniques necessarily used to organize, present, and communicate recorded specialized knowledge. On-line documentation is referred to as information that is part of the coding of a program by using REMark statements. External documentation is information that is written to accompany software.

DOS: Disk Operating System. The system disk that is required to operate the computer and is furnished by the manufacturer. Sometimes, it is referred to as SYSTEM DISK.

DOUBLE DENSITY (DD): Diskettes and drives that record approximately 5,876 bits per inch.

DOUBLE-SIDED DRIVES: Diskette drives designed so that data can be recorded on both sides of the diskette.

DOWNLOAD: The process of transferring programs from a master or host computer to other computers which are sometimes referred to as "slaves." The process is also used in telecommunication through the use of a modem and terminal software whereby the distant data base or bulletin board system will send programs or information to the computer.

DVORAK: A design change of the standard typewriter keyboard. Apple computers have a commercial software package called MASTERTYPE that used this system. The standard keyboard is referred to as "QWERTY" which is the key names of the first six letters on the row above the home base.

EBDIC: Extended Binary Coded Decimal Interchange Code. A widely used coding system for representing data in computer storage and on auxiliary storage devices.

EDITOR: A routine in software that allows a user to write and change text within the computer memory. Two types of editing are popular with microcomputers: line-editing which permits the user to change one line of a program at a time; full-screen editing allows the user to change what appears on the screen by using the arrow keys and/or special function keys.

EDP: Electronic Data Processing. The processing of data mainly by electronic digital computers.

EFT: Electronic Funds Transfer. The process of recording transactions at financial institutions which are connected to the home office by remote control.

ELECTRONIC MAIL: The process of sending and receiving items of interest to other computers using a modem and telecomputing software.

EMULATE: The ability of one system to imitate another, with the imitating system accepting the same data and programming and achieving the same results as the imitated system, but possibly with a different time performance.

ENGLISH-LIKE STATEMENTS: Commercial software which will produce computer code. This is sometimes referred to as an "authoring system."

ENIAC: Electronic Numerical Integrator and Computer. An early computer developed by John von Neumann that utilized the stored program concept.

EPROM: An abbreviation for erasable programmable read only memory.

ERGONOMICS: The study of characteristics that need to be considered in designing and arranging things that are used in order that people and the things will interact most efficiently. Thus, an ergonomic chair is one that has been researched for proper height, back-rest, and size that will be comfortable and proper for the operator.

ETHICS: The development of standards in the classroom that prohibit the unlawful copying of copyrighted software.

EXECUTE: Causing a program to be completed with output showing the data in its proper form. Another term used is "RUN."

EXTRINSIC MOTIVATION: This type of motivation should incorporate activities within the structure of the classroom that add fun to vocational education and create positive effects on work outputs.

FACE VALIDITY: Means that the documentation has a professionally prepared appearance.

FALSE FLOORS: The process of raising the floors in the computer area so that all cabling and connections are located out of the way. Usually a six inch riser is all that is required.

FIELD: A set of one or more adjacent columns of one or more bit positions in a complete word(s) consistently used to record similar information. Thus, the "name field" could be a series of positions (columns) on a record. See RECORD.

FIFTH-GENERATION COMPUTER: A computer now being developed that contains language translators and expert systems all under control of parallel processing hardware.

FILE: A block of information that, when combined with others, makes up a group of related data on a disk; similar to files as used in office work. Thus, a "file name" is the name the programmer gives to a complete group of data—such as "PAYROLL" containing all the employee names, etc.

FILE MANAGER SYSTEMS: A type of data base. File managers can utilize only one file at a time, while relational data bases can access multiple files at one time.

FIRMWARE: A term applied to software packages loaded on ROM chips and installed by the user in the microcomputer.

FIRST-GENERATION COMPUTER: Computers manufactured in the late 1940s and early 1950s containing vacuum tubes, having no memory units, and using magnetic drums as storage devices.

FIXED POINT: A notation or system of arithmetic in which all numeric quantities are expressed by a predetermined number of digits with the point implicitly located at some predetermined position; contrasted with floating point.

