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ABSTRACT

This handbook is the second in a series of five competency-based resource guides on microcomputer applications for vocational teachers. The seven units of instruction in this handbook are concerned with the content of the eight competencies included in the category, "Integrating Competency-Based Instruction into Vocational Education." Units are designed to prepare the teacher to do the following: (1) include job-specific applications of microcomputers in vocational curricula, (2) identify educational applications of microcomputers for inclusion in vocational curricula, (3) develop a plan to apply computer-based instruction to vocational curricula, (4) demonstrate an awareness of microcomputer software for developing computer-based vocational curricula, (5) write specifications for hardware and software based upon vocational curricula requirements, (6) implement a plan to apply computer-based instruction to vocational curricula, and (7) evaluate and modify applications of computer-based instruction to vocational curricula based on innovations in computer technology and work. 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. (YLB)

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Microcomputer Applications for Vocational Teachers: A Competency-Based Approach - Book B

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Integrating Competency-Based Instruction into Vocational Curricula

Illinois
State Board
of Education

Department of
Adult,
Vocational and
Technical Education

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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 by 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 post-secondary 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 facilitator 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.

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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

Dr. Gene L. Roth
Project Director

Dr. Dennis G. Tesolowski
Dr. Roger A. Rankin
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 4.4	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 programs by their respective state supervisors. Ninety-seven (97) vocational teachers (72%) responded to this survey. The following vocational disciplines were represented by this sample: agriculture; business, home economics; marketing and distribution; trade and industrial; and health occupations education. Mean ($\bar{x}$) compentency ratings were derived from respondents' ratings based on the following scale:

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

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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 (x) competency ratings were derived from respondents' ratings 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.

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 achieved their 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.

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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

Job-Specific Applications of Microcomputers for Inclusion in Vocational Curricula

UNIT OBJECTIVE

Upon completion of this unit, the learner will be able to select and apply strategies for including job-specific microcomputer applications within vocational curricula. This knowledge will be demonstrated through completion of the achievement indicators provided at the end of the unit.

SPECIFIC OBJECTIVES

Upon completion of this unit, the learner will:

1) Discuss how advancing computer technology affects vocational instructors' curricula content decisions.
2) Describe six strategies for determining vocational curriculum content that could be used by instructors when developing job-specific applications of computers.
3) Explain the relationship between competency-based vocational education (CBVE) and computer-based instruction.
4) Formulate five task statements for a vocation of interest which lists the use of the microcomputer and/or microcomputer software as a qualifier in the statements.
5) Write a task statement for a vocation of interest which considers the use of the microcomputer and/or microcomputer software as the performance activity of the statement.
6) Develop curriculum content for a total vocational program that includes job-specific applications of the microcomputer, using one or more of the curriculum content determination strategies contained within this unit.

Changing Technologies in Vocational Education

BY: DR. GENE L. ROTH

One of the first questions to resolve before beginning any course of instruction is the "what to teach" question. This is the curriculum content concern. For vocational educators, this concern is particularly imposing in that, by the very nature of their charge, vocational instructors have the continued responsibility for keeping the curriculum content abreast of technological advancements taking place in the field. An important role for vocational instructors is that of assuring that their vocational students are receiving the skills and knowledge that will make them competitive in the future job market. As the demand for new skills and knowledge emerges in the market place, the curriculum content of the vocational program must be modified to reflect these new expectations. Advancing technology thus creates a clear mandate for vocational instructors to assess and reassess the "what to teach" part of their curriculum. As a result, vocational educators are unable to rely solely on yesterday's tools, materials, or methods.

One new technology expected to affect almost all work places is the technology of the computer. Recent developments in the field of microcomputers seem particularly likely to influence the look of many business and industrial settings. Zahniser, Long, and Nasman (1983) report that a survey done in the early 1980s of 160 major corporations found that about half of the respondents used computers for in-house training. Of this number, about 71 percent indicated that they used microcomputers.

Microcomputer technology is providing increased speed and accuracy at price levels affordable to work places large and small. As one senior staff scientist with the Human Resources Research Organization in Alexandria, Virginia, comments, "The rapid and global increase in complexity of societies and their problems is happening at the same time as the rapid decrease in cost of computer power" (Hunter, 1983, p. 26). As increasing numbers of businesses and industries computerize more and more of their operations, their personnel offices will look for workers who possess microcomputer operation and application skills. Workers with such skills will receive preferential hiring treatment. Vocational instructors and the programs they direct will be expected, through the vocational curriculum content, to produce workers skilled in microcomputer operations needed within the work force. It is also probable that, as microcomputers change the manner in which job tasks are performed, technology will alter the content and level of education required to perform or hold a job (Nasman, 1982).

There also exists the position that vocational education should respond to the need for trained personnel in the fields of computer operations, programming, systems analysis, and technical representation (Charp, Bozeman, Altschuler, D Orazio, & Spuck, 1982). It is argued that vocational areas, within their present frameworks, can administer the types of programs that can help meet the growing need for trained personnel to fill these kinds of technical positions.

All these arguments serve to place vocational instructors in key positions with regard to microcomputer technology development and microcomputer operation training. For the learner to be meaningfully prepared for an intended vocation, job-specific applications of microcomputer processing must be merged into the curriculum content.

THE RELATIONSHIP OF COMPETENCY-BASED VOCATIONAL EDUCATION AND COMPUTER-BASED INSTRUCTION

Brock (1978) recognized that two technologies were traveling on converging paths in military training: (a) instructional systems design (i.e., a systematic course development process that utilizes job tasks, behavioral objectives, and job-relevant training programs) and (b) the application of computers to training. These two movements are converging in private industry as well.

The 1983 Research & Development Series No. 239A publication reports two separate surveys of companies demonstrating the wide-spread practice of computer-assisted instruction. Selected examples follow:

a) A 1981-82 survey conducted by Kearsley, Hillelsohn, and Seidel found

Xerox Corporation uses microcomputers to offer tutorial instruction for service representatives,

Guaranty Mutual uses microcomputers to provide simulated sales situations,

Eastman Kodak Company uses microcomputers to provide equipment troubleshooting practice for service representatives, American Express Company uses specially designed microcomputer-based simulators to teach data entry and inquiry skills,

b) While Quy and Covington's 1982 report cites random examples such as

General Motors and Heliflight systems of Texas use the microcomputer to deliver basic skills instruction,

Eli-Lilly's Elanco Division and Jeppenson Sanderson in Colorado use microcomputer drill and practice instructional strategies in company settings for salesperson training,

Mountain Bell at Tucson uses microcomputer in telephone installer training,

The U.S. Army's Redstone, Alabama site uses microcomputers in simulated cardiopulmonary resuscitation training. (Zahniser, Long, & Nasman, 1983, p. 25)

Given what is happening in the world of work, it follows that the technologies of microcomputer application and instructional systems design are converging in vocational education. The instructional systems design technology in vocational education is referred to as competency-based vocational education, but it is most widely recognized through its acronym—CBVE. It is the contention of this unit that the CBVE movement finds its logical partner in the budding microcomputer-based instruction technology currently being embraced by forward looking vocational programs. For the actual marriage to take place, however, the vocational teacher must first become equipped for the task of tying this nuptial knot. To achieve a productive, lasting union, one which lives up to its promises, the instructor must look for those aspects of each technology which will provide for mutual support. For the individual vocational teacher, standing solidly in the expertise of one vocational content area, the basic question becomes, "How do I identify job-specific applications of microcomputers which are appropriate for the curriculum content of my program?"

STRATEGIES FOR DETERMINING MICROCOMPUTER RELATED CURRICULUM CONTENT

The work of Finch and Crunkilton (1979) provides an in-depth study of curriculum development processes in vocational education. The writers suggest that there are six strategies or approaches that the vocational curriculum writer must use when faced with the problems of determining curriculum content: (a) philosophical basis, (b) introspection, (c) function approach, (d) occupational analysis, (e) critical incident technique, and (f) delphi technique. We will briefly examine each strategy and note how it might be used in moving toward the answer to our question about identifying job-specific applications of microcomputers appropriate for the content of a particular program.

Using the **philosophical basis** approach, the instructor considers the curriculum content to be based on a philosophy or set of beliefs which undergird the decisions that form the curriculum content. With this approach, the guiding principle of the vocational teacher might be that computer competency is mandatory for complete human development in today's world. In this light, computer training is not a means to an end, but an end in itself, and every curricular decision would be based on this perspective. The **introspection** approach sees curriculum content as determined by the amount of training, experiences, and knowledge needed by workers to perform a job. Adopting this perspective would lead the vocational teacher to project ideal marketplace skill levels. Aspects of computer usage would be incorporated into the vocational program which mirrored those skills necessary to perform potential future tasks. The **function approach** is a systematic approach similar to the introspection approach, except that the focus is on an inclusive examination of worker functions performed within an entire business or industry. Thus, the computer skills deemed to be necessary components of the vocational program would be the skills and knowledge common throughout the work place.

Using **occupational analysis,** the vocational instructor surveys workers and/or supervisors to determine job-specific microcomputer applications for a particular job or job cluster. A similar technique, coupled with direct observation, can focus on worker values and attitudes. This approach is called the **critical incident technique,** which concerns itself with the curriculum development in terms of effective components and content. Thus, the vocational teacher interested in this approach would focus on those factors which make workers feel positively and negatively about the use of microcomputers in their work. A final approach is the **delphi technique.** This perspective considers curriculum content to be established best through a process of achieving a consensus of knowledgeable individuals. A vocational educator using this approach might survey a number of programs currently using microcomputer assisted instruction to seek a consensus among participants regarding the ideal curriculum content for merging occupations when there is a limited number of knowledgeable workers, supervisors, or instructors available for a particular type of job or job cluster.

It is important to remember, as one considers each of the approaches, that, while the six strategies may be viewed in isolation, they need not be. Each strategy has strengths and weaknesses for particular educators and specific situations, so combinations of strategies may prove to be most beneficial when introducing microcomputer competency into vocational curricular content.