FLOWCHART: A graphical representation of a sequence of operations, using symbols to represent the operations, such as, Compute, substitute, compare, GOTO, IF, read, write, etc. Flowcharts of different levels of generality can be drawn for a given problem solution. Terms used are: System flow chart, program flow chart, coding level flow chart, etc.

FORMAT: The predetermined arrangement of characters, fields, lines, page numbers, punctuation marks, etc. Refers to input, output, and files.

FORTRAN: FORmula TRANslation. A high-level language designed for scientists, mathematicians, and engineers.

FOURTH-GENERATION COMPUTERS: A classification of computers, including the IBM System/370, designed using large scale integration (LSI).

FUNCTION APPROACH: A systematic approach similar to the introspection approach except that the focus is on inclusive examination of worker functions that are performed within an entire business or industry.

GAMING SOFTWARE: Commercial software that allows a great amount of eye and hand coordination. Efforts must be made to control the usage of gaming. Studies have been made showing the educational value of games.

GENERIC SOFTWARE: Software programs, such as word processing or spreadsheet, which serve common needs of many people while job specific software is designed for particular audiences.

GIGABYTES: A measurement of storage capacity. One gigabyte equals one billion bytes.

GIGO: A term used for "Garbage In—Garbage Out."

GLITCHES: Unsuspected changes in the flow of electrical power to microcomputers may cause problems which are incorrectly blamed on hardware or software.

GRAPHIC DISPLAY TERMINAL: CRT terminals capable of displaying not only letters of the alphabet and numbers, but graphs and drawings as well.

GRAPHICS: Non-text designs and patterns displayed as output.

HAND-HELD DEVICE: Generally thought of as a calculator, but with the introduction of "lap" or portable computers their popularity is growing. Security must be a factor to consider because of their small size.

HAND-HELD HALON FIRE EXTINGUISHERS: Halon fire suppressant is applied at room temperature and leaves no residue, thus allowing salvage of any components within the microcomputer not damaged by fire.

HANDSHAKING OPERATION: Interaction of the central processor and interface devices which requires the device to signal the processor as each command occurs during data transfer. This operation is performed by modems or terminals to verify that channels are cleared and that operations can proceed.

HARDCOPY: Data or information printed on paper.

HARD DISK: For years the standard on the big systems, the hard disk is starting to find its way into the microcomputer field. As the name implies, the disk is similar to a "floppy" disk, except it isn't floppy; it is "hard." A hard disk is more reliable than the floppy disk.

HARD DISK DRIVE: Hardware used to read and write information on a hard disk. The drive accesses hard disks through access arms containing read/write heads.

HEXADECIMAL SYSTEM: Commonly referred to as "HEX." A number system involving 16 characters, using numbers 0-9 and then letters A-F.

HIGH LEVEL LANGUAGE: A computer programming language using English words, decimal arithmetic, and common algebraic expressions. Each instruction represents a large number of computer operations. See ASSEMBLER, BASIC, COMPILER, FORTRAN, etc.

HIGH RESOLUTION GRAPHICS: A way of displaying graphic output using a large number of pixels per screen area, that is effective for drawing precise lines and curves.

I/O: Referred to as "Input/Output." The passage of information into and out of the computer.

ICs: Integrated circuits come in three sizes: SSI (Small Scale Integration—less than 20 gates); MSI (Medium Scale Integration—20 to 200 gates); LSI (Large Scale Integration—over 200 gates).

IN-HOUSE DEVELOPMENT: This category includes software consultants because they can design software specific to the needs of vocational education.

INDEXING: The capability to select particular fields to set up fast searches. Generally only a few fields are indexed to keep the searching simple.

INFORMATION PROCESSING: This is defined as a collection of word, data and image processing equipment, procedures, software, data, and people that integrates the subsystems of the organization and provides information for the user.

INFRARED TOUCH-SCREENS: Some microcomputers are equipped to allow the user to "touch" the screen with his/her finger and the computer will react with specific operations as predefined by selecting a specific operation.

INITIALIZE VARIABLES: It is recommended that program variables be initialized to a specific value before the program is executed. All total variables must be set at zero (0).

INK JET PRINTER: In this type of printer, a high-speed stream of electrically charged ink droplets are fired through a magnetic field. The field deflects the droplets to direct them to the proper location on the paper. This type of printer is relatively expensive, but extremely fast.

INSTRUCTIONAL SYSTEMS: This design technology in vocational education is referred to as competency-based vocational education, but it is most widely recognized through its acronym—CBVE.

INTEGRATED CIRCUIT: Any electronic "chip" that contains a large number of electronic components; microprocessors and memory, for example, use integrated chips.

INTELLIGENT TERMINAL: Terminal with built-in programmable intelligence enabling it to pre-process information and/or instructions without the aid of a CPU.

INTERACTIVE: A term used to describe a computer system that is set up for two-way communication between the user and the computer. All microcomputers are interactive.

INTERACTIVE PROGRAMMING: Keying a program into a computer and immediately executing the program, usually within a matter of a few seconds.

INTERFACE: A circuit that allows one type of electronic unit to communicate with another electronic or mechanical device. Chiefly used as a buffer between computers and mechanical devices. "Better check the serial interface."

INTERNAL STORAGE: Memory system which is a part of the computer, as opposed to external tape or disk storage. See ROM/RAM.

INTERNALLY STORED PROGRAM: A set of program instructions stored within the computer's memory units as contrasted with programs which are stored externally on cardboard cards, paper tape, or magnetic tapes.

INTERPRETER: A computer program that converts high-level language statements to "machine" code for direct computer operation. Unlike a compiler, however, it executes the statements immediately, instead of later. BASIC is an interpreter language. However, compiler BASIC can be purchased as an option. "Most interpreter languages are slow."

K or KILO: Symbol or suffix for 1,000. In dealing with computers, 1K is used to mean 1,024. A computer with 32K bytes of memory means that it has 32 times 1,024 bytes of memory.

KEYBOARD: The standard of the microcomputer industry, at least for now, is the keyboard that used the "QWERTY" format like the typewriter. Uppercase and lowercase letters are a must for word processing applications.

KNOWARE AT HOME: Is a software package designed to prepare novices with an understanding of word processing, data base management, spreadsheet and financial decision-making. It is especially written for those students or home users who are not yet familiar with their computers. It is a relatively easy package to use.

LARGE SCALE DATA BANKS: Development of data banks can aid the teacher in locating information and software for a particular discipline. Usually special-purpose peripherals such as video disk equipment, hardware and software can be made available for students to take equipment home for access to the data bank where the charges are less when not used during "prime" time.

LASER DISK: An auxiliary storage device in which characters are represented by coded holes burned in the surface of the disk by a laser beam. Recent developments have produced a laser protection system that will prohibit unauthorized copying of the software (called ProLok).

LASER PRINTER: A printer that uses a laser beam to "write" characters on a light-sensitive drum that then transfers the characters to paper in a manner like that used by a copying machine.

LCD: Liquid Crystal Display is an everyday encounter with all of the new digital watches using it instead of LED (light emitting diode) displays. Late developments now have the display terminal equipped with LCD screens showing 80 character lines and 24 lines of display.

LESSON FLOW: This is especially important in determining how successful a student has been in completing a task in prescribed time limits. This is accomplished by proper attention to concept analysis and specificity of instructional objectives. Concept maps are useful to the designer of the program and are also helpful when presented to students in the form of branching for determining what steps must be followed to complete a task.

LETTER QUALITY PRINTER: A popular type of printer that forms the actual letter, symbol, or number instead of using wires as in a dot matrix printer. If a document is to be reproduced, it is recommended to use a letter quality printer. See Daisy Wheel Printer. A dot matrix printer can appear to be "near letter quality" if the printer is equipped to "over strike" the characters but off just enough to "fill-in" the spaces between the dots.

LIGHT PEN: A wand-like device with which sketches and graphs are drawn on the screen of a cathode ray tube (CRT) for input into a computer.

LINE PRINTER: A device capable of simultaneously printing an entire line of alphanumeric characters.

LISP: A high-level computer language, but is not as popular as most of the other languages for the microcomputer.

LOCAL AREA NETWORK: A great amount of educational software will not allow the user to "down-load" a program to another computer through either hard-wire connections or software. Special license agreements can be purchased that allows down loading.

LOGO: A high-level programming language used in education as a learning tool. Problem solving is done by graphically displaying geometric principles.