It will be challenging for instructors to sift through data in order to specify which microcomputer oriented tasks should appear in the curriculum. Once this task is completed, however, the more imposing task may be to originate the identified competencies into an instructional format. At this point CBVE can make its important contribution to the marriage. The accurate depiction of learner activities and progress within these activities has made CBVE a successful means of training students in the recent past. The move by vocational educators toward competency-based instruction is predicated on personal experiences and research that indicate that CBVE produces better results for students. Researchers have collected sufficient hard data to identify CBVE as an approach to training that is generally superior to traditional approaches in terms of student outcomes (Blank, 1983). Microcomputing, because of its hierarchical knowledge system and skill structure, is a natural for a CBVE approach. The marriage between microcomputing and CBVE should be viable.

Instructors who intend to use CBVE delivery are well-advised to rely heavily upon occupational analysis strategies which distinguish work tasks requiring critical training attention from tasks that are merely "nice to know" but unessential learning requirements (The Center for Vocational Education, R and D Series, No. 121). Occupational analysis has proven itself time and again as an effective tool in situations where uncertainty surrounds critical performance requirements. An occupational analysis approach insures that the inclusion of microcomputer technology in the content curriculum will add only those tasks systematically identified as critical training tasks by workers who represent the profession.

ANALYZING MICROCOMPUTING AS QUALIFIERS FOR TASK STATEMENTS

The process of occupational analysis is an objective and comprehensive method for determining curriculum content. An essential component of this process is the development and refinement of task statements. Grouped task statements form a synoptic task list that represents work skills and knowledge of a specific vocation. An initial task listing can be used to create a survey instrument to be distributed to workers in the trade or occupation of interest. This list can be refined by administering the survey to workers and soliciting their judgment as to the significance of each task. Typical types of judgments requested include an assessment of the importance of each task listed, the frequency of performance of each task, and the estimated amount of training required to adequately perform the task.

This task listing approach can be utilized by vocational teachers to determine which microcomputer competencies are most valued by the work place. A well written task statement consists of an action verb, the object or element being acted upon, and a qualifier (as needed). The qualifier in the task statement is meant to differentiate the task for comparable work activities, to limit and define the magnitude of the concern, or to communicate unambiguously exactly which task is being addressed (The Center for Vocational Education, R and D Series, No. 122). For example,the vocational instructor may choose to consider the workers' use of microcomputers and related software applications as qualifying components of task statements, rather than as independent task statements themselves. From this perspective, microcomputers are seen as tools or job-aids that assist workers in completing a work activity. The emphasis in this view is on the task to be done; the computer system enables the worker to accomplish the work assignment in more effective and efficient ways. Thus, the computer is a qualifier, an enabler.

The following sample task statements feature microcomputer software applications as qualifiers:

a. Record and project business cash flow transactions using a microcomputer spreadsheet software program.

b. Construct pie charts of monthly expenditures using a microcomputer graphics software program.

c. Develop form letters using a microcomputer word processing software program.

d. Maintain customer records using a microcomputer filing software program.

e. Keep inventory records using a data based management microcomputer software program.

The five sample statements demonstrate the important contribution the qualifying phrase makes to the task description. Each stem specifies a task to be performed while the qualifier indicates that a particular tool should be used in its performance. Without the qualifier, the vocational student would be misinformed of the exact nature of the skills required by the employer. Likewise, the vocational instructor's work would be only partly accomplished if the qualifying statement were not taken into account for the task specified. The overall concern for both the vocational student and the vocational teacher is that the student learn to perform specific job tasks applying computing skills that will enable those tasks to be performed most efficiently and effectively.

ANALYZING MICROCOMPUTING AS INDEPENDENT TASK STATEMENT

Although microcomputers can be viewed as tools which help workers accomplish work assignments, vocational instructors may decide that it would be best to treat the microcomputer as a piece of equipment that merits consideration for special task statements. Often, instructors who favor this approach believe that before one can learn to perform a task on the microcomputer, one must first learn the basics of how to operate one. This belief is based on the data that some basic skill training should precede actual job related performance training.

From this perspective, the vocational teacher would be better off to construct the task listing within a separate section of course competencies that pertains to the use of specialized equipment. In this case, the reader would find basic computer competencies listed separately from the job task description to be found in an earlier section. Those competencies could be based, as described before, on a survey of workers actually using microcomputers on the job. Items on the survey would include the types of microcomputers being purchased, the amount of use, the most common peripherals, and the most common software applications.

The results of this survey should give the instructor insight into the particular brands of microcomputers on which to focus instruction. They would also be informative regarding types of modems, printers, and storage devices in use. This data is valuable when determining the microcomputer hardware to be purchased for the vocational program. The responses regarding software are of great importance because software manufacturers often produce their programs for numerous hardware devices. Thus vocational students could practice on appropriate software programs even though the hardware might be manufactured by a different company.

A related approach would be to create a special section on software application task analysis. In this instance, software application packages could be listed separately (e.g., data base, word processing, etc.) and related skills delineated. Job-specific applications, as opposed to generic applications, may be of interest. Generic applications are software programs, such as word processing or spreadsheet, which serve the common needs of many people while job-specific software is designed for particular users. The programs in the job-specific category are sometimes referred to as vertical market applications, and could include such specific tasks as church management, designing retaining walls, woodtruss production, medical record keeping, apartment managing, insurance processing, and stress analysis for planes. Ellen Rony, an independent technical writer whose specialty is vertical market software, believes that job-specific software will play an increasingly important role in the computerization of professions and industries (Rony, 1983). On the other hand, Bill Grout, who reviews business software for the *San Francisco Chronicle*, suggests caution to firms interested in personalized applications. It is his feeling that, because these programs are directed toward limited audiences, they are expensive and yet may not even meet specific job requirements (Grout, 1983/1984). He does agree, however, that vertical market applications are experiencing increasingly better times.

Using the task analysis provided by the instructor in this special section of the course outline, the vocational student could then follow through the tasks generally performed by selected software packages. This procedure would permit employers to quantify the degree of proficiency workers might/should attain with various software packages. Accordingly, vocational instructors could use the data to help them integrate appropriate software packages into vocational curriculum and instruction.

TWO JOB-SPECIFIC APPLICATION EXAMPLES

Drafting

A publication of the National Center for Research in Vocational Education cites the use of the DACUM (Developing a Curriculum) process to identify drafting competencies for computer aided drafters. The DACUM process (Adams, 1975) is a curriculum development method originally used by the Experimental Projects Branch, Canada Department of Regional Economic Expansion and the General Learning Corporation of New York. The process is based on three assumptions: (a) expert workers can define and describe their jobs more accurately than anyone else; (b) any job can be effectively described in terms of tasks that successful workers in that occupation perform; and (c) all tasks, in order to be performed correctly, demand knowledge and certain attitudes from workers (Miller-Beach, 1980)

In the National Center for Research in Vocational Education publication (Abram, Ashly, Hofman, & Thompson, 1983), a DACUM panel of Computer Assisted Design users and educators developed the competencies for the drafters. Figure B.1.1. depicts the resulting entry level job tasks defined for computer aided drafters and the major impact of these tasks on traditional drafting curricula.

OPERATE SYSTEM

- Boot system/Start up procedure
- Log in/on terminal
- Load start file
- Execute drawing assignment
- Manage files
- Plot out drawings
- Store a file
- Shut down a system
- Log off/out

EXECUTE DRAWING ASSIGNMENT

Change Existing Drawings or Details

- Plan drawing changes
- Find drawing file
- Load drawing file
- Executive changes
- Obtain approvals/check drawing changes
- Plot out drawing
- Update file

Document Original Designs

- Plan drawing layout
- Load start file
- Execute detailed drawings
- Obtain approvals
- Plot out drawings
- Store files

EXECUTE/CHANGE DETAILED DRAWINGS

- Set up drawing format
- Create drawing components
- Confer with designer/engineer
- Compose drawings

COMPOSE DRAWINGS

- Understand and use system commands
- Create and manipulate geometry
- Select geometry
- Add text
- Rotate views
- Move views
- Scale views
- Dimension a drawing

Two features of the DACUM process make it a realistic alternative for instructors as a method of determining curriculum content. The meeting format allows the information to be generated in a relatively short period of time and it is a fairly inexpensive method for identifying worker tasks if the panel is composed of local personnel. This process would likely generate local business and industrial support. The DACUM process has proven credibility and has been recognized as a procedure that can identify worker tasks in a manner similar to that of occupational analysis.

Marketing and Distributive Education

Howerton (no date) has examined the importance of students being able to apply microcomputer knowledge and skills to solve realistic business problems. His work features a list of 226 microcomputer skill and knowledge statements that could logically be integrated into marketing and distributive education curricula. The followng are selected examples from the section on the subject of advertising:

> Skill: Developing advertising layout and illustrations using stored information and the graphics capabilities of the (micro) computer and printer.
>
> Knowledge of or Understanding: Advertising using electronic mail or voice mail and message systems.
>
> Skill: Use (micro)computers to prepare an advertising budget and schedule of advertising.
>
> Skill: Use on-line inventory management systems to verify the availability of merchandise in the quantity necessary to back-up an advertisement.
>
> Skill: Use (micro)computer for archival storage of advertising.
>
> Skill: Use (micro)computer software to evaluate the effectiveness of advertising campaigns.
>
> Skill: Maintain customer/prospect or vendor lists on (micro)computers.
>
> Skill: Access data bases to identify new prospects.
>
> Skill: Use (micro)computer models of populations to select market segmentation strategy.
>
> Skill: Use data bases to retrieve information on special events in the life of customers to which personalized advertising can be directed (e.g., birthdays, anniversaries, weddings, funerals, graduations, etc.).
>
> Skill: Use (micro)computers to keep informed about sales promotion activities in the store.
>
> Skill: Use on-line inventory management systems to locate advertised merchandise in the store and to check on its availability.
>
> Skill: Use (micro)computer printouts of advertised merchandise to spot-check displays for refilling, rearrangement, or notifying sales force of dwindling supply.
>
> Skill: Use on-line inventory management system to check pricing and availability of merchandise in the store against competitors' advertised prices. (Howerton, no date, p 234)

ACHIEVEMENT INDICATORS

1) Discuss how advancing computer technology affects vocational instructors' curricular content decisions.
2) Describe six strategies for determining vocational curriculum content that could be used by instructors when developing job-specific applications of microcomputers.
3) Explain the relationship between competency-based vocational education (CBVE) and computer-based instruction.
4) Formulate five task statements for a vocation of interest which lists the use of the microcomputer and/or microcomputer software as a qualifier in each statement.
5) Write a task statement for a vocation of interest which considers the use of the microcomputer and/or microcomputer software as the performance activity of the statement.
6) Develop curriculum content for a total vocational program that includes job-specific applications of the microcomputer, using one or more of the curriculum content determination strategies contained within this unit.

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Unit 2

Identify Educational Applications of Microcomputers for Inclusion in Vocational Curricula

UNIT OBJECTIVE

Upon completion of this unit, the learner will be able to identify educational applications of microcomputers for inclusion in vocational curricula. This knowledge will be demonstrated through completion of the unit achievement indicators.

SPECIFIC OBJECTIVES

Upon conclusion of this unit, the learner will be able to:

1) List the main reasons why microcomputers are more than just another instructional tool for vocational teachers.
2) Define the following categories of educational applications of microcomputers: (a) learning from, (b) learning with, and (c) learning about.
3) List five competencies for teachers using microcomputers for instructional purposes.
4) Cite examples demonstrating how courseware packages can function in the vocational classroom to supplement, tutor, or manage instruction.
5) List three controversial issues regarding computer usage in schools and discuss each issue in relation to vocational education curriculum.
6) Delineate the potentially strong relationship between microcomputer usage and problem-solving skill integration in vocational curriculum.
7) Explain why vocational curricula of the future must creatively reflect computer innovations in work.

Identify Educational Applications of Microcomputers for Inclusion in Vocational Curricula

BY: DR. GENE L. ROTH
DR. RICHARD A. McEWING

MICROCOMPUTERS: MORE THAN ANOTHER INSTRUCTIONAL METHOD

Effective vocational teachers seek continuing input for developing or changing vocational curricula from a combination of fellow vocational teachers, advisory committee members, and workers in the field. With the arrival of microcomputers on the work scene, it follows that vocational educators will once again be relying on these data sources for helping to make the determination as to how, when, and where microcomputer applications should be incorporated into vocational curricula and instruction.

In the last few years, the topic of "microcomputer as instructional tool" has occurred frequently in the professional literature. Microcomputer usage has been the topic for discussion at educational conferences and workshops, while an ever-widening array of journals continue to feature computer technology as the "in" innovative tool for educators. However, with all of this attention given to educational computing, there has been little concern for the unique computing needs of vocational teachers.

The vocational teacher employs instructional strategies similar to those used by the nonvocational teacher. Therefore, a large segment of the literature written about nonvocational educational computing is relevant to vocational teaching. However, little has been written about a major difference which affects vocational educators as they interact with computers. Vocational instructors, because of their charge to prepare workers for the workplace, must use computer technology as more than just an additional instructional tool. Microcomputers will form a significant segment of vocational curricula because they are major tools of work that vocational students must learn to operate (Rodenstein & Lambert, no date).

Instructors need to become comfortable with microcomputers as integral parts of their programs. Computers are not just additional pieces of audio-visual equipment that can be periodically wheeled out from the storeroom to spice-up a presentation. Microcomputers are now, and increasingly will be, used as tools in jobs for which vocational programs are preparing students to work. As microcomputer usage expands throughout the workforce, the need for vocational training in this technology expands proportionally. Sooner or later, all vocational instructors must not only deal with microcomputer systems, but they will find themselves modifying curricula content to accommodate this new technology.

THE PUZZLE AND PIECES: VOCATIONAL CURRICULA AND COMPUTER TECHNOLOGY

Instructional content must be modified to reflect computer technology—few vocational teachers will disagree with this assertion. A variety of differing viewpoints surface, however, when educators move to the question of how microcomputers should be introduced to begin this modification process. One approach recommends that a three step process be used to introduce educational computing into vocational programs: a) development of computer literacy, b) modification of existing vocational course content, and c) development of the ability to use and operate microcomputers (The National Center for Research in Vocational Education, 1983).

Stewart (1981) has provided a rubric for microcomputer applications that categorizes use as "learning from, learning with, and learning about." (1) Learning from computers involves educational computing activities that are included in computer assisted instruction (CAI) and computer managed instruction (CMI). (2) Categories C and E of this microcomputer handbook treat these types of educational computing. (3) Learning with microcomputers permits students to solve vocational education problems with simulations and other computer-based problem-solving activities. (4) Several examples of learning with problem-solving and simulation activities for educational computing are included in the work of Howerton (no date), which is featured in another section of this unit. (5) Learning about computers, which focuses on the computer as the topic of instruction, is often referred to as computer literacy. (6) Learning about is the subject of interest of several of the units of Category A of this handbook.

ERIC

EDUCATIONAL APPLICATIONS OF MICROCOMPUTERS FOR VOCATIONAL INSTRUCTORS

Learning from, learning with, and learning about microcomputers are broad classifications that lead vocational teachers to seek more specific applications in each area. Potentially, educational computer applications for teachers should be viewed as a means of increasing efficiency and effectiveness in the day to day responsibilities of teaching. Which types of microcomputer skills and knowledge will make vocational teachers more effective in their jobs? The Texas Educational Agency (no date) outlines a series of microcomputer competencies for public school educators. Most of these competencies are as relevant to vocational teachers as they are to general public school educators. One of these competency areas deals with the educational applications of microcomputers:

RATIONALE

Computers are powerful tools that may free teachers from unproductive routines, offer more individualized instruction, and aid student productivity and creativity. Such potential may become a reality as educators become aware of practical applications of computers. Indeed, computers will be accepted in education when teachers learn to use them successfully in the daily routine of teaching.

What educators learn about computers should be useful and transferable so that educators themselves will lead the way in creating new applications to teaching.

COMPETENCIES

To use computers for instructional purposes, educators should be able to:

1. Characterize the use of the computer as an object of instruction, as an instructional medium, and as a problem-solving tool.

2. Identify various options for using computers in an instructional setting for teaching and classroom management, such as:

*computer assisted instruction (CAI)
*computer managed instruction (CMI)
*problem solving
*test scoring
*word processing
*materials generation and management
*data-base management

3. Differentiate between instructional computer applications such as drill-and-practice, tutorial, simulation, and problem solving.

4. Apply and evaluate the general capabilities of the computer as a tool for instruction.

5. Use computer courseware to individualize instruction and increase student learning. (p.2)

These applications imply changes from traditional modes of vocational teaching. Microcomputers will definitely influence vocational curriculum and instruction; this degree of influence will be governed by vocational instructors' willingness to attempt new and different educational applications with microcomputers.

Computers have the potential to absorb much of the labor-intensive responsibilities of the vocational instructor. Microcomputers can be used to reduce the time and effort that teachers devote to burdensome tasks that are scattered throughout a typical teaching day. Additionally, teachers can utilize microcomputers as tutorial aids in a fashion that permits a greater amount of individualized instruction to occur. Courseware that assists teachers in the classroom in maximizing their teaching productivity can be grouped into three categories (Blum, 1982):

a) "Adjunct" applications will permit teachers to employ educational computing activities as supplements to regular vocational curricula. Problem-solving, simulation, and drill-and-practice exercises may be used to enhance existing curricula.

b) Software may be integrated into vocational curricula to serve as a central focus for a unit of instruction. In many instances, the computing system can be tutorial, teaching concepts and then providing practice on these concepts. Progress records can be maintained by the microcomputer with minimal assistance from the teacher.

c) Software for managing instruction will permit teachers to use microcomputers to keep track of student progress and to manage and store student data. Once again, Category E of this handbook documents the many facets of computer managed instruction.

Although the focus of this handbook is for vocational teachers, a brief glimpse of applications used by other educators may help vocational teachers recognize possible additional computing activities. Management functions, such as monitoring school attendance figures and maintaining student records, are well-defined applications of microcomputers. In-service planners can feature computer technology as a topic for the professional development of faculty and staff to complement the infusion of computers into planning, implementing, and evaluating curricula and instruction. Educators need to become familiar with software packages for vocational guidance, as well as diagnostic and prescriptive software. Finally, the topic of computer science itself, which includes programming languages and skills using computer components, may become an important part of select vocational programs (Hofmeister, 1982).

CONTROVERSIES REGARDING EDUCATIONAL APPLICATIONS OF MICROCOMPUTERS AND THEIR RELATIONSHIPS WITH VOCATIONAL CURRICULA

Although many authors extol the benefits of educational computing, some writers believe that current applications for computer-based instruction are not maximizing the uses of the technology. Many types of educational software are considered to be no more than "electronic page turning." That is, some software does not use the graphic and sound capabilities of microcomputers to immerse users in creative learning activities.

Moursund (1983) describes twelve controversial issues involving the uses of microcomputers in schools. His intent is to call readers' attention to several issues that are yet to be resolved regarding educational computing. Three of those issues pertain directly to the educational applications of microcomputers and their relationships to curricula.

Drill and practice versus more intense levels of computer usage

Many instructors utilize microcomputers for drill-and-practice exercises for their students. Other teachers have students perform activities that require knowledge of word processing, electronic spreadsheets, data base systems, and/or programming languages. Research is needed to help teachers determine which are the best uses of microcomputers in vocational education.

Content of traditional vocational curricula

Vocational teachers will increasingly discover that microcomputers can be a significant aid to students in problem-solving activities within vocational curricula. Teachers must determine what curriculum problems students should solve with paper and pencil, and what curriculum problems should be worked through with the aid of computers.

Publisher control of curricula

Books and manuals play a significant part in the formation of vocational curricula. Whether vocational teachers like it or not, publishers of vocational education textbooks have a major impact on curricula content for local vocational programs. However, as more and more software is used in the instructional delivery system, textbook publishers will have less control over the curricula content of vocational programs.