LOTUS 1.2.3: A very popular data base management program.

LSI: Stands for Large Scale Integration. A way of making denser and more complex integrated circuits. Eventually LSI will be replaced by VLSI (Very Large Scale Integration), and VLSI by ELSI (Extremely Large Scale Integration). "General Motors uses advanced LSI-hybrid circuits in fuel regulators."

MACHINE LANGUAGE: The lowest level of computer programming; this is the only language the computer can understand without the aid of another program. Looks like this: . . . . . FF FF FF FF B8 C9 D9 C0 . . .

MACROINSTRUCTION: An instruction which causes the computer to execute one or more other instructions. These "other instructions" are called microinstructions.

MAGNETIC DISK: An auxiliary storage medium on which data is magnetically recorded on a disk covered with microscopic bars of magnetizable material.

MAGNETIC INK CHARACTER RECOGNITION: MICR. An input system used by banks to read magnetic numbers printed across the bottom of checks and deposit slips.

MAGNETIC SCANNER: An input device that reads magnetically encoded data from a short strip of magnetic tape such as used on the back of credit cards.

MAINFRAME: A large-sized computer.

MANAGEMENT INFORMATION SYSTEM: MIS. A data processing system that provides information to management. The objectives differ for each management information system because each system provides information on a separate business data processing activity.

MARK I: A computer having mechanical counters controlled by electrical devices, developed in 1944.

MATRIX: Row and column arrangement, another name for a table.

MEGABYTE: One million bytes of computer or peripheral systems.

MEMORY: Storage locations that are directly addressable by the processor.

MEMORY CHIP: A chip which stores data in the form of electrical charges. See RAM, ROM.

MENU: A list of operations from which the user may choose. Usually, the menu is displayed on the CRT and waits for the operator to make a choice.

MICROCOMPUTER: A small but complete digital computer having an input unit like a typewriter keyboard. The most commonly used output devices are visual display units and printers.

MICROPROCESSOR: The central unit for processing and control in a minicomputer. A microprocessor is to a personal computer what a CPU is to a larger computer. Because the microprocessor tells the input, output, and storage units what to do and when to do it, a microprocessor is often called a controller.

MICROSECOND: A millionth part of a second.

MILLISECOND: A thousandth part of a second.

MINICOMPUTER: A computer having a smaller capacity for both primary and secondary storage than medium-size and large-size computers.

MODEM: An abbreviation of the words "MOdulator DEModulator." It is a device which permits computers to transmit information over regular telephone lines. Digital electronic signals generated by the computer, are converted by the MODEM into high and low tones. This process is known as "Modulation." The tones are a type of analog signal. The modem also converts analog signals to digital signals.

MODULE: A small part of a computer program.

MONITOR: A television-like device that displays information from the computer.

MOS-CHIP: MOS is an acronym for metal oxide semiconductor. A MOS chip is a chip in integrated circuit (IC) which can perform a vast number of electrical operations. A MOS chip one-quarter of an inch square can perform operations equivalent to 6,000 discrete electronic devices. A chip this size has the power and ability of a room-sized computer of a few years ago. See IC.

MOTHERBOARD: A card in a microcomputer with connections for various components and which is connected to the microprocessor. It forms the interface or connecting link between memory and peripheral devices.

MOUSE: A pointing device that is moved across a surface; as it is moved, a pointer on the video display moves in the same direction. The Apple Macintosh and other microcomputers use the mouse for input.

MULTIPROCESSING: The simultaneous execution of two or more sequences of instructions by two or more central processing units within a single computer system.

NANOSECOND: One billionth part of a second, or 1/1000 of a microsecond. "Some of today's faster personal computers operate in the nanosecond range."

NETWORK: Any system composed of two or more large computers, personal computers, or terminals.

NON-IMPACT PRINTERS: A printer that produces printed output without striking the paper through an inked ribbon. The image might be created instead by lasers, inkjets, or xerography.

OPERATING SYSTEM: OS. A group of special programs that are used in various combinations to make a computer easier to use.

OPTICAL CHARACTER READER: OCR. A machine that accepts data recorded by hand or typewriter, or by printer, reads the typed data, and converts it into machine-readable form for input to a computer or word processor.