Vocational instructors must take a hard look at existing vocational curricula and the influence that microcomputers are likely to exert upon them. As vocational teachers examine their programs, they should also question the validity of using the standard selection criterion, "Is it contained in the curriculum?" Perhaps a better selection criterion would be, "If it is not in the curriculum, then let's consider it!" This attitude might create the opportune changes in vocational curricula that will prepare students for the fast paced rate of change that they will encounter in the workforce (O'Brien, 1983).

EDUCATIONAL COMPUTING: OPPORTUNITIES FOR INTEGRATING PROBLEM-SOLVING SKILLS INTO VOCATIONAL CURRICULA

It will take research, trial and error, and a considerable amount of time and effort by vocational education personnel before the best educational applications of microcomputers are determined for vocational programs. One of the more obvious assets of educational microcomputer applications is their ability to help students develop and practice problem-solving skills (Eisele, 1981).

Humans seem to have an inherent tendency to gain satisfaction from the discovery of new information. Microcomputers have features that encourage a student's sense for and interest in inquiry (O'Brien, 1983).

Vocational instructors can build educational computing activities into curricula that revolve about learners' inquisitive natures. To effectively use microcomputers in problem-solving situations vocational instructors must concentrate less on using microcomputers to teach, and more on teaching students how to use the microcomputer to discover (Howerton, no date).

To develop relevant computer-based instruction, the focus for educational computing might be initially placed on the application of computer technology to the solving of problems already contained within vocational curricula. Students trained to use microcomputers for solving work related problems will develop skills highly transferable to entry level employment. However, prior to applying microcomputers to solving work related problems, students need to develop higher level skills. Students need to identify and analyze the work related problem, determine data inputs and outputs, and utilize a logical progression of steps to solve the problem. In essence, vocational students need to master a problem-solving process and incorporate the microcomputer into this process (Howerton, no date). Problem-solving applications promise to be the types of microcomputer applications that will most help vocational students succeed in using computer technology on the job after graduation from vocational programs.

THE NEED FOR CREATIVE APPLICATIONS OF MICROCOMPUTERS IN VOCATIONAL CURRICULA

The extent to which vocational curriculum and instruction is modified by the incorporation of educational applications of microcomputers should be viewed as a product of teacher and student creativity. However, most efforts at integrating educational applications of microcomputers into curricula have fallen considerably short of their potential for creative educational computing.

Programs designed to drill students in basic facts are the most easily derived and implemented forms of computer assisted instruction. Unfortunately, educational software of this type is too often written in a simplistic mode of educational computing that becomes, essentially, a very costly method of drill (Becker, 1982). It is a form of computer assisted instruction that is little more than an electronic workbook.

Vocational instructors should be most interested in microcomputer applications that do not necessarily fit existing vocational curricula. Applications that maximize the sound and graphic capabilities of microcomputers, that introduce students to word processing and budget forecasting, and that let students enjoy some intellectually challenging recreational activities with microcomputers are most exciting (Becker, 1982). The attribute of educational computing that will keep microcomputers a major factor for education in the 1980s is that learning with microcomputers can be terrific fun and thus motivating. The ultimate successful integration of microcomputers into vocational curricula will depend on such factors as the quality of software, the follow-up activities that instructors employ in conjunction with educational computing, and the manner in which instruction is combined with the student's total instructional and socialization program (Thelen, 1977).

Where will computer technology lead instructors who are pursuing state-of-the-art vocational curricula? The answer to that question will be a function of time and effort, as vocational education researchers, teachers, representatives of the workforce, and others work together to plan, implement, and evaluate exemplary curriculum projects that demonstrate the creative educational applications of microcomputers. Key questions remain to be resolved with respect to the relationship of computer-based instruction and vocational curricula.

Vocational education research efforts must focus on the unknowns of computer-based vocational curricula. If such data are not available, computers in vocational education will be relegated to the same status as teaching machines—unwanted and unused (Shively, 1984). Vocational curricula and microcomputers are relatively untested allies; their well-conceived association may well revitalize the foundations of vocational curriculum and instruction.

SUMMARY

Identifying educational applications of microcomputers for existing and new vocational curricula has been the focus of this unit. The varying roles (drill and practice, tutoring, assisting, and managing) microcomputers play and will play in vocational education is the subject of the work of several authors cited. While a number of suggestions for using computers are offered, it still remains for the effective vocational teacher to experiment with educational applications of microcomputers to determine what works best with his/her vocational curricula. From the authors' viewpoint, those applications which feature problem solving and creativity will be most beneficial because they will generate the most positive, long lasting effects.

ACHIEVEMENT INDICATORS

1) List the main reasons why microcomputers are more than just another instructional tool for vocational teachers.
2) Define the following categories of educational applications of microcomputers: a) learning from, b) learning with, and c) learning about.
3) List five competencies for teachers using microcomputers for instructional purposes.
4) Cite examples demonstrating how courseware packages can function in the vocational classroom to supplement, tutor, or manage instruction.
5) List three controversial issues regarding computer usage in schools and discuss each issue in relation to vocational curriculum.
6) Delineate the potentially strong relationship between microcomputer usage and problem-solving skill integration in vocational curriculum.
7) Explain why vocational curricula of the future must creatively reflect computer innovations in work.

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Unit 3

Develop a Plan to Apply Computer-Based Instruction to Vocational Curricula

UNIT OBJECTIVE

Upon completion of this unit, the learner will be able to develop a plan to apply Computer-Based Instruction to a vocational curriculum using a systems approach. This knowledge will be demonstrated through completion of the achievement indicators.

SPECIFIC OBJECTIVES

Upon completion of this unit, the learner will be able to:

1) List three uncertainties vocational teachers may encounter during the initial stages of integrating Computer-Based Instruction with vocational curricula.
2) Define the term "systems approach."
3) Delineate each of the eight steps of a systems approach to curriculum development.

Uncertainties for Vocational Teachers Regarding Integrating Computer-Based Instruction With Vocational Curricula

BY: DR. GENE L. ROTH

The preceding two units focused on the identification of job-specific applications of microcomputers (B.1) and the identification of educational applications of microcomputers for inclusion in vocational curricula (B.2). Successful implementation of the identified job-specific and educational applications of microcomputers into curricula hinges on the vocational teacher's ability to formulate plans for integrating Computer-Based Instruction with vocational curricula. Several uncertainties confront vocational teachers during the initial stages of applying CBI to vocational curricula:

1. How much orientation will students need for CBI?
2. What will determine student objectives for CBI?
3. Which instructional strategies mesh well with CBI?
4. Should instructional materials be purchased for CBI components of vocational programs, or are teacher-made instructional materials preferable?
5. How is CBI different from other forms of instruction and how will such differences affect vocational curricula?
6. When and how should CBI be evaluated?
7. How should CBI be altered in light of evaluative outcomes?

Vocational teachers will encounter many new problems with CBI and need to answer questions similar to the [illegible] listed above as they experiment with this new instructional technology. This unit introduces vocational teac[illegible] a systems approach for planning applications of CBI to vocational curricula.

A SYSTEMS APPROACH TO CURRICULUM DEVELOPMENT

What is meant by the phrase "systems approach"? Calhoun and Finch (1982) describe a systems approach to vocational curriculum development as a rational, problem-solving method of analyzing the educational process. Instructors should view the system in its entirety, focusing on students, teachers, curricula, instructional materials, teaching strategies, learning environments, and evaluation practices.

The main reason for enacting educational reform is to achieve specific changes in student behavior. These changes must be accomplished within the resource parameters of the educational system. Educators who employ a systems approach to improve educational effectiveness clarify their educational objectives and restructure the educational process within resource parameters to ensure student achievement of these objectives (Calhoun & Finch, 1982). It is a system without surprises. Students and teachers know exactly what their roles and achievements must be to achieve the educational objectives defined by the system.

INSTRUCTIONAL SYSTEMS DEVELOPMENT FOR CBI AND VOCATIONAL CURRICULA

A systems approach for curriculum development requires planners to look at the segments of curriculum and instruction both as separate entities and as a whole. A first task in a systems approach is to create a graphic model of the interrelationships of the component steps of curriculum development.

Figure B.3.1 presents a model of instructional systems development for incorporating Computer-Based Instruction into vocational curricula.

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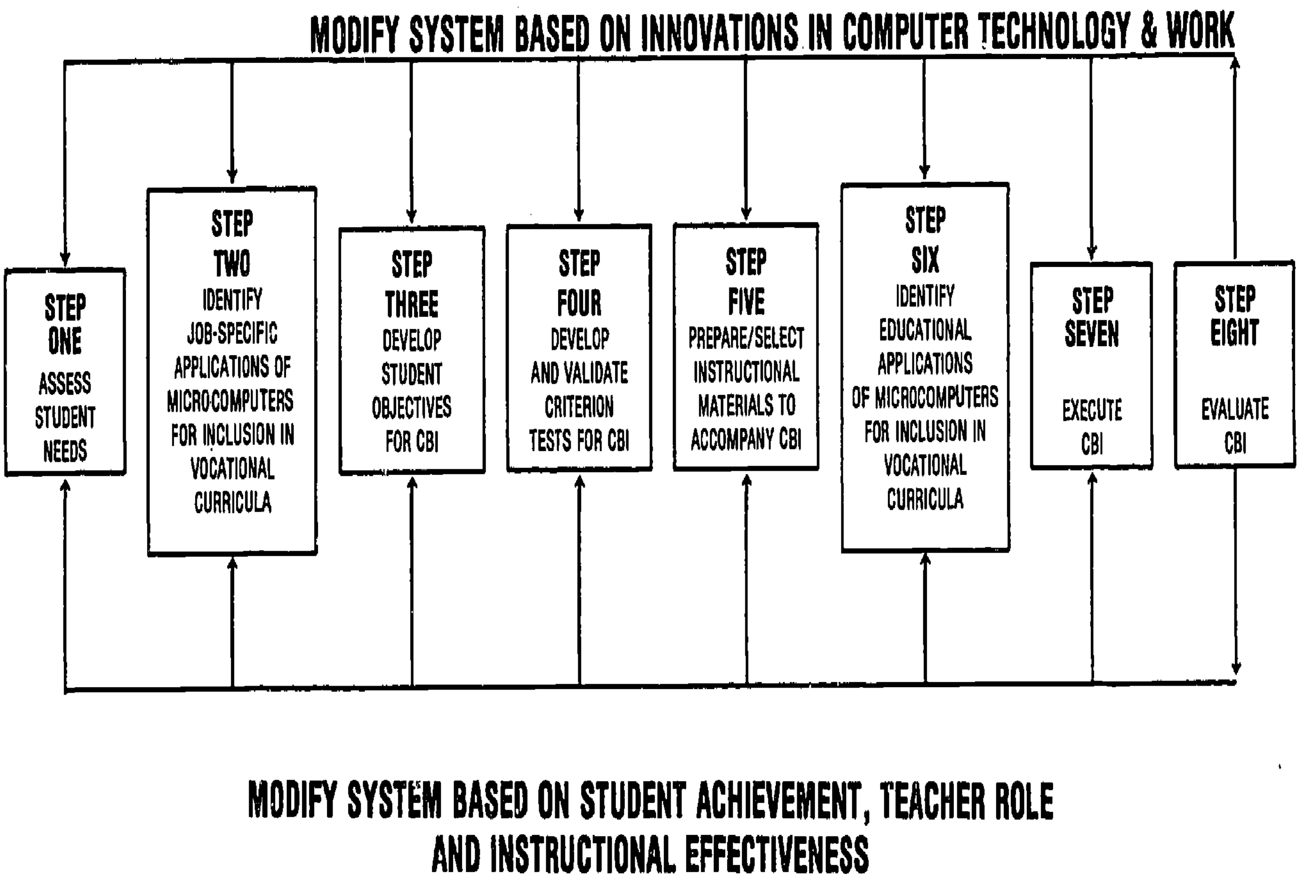
INSTRUCTIONAL SYSTEMS DEVELOPMENT FOR COMPUTER BASED INSTRUCTION AND VOCATIONAL CURRICULA



The model illustrates both aspects of integrating CBI into vocational curricula (Category B of this handbook) and considerations for planning, executing, and evaluating CBI (Category C of this handbook). Since several components of this model are detailed in other units of this document, this unit provides a useful overview of each component of the model.

Step I Assess Student Needs

Vocational educators, probably more so than their nonvocational counterparts, are attuned to the idea that programs must meet the needs of students and the needs of the larger community. Instructors garner support for improving vocational programs by involving staff, students, parents, community leaders, and business executives in identifying those student needs that should be served by the program (Calhoun & Finch, 1982).

Vocational educators using a systematic approach to needs assessment should use this broad based support group in order to determine how educational computing will serve student needs in vocational programs. To do this, instructors can follow three steps for identifying student needs (Calhoun & Finch, 1982):

1. Determine desired student outcomes for the vocational program.
2. Collect, analyze, & interpret data that indicates the degree to which objectives are being achieved.
3. Based on identified needs, administer a questionnaire to student, parent, teacher, business, and community representatives to seek input regarding
   A. Omission of major needs
   B. Extent of agreement with identified needs
   C. Priority of needs

The vocational curriculum development process works best as a team approach because the assessment of student needs yields valid results only when the procedure is systematized to receive input from a number of interested parties.

Step II Identify Job-Specific Applications of Microcomputers for Inclusion in Vocational Curricula

One of the challenges facing vocational instructors is keeping curriculum content in step with advancing technology. Vocational teachers must try to provide students with opportunities to learn skills and knowledge within a vocational curriculum that features the most accepted innovations in the world of work.

Innovative computer technology affects the roles of many workers. As microcomputer technology expands in business and industrial settings, vocational curriculum content will be expected to mirror these microcomputer applications in the workforce. The identification of worker tasks specific to using microcomputers is the cornerstone of a competency-based vocational curriculum. Readers are directed to Unit B.1 of this document for an examination of various methods for identifying job-specific applications of microcomputers for inclusion in vocational curricula.

Step III Develop Student Objectives for Computer-Based Instruction

Educational computing activities for students should be based on measurable performance objectives derived from task statements that represent a specific vocational discipline. These student objectives for CBI should be drawn from the needs assessment and outcomes of identifying job-specific applications of microcomputers for inclusion in vocational curricula. Vocational instructors will need to use vocational curriculum content derivation strategies (see Unit B.1) to determine which job-specific applications of microcomputers are appropriate for inclusion in vocational curricula. The selected applications should then be grouped into instructional units.

All CBI units should focus on student performances. Lessons should be directed toward student skill development using microcomputer applications that will be useful later on the job. Educational objectives in CBI should contain three components: a) behavior(s) to be exhibited, b) conditions under which the behavior is to be performed, and c) standards by which the performance is to be judged. Thus, vocational students will understand what their behaviors must be for success and how those behaviors will be evaluated.

Step IV Develop and Validate Criterion Tests for CBI

Vocational instructors must develop activities and criteria for realistically measuring student achievements in CBI. Assessment activities should include hands-on experiences in microcomputer operation that require students to successfully handle simulation and problem-solving situations.

Teachers who integrate CBI into vocational curricula will find the criterion referenced test most suitable to their evaluation purposes. Criterion referenced tests are constructed so that student performances are measured against specific standards. That is, students are encouraged to work to achieve pre-determined standards for specific learning tasks. In this way, student achievement is not measured by comparing his or her progress to other students in the program. Students learning in a CBI environment should be permitted to proceed at their individual paces toward the accomplishment of learner objectives.

Step V Prepare/Select Instructional Materials to Accompany CBI

Many instructional materials to support CBI may be obtained from commercial outlets. However, because vocational education often serves uniquely defined local needs, vocational teachers will need to develop additional instructional materials in order to successfully integrate CBI into vocational curricula. Units C.5-C.8 of this document discuss the development of software and instructional materials to accompany the performance objectives of vocational curricula.

Step VI Identify Educational Applications of Microcomputers for Inclusion in Vocational Curricula

A key decision for curriculum planners is to ascertain which educational applications of microcomputers are best suited for the specific educational objectives of vocational curricula. Educators recognize the overlap between curriculum and instruction. Therefore, instructors cannot integrate microcomputing skills and knowledge into vocational curricula without determining the appropriate teaching strategies associated with Computer-Based Instruction. Units B.2 and C.1 provide readers with ideas for infusing educational applications of microcomputers into vocational curricula. In particular, Units B.2 and C.1 describe five educational applications of microcomputers: drill and practice, tutorial, problem solving, simulation, and gaming.

Step VII Execute CBI

The CBI approach to curriculum and instruction asks vocational teachers to serve less in lecturing roles and more in guiding roles. This facilitating function of vocational teachers will include diagnosis of learning problems, prescription of learning sequences, formation of small group activities, development of the student's ability to engage independently in such discussions, and facilitation of self-paced CBI activities (Calhoun & Finch, 1982). Unit C.10 centers on the effective execution of CBI.

Step VIII Evaluate CBI

Wentling (1980) offers five statements that help vocational educators clarify decision making and evaluation in a systems development approach:

1) The quality of a vocational program is dependent on the quality of decisions in and about the program.
2) The quality of decisions that vocational instructors make hinge upon their abilities to identify and assess alternatives during decision situations.
3) Vocational instructors will need access to valid and reliable information pertinent to alternative solutions in order to make sound judgments.
4) The availability of such information can be improved by implementing a systematic means to provide it.
5) The processes necessary for supplying information for decision making situations collectively comprises a system for evaluation.

The evaluation component of the instructional systems development model provides curriculum planners with information necessary to improve the relationships between vocational curricula and CBI. The evaluation process of this model features the gathering of information concerning the effectiveness and relevancy of CBI in vocational curricula from two sources of information:

1) Information regarding student achievement, the role of the teacher in CBI, and the instructional effectiveness of CBI.
2) Information regarding innovations in computer technology and work that will affect CBI and vocational curricula.

Data gathered by curriculum planners regarding these two areas should introduce change into all other steps of the instructional systems development model. Evaluation is the key ingredient for refining procedures and strategies of CBI. Efforts at integrating CBI into vocational curricula will be only as good as the evaluative practices employed by vocational instructors. These practices will permit teachers to make informed and sound decisions regarding the continuingly relevant role of educational computing in the vocational curriculum. Units B.7 and B.8 of this manual discuss the evaluation of applications of CBI to vocational curricula, and the modification of such applications as needed. Units C.13 and C.14 discuss the evaluation and modification of CBI as it relates to delivery of instruction.

ERIC

SUMMARY

Vocational teachers will face several uncertainties during the initial stage of infusing Computer-Based Instruction into vocational curricula. Curriculum development questions regarding orientation of students, formation of instructional strategies, development of instructional materials, and evaluation of CBI will surface and resurface as vocational teachers experiment with this new technology.

This unit advocates a systems approach to curriculum development. Steps of this model may be implemented by vocational teachers in the form of a plan for applying CBI to vocational curriculum. A systems approach offers the most beneficial aid to vocational teachers in the planning, implementation, evaluation, and modification stages of applying CBI to vocational curricula.

ACHIEVEMENT INDICATORS

1) List three uncertainties vocational teachers may encounter during the initial stages of integrating Computer-Based Instruction with vocational curricula.
2) Define the term "systems approach."
3) Delineate each of the eight steps of a systems approach to curriculum development.

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Unit 4

Demonstrate An Awareness of Microcomputer Software for Developing Computer-Based Vocational Curricula

UNIT OBJECTIVE

Upon completion of this unit, the learner will understand two types of microcomputer software programs that may be used to develop a computer-based vocational curriculum. This knowledge will be demonstrated through completion of the unit achievement indicators.

SPECIFIC OBJECTIVES

Upon completion of this unit, the learner will be able to:

1) Define the term "authoring system."
2) Outline the process of creating a lesson using an authoring system.
3) List five features or capabilities of authoring systems that should be considered by vocational teachers prior to purchasing an authoring system.
4) Write out eight word processing program capabilities that could prove advantageous to vocational teachers.
5) Delineate points to consider during the selection process for a word processing program.