OPTICAL MARK: Mark made by a pencil on a designated area of paper, usually an answer sheet, that can be read by a scanner.

PARALLEL: A term used to describe an interface in which the bits used to represent a character are all sent at the same time (side by side).

PASCAL: A powerful new high-level language that combines all of the best features and capabilities of BASIC, FORTRAN, and COBOL. It is becoming available on many small computers. It is a very structured language.

PERIPHERAL: A device that is part of the hardware that is separate from the computer. Examples are printers, disk drives, and terminals.

PICOSECOND: One millionth of a microsecond, or 1/1,000 of a nanosecond. "A picosecond is almost too small an interval of time to conceive."

PIXEL: An individual point of color or light on the CRT.

PL/1: Programming Language. A very powerful high-level programming language, generally found in use on large computer systems, but which will inevitably be used with the personal computer. Was developed by IBM for use as a general-purpose language in both business and scientific applications. It was designed with some of the computational concepts of FORTRAN and some of the file processing capabilities of COBOL.

PLATO SYSTEM: A widely used time-sharing system used in education. Originally developed for mainframe systems, but was recently developed for Control Data Corporation for use of desk-top systems.

PLOTTER: An output device which draws two-dimensional shapes using ink pens to draw on paper. Used with CAD systems for drafting.

POINT OF SALE: (POS). Terminals placed at locations where business transactions occur. Supermarkets are currently using electronic scanning systems and department stores are using a wand type of scanner.

PORT: The two most common types of ports are RE232 and 20ma (read twenty miliamps). These ports are frequently referred to as I/0 ports and are the connections through which the computer communicates with the outside world. Thus, ports are the "plugs" which connect the computer to peripheral devices such as keyboards and printers.

PRINTER: An output device to print documents on paper.

PSEUDOCODE: The steps to be performed by a computer program, written in English instead of a particular computer language.

PUBLIC DOMAIN: Software that is generally free and can be copied since it contains no copyright restrictions.

QUERY LANGUAGE: A very high-level language that allows the user to ask questions of the computer.

QWERTY: Represents the standard placement of the keys on a typewriter or keyboard.

RAM: Random Access Memory. Any memory which can be written on or read from by a program and in which the memory locations can be accessed in a random sequence. RAM can be erased and reprogrammed by the programmer as frequently as necessary. RAM size is expressed as a quantity of bytes such as 4K (4,000 bytes). RAM can be expanded by adding memory chips or memory boards.

REAL NUMBERS: A decimal number, also known as a floating-point number.

REAL TIME PROCESSING: Data processing operations whereby the computed results are received so quickly they can be used to influence the operation of the process being simulated.

RECORD: All the data in a file for a particular product, customer, supplier, or employee. Thus, an employee record would contain all information about that employee.

RELATIONAL DATA BASE: A data base management system that can create data which relates to other files and can update those files as the current file is created.

RF MODULATOR: An interface that makes it possible to use a standard television set to display information from the computer. RF is an abbreviation for radio frequency.

ROBOT: A computer-controlled mechanical arm that can be programmed to do repetitive and intricate movements.

ROM: Read Only Memory. Information in this part of memory is permanently stored and cannot be altered by the user. This is the section of memory where the computer's language and operating procedures are generally stored.

RPG II: Report Program Generator. A simple business oriented language. Is not presently available for use with microcomputers.

SECOND-GENERATION COMPUTER: Computer developed in the late 1950s that used transistors as part of the processing hardware. It contained core memory, used an operating system, and was programmed in high-level programming languages.

SECTOR: A segment of a disk. Also known as a track on the disk.

SEQUENTIAL ACCESS: A method of accessing a storage device in which data must be read from the medium in a one-after-the-other sequence.

SEQUENTIAL FILE: A file in which the records are stored and retrieved one after the other.

SERIAL: A term used to describe an interface in which the bits used to represent a character are sent one after the other.

SERIAL PORT: An I/O port that allows only one bit of a byte to be sent at a time.

SERIAL PRINTER: A printer that types only one character at a time.

SHEET-PAPER PRINTERS: A printer that allows the user to place a single sheet of paper at a time. The printer must have a "friction-feed" control as contrasted to one that is "pin-feed" (using fan-fold paper).