Demonstrate an Awareness of Microcomputer Software for Developing Computer-Based Curriculum

BY: DR. GENE L. ROTH

A PAUSE FOR REFLECTION

Category B's first three units of instruction clearly tell vocational teachers that the complete integration of Computer-Based Instruction into vocational curricula will not happen overnight. Units B.1 (pertaining to identification of job-specific applications), B.2 (pertaining to educational applications of microcomputers for inclusion in vocational curricula), and B.3 (which provides vocational teachers with a model for integrating CBI into vocational curriculum) each illustrate long, painstaking processes and products.

Unit B.4, however, focuses on the types of software programs that can have an immediate impact on the process of developing computer-based vocational curricula. Two types of microcomputer software will be highlighted in this unit:

1. Authoring Programs
2. Word Processing Programs

While these two software programs perform different functions for vocational teachers who are developing a computer-based curriculum, they possess the common characteristic of permitting vocational teachers to simplify and quicken the development of instructional programs and materials.

A GLIMPSE AT AUTHORING SYSTEMS

Because of differing knowledge levels and time requirements, many vocational teachers are not able to write educational programs using BASIC or comparable programming languages. These constraints on teachers have led to a surge of interest in commercial programs. Of special interest are software packages which allow teachers to use their own curriculum content to create or "author" a microcomputer program. Such packages, referred to as "authoring languages" or "authoring systems," permit teachers to develop their own instructional microcomputer programs unique to their classrooms (Judd, 1982). As vocational teachers experiment with constructing their own instructional software, they will find the time saving advantage of using authoring systems becoming increasingly beneficial to them. Authoring systems are considerably easier to use than most programming languages, and they have been shown to reduce the time needed to write a computer-assisted instruction lesson by up to ninety percent (Schleicher, 1982).

An article by Bruce DeBoer is included at the end of this unit to provide readers with an example of how authoring systems may enable vocational teachers to develop instructional programs.

A GLIMPSE AT WORD PROCESSING

Whereas authoring systems assist teachers in writing instructional software programs, word processing programs provide vocational teachers with a system that considerably eases the workload associated with creating personal, institutional, and business documents. Vocational teachers can use word processing in the development, revision, and production of units of instruction as well as other written pieces that accompany vocational curriculum. Instead of vocational teachers sitting down with a paper and pencil to construct units of instruction, instructors can use microcomputer systems and word processing software programs to improve the curriculum writing process. Word processing programs provide users with easy methods for inserting/deleting words, rearranging sentences and paragraphs, and correcting spelling errors and other mistakes. Microcomputer word processing can increase productivity for vocational teachers who are developing their own curriculum materials.

A key factor for vocational instructors to remember is that using a word processing package should never hinder the writing activity. If word processors prove to be more of a hindrance than a help to curriculum writing for an instructor, then the instructor should discontinue their use. A good word processing program should facilitate the curriculum writing process. The best word processing software should be transparent during its usage. That is, as teachers develop materials the word processor should be as out-of-sight and out-of-mind as a typewriter. As instructors revise and change materials, the operation of the software package should serve much as a typesetter or cosmetician (Emmett, 1984). Word processors, effectively used, should complement the abilities of the instructor in the curriculum writing process.

ERIC

CAPABILITIES OF WORD PROCESSORS

Word processing software programs permit computers to manipulate and generate text copy. Most microcomputer word processors combine the use of the typewriter-like keyboard, a cathode ray tube (CRT) display, a storage device, a hardcopy printer, and the microcomputer. The operator enters the text in a manner similar to typing on a typewriter. The text is displayed on the CRT to help users make corrections, additions, deletions, and text insertions. Additionally, text can be stored for retrieval, use, or modification at a future date (Bozeman, 1984).

Although many versions of microcomputer word processing packages are on the market, several features are common to general purpose systems:

1. Character and text editing.
2. Text/line insertion and deletion.
3. Moving of text.
4. Overall or global searches or modification.
5. Flush left and right margins.
6. Automatic centering of lines.
7. Page and margin control.
8. Automatic entry of headers and footers.
9. Merging and appending of documents. (Bozeman, 1984, 7)

As vocational teachers gain proficiency in operating word processing systems, they will recognize gains in productivity when engaged in curriculum development. Curriculum development entails enormous writing and rewriting to eventually formulate a draft copy suitable for field testing. The revising and editing activities that follow field testing necessitate additional rewriting. Word processors simplify the revision process because draft documents can be changed without having to retype entire manuscripts. No longer will curriculum developers need to use cut and paste methods for creating curriculum materials — word processors have made those approaches to curriculum writing obsolete.

Vocational teachers who consider themselves weak spellers can use a spelling program in conjunction with a word processing software package. Such programs contain dictionaries composed of thousands of the most commonly used words. For vocational teachers who pride themselves on their extensive vocabularies, spelling checker programs are available that contain special or unusual words. These programs screen a text for words that are spelled differently from those contained within the system dictionary (Bozeman, 1984).

Word processors are often used to generate personalized "form" letters by matching a computer file containing lists of inside addresses and salutations to a particular letter body. Teachers can utilize this same capacity for generating personalized information records, job sheets, objective pages, and other curriculum forms that have uniform formats. It is merely a matter of retrieving a standard format for a particular form type and inserting the appropriate text.

SHOPPING FOR A WORD PROCESSOR

When it comes time for vocational teachers to shop for word processors, they will find many brands on the market. There is also a variety of price ranges and capabilities of word processing packages. The two billion dollar word processing industry has saturated the marketplace with over 200 products for microcomputers. Word processing packages are advertised with a variety of selling points, performance features, and claims: "simplified human interface," "easy text editing," "fast, flexible formatting," "column and block move," "multiwindowing capability," "proportional spacing," "word wrap," "dynamic page break," "hyphen-help," and "automatic disk buffering." It is fairly safe to assume that purchasing a word processor package can be confusing (Emmett, 1984).

Perhaps the most important action that vocational instructors can take prior to shopping for a word processor is to analyze the steps of their own writing process. By analyzing their writing process, instructors can determine exactly what they do from the initial idea stage of the writing process, through the draft copies, to the final product. With this type of personal inventory for curriculum writing (or other forms of writing) instructors can go to a dealer knowing their performance needs and "road test" a variety of word processors that might best mesh with their writing requirements (Emmett, 1984).

As vocational teachers evaluate their needs for a system and then apply comparative analyses to determine the best processor for them, several points can guide them in the selection process (Mau, 1983):

1. A word processor should be sampled before it is bought. Vocational teachers should try it out and learn its capabilities prior to sinking money into a purchase.

2. Instructors should not rely on sales presentations alone. Most sales promotions are packaged to showcase the best features of a system. Sales personnel are usually more interested in selling the system than in meeting the word processing needs of the buyer.

3. Vocational teachers should not place undue faith in other people's preferences for word processing software programs. There is a good deal of personal taste involved in buying a word processing system. Once again, instructors must recognize their personal needs and strive to find a system that will adequately serve those needs.

4. Instructors should spend considerable time surveying the field of available systems. Current microcomputer magazines are an excellent source. They will contain advertising, product releases, and software reviews that can aid teachers in identifying products likely to meet their needs.

5. Toward the end of the selection process, vocational teachers will now feel prepared to visit computer retail stores and request demonstrations of the systems that appear to be suitable to their needs.

6. Instructors must be adamant about receiving "hands-on" experience with the system. Vocational instructors should take a sample document into the computer store to tryout on the word processor. Vocational teachers should test every needed function and feature of the system and not let sales personnel rush them into a hasty decision.

If these steps are followed, vocational teachers should make a well informed decision when it is time to purchase a word processing program.

Authoring Systems for Courseware Development

By: Bruce DeBoer
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INTRODUCTION:

If you are in education and if you have taught with a computer, then you have most assuredly wished at some point that someone would design software packages that teach what you want to teach and present the material in the manner and sequence that you find best suits your students. Well, stop wishing and do it yourself! There are a number of software packages on the market today called authoring systems that allow even the most "non" of "nonprogrammers" to design software quickly and efficiently. This short paper will give you a working definition of authoring systems and tell you what to look for when selecting an authoring system.

WHAT IS AN AUTHORING SYSTEM?

An authoring system is a software package that allows the author to create lessons, tests, or tutorials by simply choosing from a menu and typing information onto "template" screens that have been formatted by the program to accept text, questions, graphics, or combinations of each. The order and sequence in which the material is presented is determined by the author. Usually some form of record keeping is provided.

HOW DO THEY WORK?

To create a lesson using a typical authoring system we would simply load and run the program. A menu would then appear on screen allowing us to choose from a number of options. A typical menu screen is shown below:

AUTHORING SYSTEM—MAIN MENU

1. CREATE a new lesson
2. REVIEW or MODIFY a lesson
3. REVIEW student results file

ENTER the number of your choice—►

Choosing NUMBER 1, we would then proceed to create a new lesson. A new screen would appear and we would be asked to type in the name of the lesson and again press enter. Having done so the following menu would appear.

AUTHORING SYSTEM—
LESSON CREATION MENU

1. Create a TEXT screen
2. Create a question screen (multiple choice)
3. Create a question screen (fill-in)
4. Save the lesson to disk
5. EXIT to main menu

ENTER the number of your choice →

Again Choosing NUMBER 1, the screen would go blank except for an information line at the bottom. This line would inform us that this is a text screen and we should TYPE in the text that we wish to have displayed.

For our example, we will do a short tutorial on stamp collecting. Our first text screen will simply be the title of the lesson.

A SHORT TUTORIAL

on

STAMP COLLECTING

Having typed in the title and pressing the appropriate key to indicate that we are done designing the screen, we would be asked to indicate where this screen is to appear in the lesson. This would be done by a prompt such as SCREEN #:. We would simply enter 1 indicating that this is the first screen. The program would then take us back to the CREATION MENU (see top of this page).

Again, we would indicate that we want a text screen and when it appears we would type the following:

Stamp collecting is called philately. So a person who collects stamps is called a philatelist. There are an estimated 16 million philatelists in the United States alone.

Stamp collecting, the world's most popular hobby, got its start only a year after the introduction of the postage stamp. And if you think postage stamps have been around for centuries, think again, the first appeared in England in 1840.

This time we would indicate SCREEN #: 2 to tell the system that this screen should appear after the title screen.

Again returning to the CREATION MENU, we are presented with the option list. Let's take option NUMBER 2 and prepare a multiple choice question. A "template" similar to the screen below would appear. The cursor would be flashing after the colon (:) following the word INSTRUCTIONS.

INSTRUCTIONS:

QUES. #   :

A.
B.
C.
D.
E.
ANS:

We would type in the instructions to the student and upon pressing <ENTER> the cursor would move to the blank behind #. Entering the proper question number, the cursor would jump to the space behind the next colon where we would now type the question. Having entered the question, the cursor jumps to the space reserved for answer choice A. We would continue this process until we are finished entering all the information for this screen.

The finished question screen for our lesson on stamp collecting appears below.

INSTRUCTIONS: Please choose the best answer given below. Type in the letter of your choice and press <ENTER>
QUES.# 1: What is another name for stamp collecting?
A. lapidary
B. stampography
C. philately
D. effectuation
ANS: C

After we have entered the question and the response choices, a typical program might now provide us with the opportunity to provide feedback to each specific incorrect answer and a response to the correct answer. For example, the screen might read—

What is the message if the student takes choice A?

We could then type a response such as: Sorry, Lapidary is concerned with the art of cutting gems.

When we have entered feedback for each answer choice, the screen would be saved as SCREEN #: 3.

Once again returning to the CREATION MENU, we now might choose option NUMBER 3 for a fill-in question.

Again, we would be provided with a "template" and would fill it to produce the following screen.

INSTRUCTIONS: Please answer the following by typing in the answer and then pressing <ENTER>

QUES.# 2: In what country was the first postage stamp used?

ANS: ENGLAND! BRITAIN! GREAT BRITAIN

Note: A typical program will allow a number of acceptable answers. Here we will accept ENGLAND, BRITAIN, and GREAT BRITAIN. The symbol —!— is a means used by our sample program to separate answers.

Again, we would enter the command to save the screen. This time SCREEN #: 4.

Our short program on stamp collecting is now finished. But at this point we could add additional text screens of new tutorial material, more questions, or summary materials if we so desired.

Our program could now be used by the student. When the program is run, the title screen would appear and the student would be prompted at the bottom of the screen to press <ENTER> to continue. Upon pressing enter, screen 2 would appear, then the questions, etc. If the student answers the questions incorrectly, the feedback would automatically be provided. At the end of the lesson, the student's score might be recorded onto the diskette for future review by the instructor.

HOW TO CHOOSE AN AUTHORING SYSTEM

Authoring software falls into three general categories.

a. Software that develops banks of test questions for printout as paper copies.

b. Programs that develop banks of questions for computerized presentation of tests or drill and practices.

c. Software that allows generation of tests, drills-and-practices, or tutorial presentations.

Many authoring systems of the b. and c. variety contain a number of options not discussed in the sample lesson we developed in the first part of this paper. When considering one of these, we must ask the following questions:

1. Does the lesson sequence structure allow branching?

Although you may wish to present the same lesson in the same straight-line sequence to all students on some occasions, the real power of lessons delivered by microcomputer is that the flow and sequence of the material can be individualized. The student may be provided with as little or as much of the lesson as deemed appropriate by the computer based on how the student answers specific questions and the standards you, as the author, have set for specific branching. Some systems allow very complicated branching based on the percentage of questions a student has answered correctly in a series of questions based on the previous text material. An example of an actual flowchart from such an authoring system is given on the next page.

Tutorial text material is presented. A test is given. Based on the test results, the student may skip all review material or be given a portion of it as determined by the percentage of correct answers. The percentages are set by the author during the creation of the program.

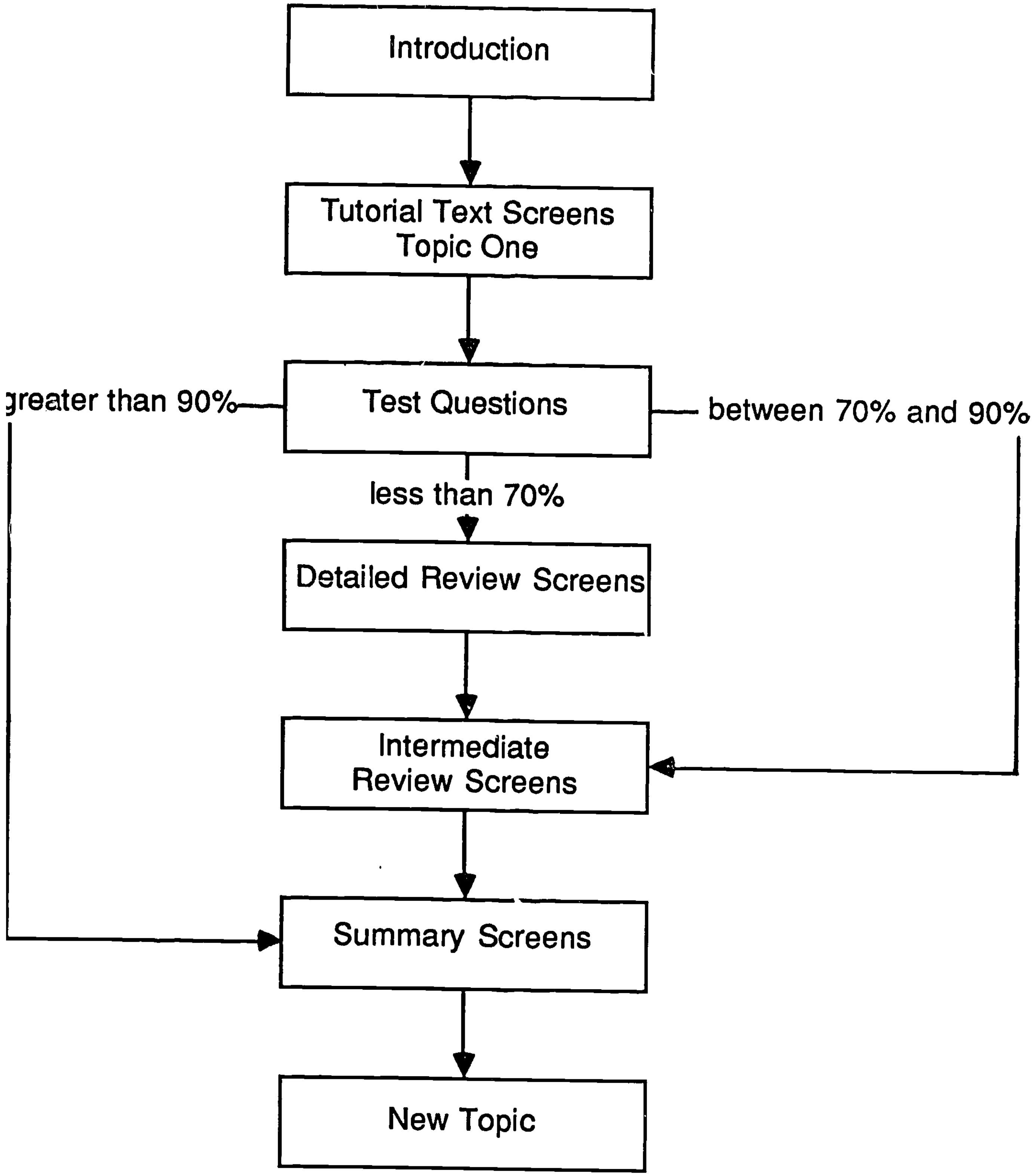
There is a second important sequencing question. Does the program allow the student to review a previous screen with just a single key input? In learning by means of computer generated text, the student often finds the need to review a previous page as he often does when learning by means of paper-based text materials. A good program will afford the student this opportunity.

Does the program allow temporary exit to hint, help, and glossary screens during the execution of tutorials? Some systems have excellent user control of flow and sequence in these areas.

Although some authoring systems allow more specific sequence control and branching capabilities than others, it is still important to remember that in all cases your program design will be limited to what the system offers.

2. What question formats are allowed?

Authoring system question formats range from single format programs such as "templated" multiple choice to systems that allow almost any type of questions on "nontemplated" text screens. The software package you choose will depend on the variety and type of the questions you will incorporate into your lesson program.


Introduction
Tutorial Text Screens Topic One
Test Questions
greater than 90%
between 70% and 90%
less than 70%
Detailed Review Screens
Intermediate Review Screens
Summary Screens
New Topic

If you are using completion items, you must also consider the fact that there may be more than one answer for a particular question. In such cases, you should compare the various systems in terms of their answer matching options. Some systems require a perfect match. Some systems scan the student response for short sequence of matching letters thereby allowing for minor errors in spelling. Some systems allow only a single response to be matched, while others allow a list of possible responses to be checked by the letter scan or perfect match.

3. Do you have control over the number of tries a student is given to answer a question?

Some systems allow the student an infinite number of chances to answer a specific question, while other systems allow the author to limit the tries to a single attempt. Along with this feature, some systems "mark" the question wrong after the first attempt, while others may be "programmed" by the author to "relaxed scoring" with credit still given on the second and third attempt.

4. Do you have control over the length of time the questions appear on the screen?

Some systems permit the author to control the length of time a question appears on the screen. This may be a very important feature in testing skill areas where an immediate and accurate response to particular questions is important.

5. Does the system allow questions to be randomly selected from a "bank" of questions?

This feature is especially important in drill-and-practice lessons. If the question is from a large bank of questions, the student will be presented with a different set of questions each time through the program. And even with a small set of questions, random selection means that the student is seeing the questions in a different sequence each time through the program, thus making the program more interesting.

6. What graphic capabilities will you need?

Not all authoring tools take advantage of the graphic capabilities of the computer for which they were written. And even if they do, the ease of programming graphics ranges from easy to very complex to produce virtually the same type of graphics display. If you need graphics, check very carefully the ease of creating graphics screens and whether or not text and graphics can easily be displayed on the same screen.