SILICON: A common element in the earth's crust from which computer chips are made. Usually, this is pure white sand.

SIMULATION: The representation of a physical system or dynamic process with a mathematical model. This is a program that models or mimics a real-life situation, allowing the user to react without endangering life or property.

SINGLE DENSITY: SD. Diskettes and drives that record approximately 2,768 bits per inch.

SMART MODEM: Modems, also called intelligent modems, that contain a microcompressor which controls many functions, allowing easier and more flexible use of data communications.

SOFT COPY: Output that is not in printed form, such as display on video screen or audible output.

SOFT-SECTORED DISKETTES: A diskette on which the number and size of sectors is determined by the formatting of the diskette.

SOFTWARE: The list of instructions (programs) and other procedures the computer system uses in processing data. Such materials contrast with the physical equipment that makes up a computer system, which is known as computer hardware.

SOLID STATE DEVICE: A nonvacuum electronic device fashioned from semiconducting materials which performs some of the functions of a vacuum tube.

SOURCE DOCUMENTS: Printed or handwritten forms containing the raw data values which are coded into machine readable form by the data entry clerk. A sales invoice is a form of a source document.

SPREADSHEET: A program that uses a row and column arrangement of data to make calculations. The most popular commercial software is known as VisiCalc. This program allows the user to develop a total of sixty-three columns and two-hundred-fifty-five rows. It also allows the operator to ask the computer "What if" to see what would happen if a formula was to be changed.

STATIC MEMORY: A type of programmable memory which changes only when an electrical charge is applied. It is often found in a MOS chip. It does not require refresh operations as does dynamic memory. See RAM, ROM.

STRUCTURED PROGRAMMING: Programming according to a proven set of standards for planning and writing a program that is more error free.

STRUCTURED WALKTHROUGH: The process of several persons reviewing the steps to be taken by a program; the process can catch many errors before the program is coded.

SYNTAX: The rules of the particular programming language.

SYSTEMS ANALYST: The person responsible for determining the most effective way of doing work. Part of this responsibility is determining the most efficient equipment for processing data.

TELECOMMUNICATIONS: The transmission of data electronically by telephone circuits, microwave networks, or satellite transmissions.

TELEPROCESSING: The use of telephone lines to transmit data and commands between remote locations and a data processing center or between two computers.

TERMINAL: A typewriter-like keyboard and television-like screen used for communicating with the computer. Most microcomputers have the actual computer located inside the terminal.

THIRD-GENERATION COMPUTER: Computer developed during the 1960s that uses integrated circuits as the basis of processing. It normally has multiprogramming and online capabilities.

TIME-SHARING SYSTEM: A system in which a computer's time is sequentially apportioned among several different input-output terminals. Before microcomputers were introduced, time-share systems were very popular since it allowed users to purchase time on a remote computer rather than buying their own in-house system, thus saving a great amount of capital investment.

TOP-DOWN DESIGN: To develop a project by starting with a main idea and refining it until it is broken into workable and distinct modules.

TUTORIAL: A computer-assisted instruction application, used in lieu of a textbook, that introduces new material to students and then quizzes them over it.

TURNKEY PACKAGE: The combination of hardware and software to perform a specific business task. Use of such application packages is common in small businesses making their first computer purchase.

UNIVAC 1: The first commercially available computer.

UNBUNDLING: The separate pricing of hardware, software, and related services.

UNIVERSAL PRODUCT CODE: UPC. A series of bars varying widths that is used to identify an item; it is especially popular for use by grocery stores.

VARIABLE: A named storage location in the computer's memory.

VISICALC: See spreadsheet.

VLSI: Very Large Scale Integration. Refers to the number of electronic components on an integrated circuit-chip.

VOICE SYNTHESIZER: An output device which translates computer :t into human-like sounds.

WORD PROCESSING: The ability of a computer to allow the user move or change words, sentences, and paragraphs without retyping them.

Z-80: This is a beefed-up version of the 8080 microprocessor chip. It s faster speed and a larger number of instructions that it can perform.

ZONED DECIMAL MODE: A specific subset of the EBCDIC code in which each alphanumeric character is represented by eight adjacent binary digits.