7. What type of record keeping does the system do?

The amount of information stored by various systems ranges from as simple as the student's name, name of lesson, and score, to as complex as the name of student, name of lesson, date, time of day, time spent on the lesson, score, which questions were answered incorrectly, and the answers each student gave to each question. Some systems are complex enough to actually manage the student's progress through a series of lessons by keeping track of the previous level of achievement and slotting the student into the lesson most appropriate to their present skill level.

Also important is the ability to combine the scores from a series of individual lesson diskettes to a single results file for summary reports of student progress and item analysis of test questions. Some programs do not have this capability.

Now that you know some of the things to look for, you should answer the following questions to assure that you purchase the authoring system that is right for you.

1. Just what type of lessons do you want to author?
2. Is software that generates the type of lessons you want available for your brand of computer?
3. Is your computer system capable of supporting the software? (For example: Does the software require two disk drives? What memory is required to run the program? Do you need a printer?)

SUMMARY

The focus of this unit has been on demonstrating an awareness of microcomputer software for developing computer-based vocational instruction. Two software program types—authoring systems and word processing systems—are introduced. The reader is provided with detailed examples of an authors system at work and points to consider when choosing a word processor. Both types of software programs are easy to use and useful to the vocational teacher taking the first steps of initiating Computer-Based Instruction into the instructional curriculum.

ACHIEVEMENT INDICATORS

1. Define the term "authoring system."
2. Outline the process of creating a lesson using an authoring system.

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3. List five features or capabilities of authoring systems that should be considered by vocational teachers prior to purchasing an authoring system.

4. Write out eight word processing program capabilities that could prove advantageous to vocational teachers.

5. Delineate points to consider during the selection process for a word processing program.

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Unit 5

Write Specifications for Hardware and Software Based Upon Vocational Curricula Requirements

UNIT OBJECTIVES

Upon completion of this unit, the learner will be able to evaluate hardware and software necessary to support Computer-Based Instruction (CBI) in a given vocational curriculum and write the technical specifications necessary to place the proper computer system in operation. Mastery of these skills will be demonstrated through completion of the unit achievement indicators.

SPECIFIC OBJECTIVES

Upon completion of this unit, the learner will:

1) Be able to describe which specific type(s) of computer hardware best suit the needs of the vocational curriculum.
2) Determine which general software packages achieve the goals of the CBI portion of the vocational curriculum.
3) Assess which specific computer system best supports the software necessary to achieve the CBI goals.
4) Be able to write detailed specifications for the hardware and software to support a request for bids (RFB) proposal to vendors.
5) Plan and administer a computer demonstration by vendors desiring to bid to supply a computer system which meets basic system specifications.
6) Screen all qualifying bids for the system which best suits your needs and award the procurement contract to the successful bidder.

Write Specifications for Hardware and Software Based Upon Vocational Curricula Requirements

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INTRODUCTION

Purchasing a computer system for Computer-Based Instruction (CBI) is not an easy task. Computer technology is expanding at a rapid pace in both hardware architecture and software development.

How do vocational educators determine which system is best for their needs? This unit provides general methods for purchasing computer systems which support Computer-Based Instruction. Vocational instructors should preview these general guidelines with consideration of two factors:

(1) There is no one specific computer system or type of system which can meet all the CBI needs of divergent vocational curricula.

(2) Computer systems, especially microcomputer systems, are changing at such a rapid pace that the best overall system today may be obsolete in a short period of time.

STARTING THE EVALUATION PROCESS

An initial step for instructors who will be evaluating computer systems is to assess the possible resources of computer expertise. Vocational education personnel may be the best prepared of all educators to pursue computer procurement because of the high percentage of technical disciplines within the faculty. Instructors should draw from these resources to establish a committee to methodically pursue the acquisition of computer systems. This committee should first perform an unbiased assessment of its collected expertise in computer systems. The committee must decide upon which areas of computer use the committee feels capable of making reliable decisions. Conversely, the committee must identify areas in which decisions will require outside assistance. For example, teachers with extensive microcomputer experience may have little or no minicomputer or mainframe computer experience. If there are no faculty members competent in a particular area of expertise (i.e., a type of hardware or software), volunteer assistance should be sought from the vocational advisory board members from the general community. Consultants can be hired to provide specific information pertinent to the purchase of computer systems. Consultants may be expensive, but can prove to be worth their cost compared to the expense of purchasing an inappropriate computer system (Braun, 1981).

DETERMINING GENERAL COMPUTER SYSTEM NEEDS

Often, a computer system is purchased without appropriate thought regarding the intended purpose of the system (Frankel, 1982). For the purposes of this unit, the term *computer system* includes both the hardware and the software needed to complete the required task. Neither the best hardware nor the best software will function independently to adequately serve vocational education. Together they form the needed computer system. Often, educators falsely assume that choosing the correct hardware will win the computer procurement battle. It is imperative that vocational educators choose the software that will meet CBI objectives and then find the system or systems that best support the software (Auten, 1982; Barden, 1983; Botterell, 1982).

At an early point in the procurement process, an assessment of the type of computer system needed should be made with regard to the specific educational objectives of the vocational program. Often, this evaluation is made on the basis of available funding. However, instructors should not get trapped by the microcomputer syndrome because funding is apparently low. The purchase of a series of microcomputers can escalate costs rapidly to the point that other alternatives become economically feasible. Instructors should examine all computer options for their relative merits. The computer system options available to vocational educators include:

(1) Mainframe computers;
(2) Minicomputers;
(3) Microsystems;
(4) Time-share microcomputers; and,
(5) Stand-alone microcomputers.

Mainframe Computer Systems

Because mainframe computers cost hundreds of thousands of dollars for the least expensive systems, the purchase of these systems is extremely limited for individual vocational programs. Even if instructors could assume adequate funding, the purchase of a mainframe computer would still not be recommended. Microcomputer systems exist that can perform the functions of a mainframe at a fraction of the cost. Furthermore, the attributes that make mainframe computers desirable are not congruent with the goals of CBI.

For educational purposes, an advantage of a mainframe computer is the availability of a time-share lease of educational software such as the PLATO system (Hirschbuhl, 1980). Generally, a timeshare agreement includes the leasing cost of the terminals and communications equipment, hookup charges for accessing the database of the mainframe computer, and the cost of the telephone time to access the computer. Mainframe hookup charges are generally limited to the actual access of the mainframe's central processing unit (CPU). This use may only amount to one or two minutes per hour. Phone rates are continuously charged during on-line sessions and can result in considerable expense which is not readily predictable for budgeting purposes. Modified CBI timeshare systems exist in which the user can transfer a learning session to an Intelligent Terminal or microcomputer from the mainframe computer in order to minimize telephone costs.

Minicomputer Systems

Minicomputers rival mainframe computers in the amount of main memory (i.e., CPU), auxiliary storage (i.e., magnetic disk and tape), and the number of users that can be supported at a given time. Minicomputers are priced in the range of $30,000 to several hundred thousand dollars. If a school initiates CBI for a large number of courses, the cost of a reasonably powerful minicomputer could be justified by the total cost of minicomputer systems needed to satisfy the computing requirements. Additionally, the distinct advantage of the operating speed of a minicomputer as compared to a microcomputer would be gained. Moderately priced minicomputers (e.g., $30,000 - $80,000) achieve system response times of several seconds for a large number of concurrent users, while the same application on a microcomputer could take the same time or much longer for a single user. The initial purchase of twenty or more microcomputers for the school should put the option of a minicomputer solidly within the realm of serious evaluation. Once the minicomputer is in place, it can be upgraded with terminals for less cost than adding additional microcomputers as needs arise.

An often overlooked source of computer power may be quietly resting in the administrative offices of schools. Many school districts and vocational schools utilize a minicomputer for administrative purposes. This computer system should be considered as a viable option for C[illegible]he system is expandable and suitable for CBI software. An upgrade of an existing minicomputer is much [illegible]aper than either the purchases of another minicomputer or the purchase of several microcomputers. In all pro[illegible]ility, small CBI applications can be executed on an existing minicomputer by merely purchasing a number of stude[illegible]rminals and terminal-driven printers.

For security reasons, all files except CBI applications can be se[illegible]ured from student access via the operating system. The investment costs of the computer could be recovered at a faster rate if the system were used for both administrative uses and CBI.

Microsystems

Microsystems is an all inclusive term which is used to describe a centralized microcomputer with several satellite terminals. A microsystem should not be confused with networked or time-share microcomputers. A microsystem may have several megabytes (MB) of CPU and use the same disk drives and magnetic tape units that are normally associated with minicomputers. The result is a very powerful, fast, and reasonably priced ($20,000 - 30,000) system. A primary disadvantage of a microsystem is its comparative high cost to that of quality stand-alone microcomputer systems. However, if the microcomputer requirements for a school or program demand several high quality stand-alone microcomputers (e.g., for sciences, drafting, or other highly technical programs), the microsystem option could prove to be a logical choice. Microsystems have the distinct advantages of allowing a large amount of storage (40 MB or more) and requiring less peripherals in a multi-user environment than stand-alone microcomputers. Because microsystems are capable of utilizing an input/output (I/O) technique known as **spooling**, fewer of the more expensive peripheral devices (such as plotters and letter-quality printers) are necessary to support the same number of students as stand-alone microcomputers.

Time-share Microcomputers/Microcomputer Networks

Several vendors produce small time-sharing microcomputer systems. These systems generally include one microcomputer with approximately 256 Kilobytes (KB) of CPU, one or more slave terminals, and one or more Winchester technology hard disk drives for auxiliary storage. As these systems are presently configured, they are

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not desirable for CBI use for one main reason — they are slow! The slave terminals must access the same CPU as the microcomputer. This feature slows down system response time. One of the requirements of a successful CBI program is maintaining student interest. The response time of presently available time-share microcomputer systems is guaranteed to cause a loss of student interest. The impact of the computer response time on student interest negates the cost savings of a time-share microcomputer. Several computer vendors are marketing microcomputer networks to interconnect a number of microcomputers and a large central data storage medium. Micro networks are expensive initially, but provide the ultimate in interactive CBI. These networks do not have the response time problems exhibited by time-sharing microcomputers. However, their main advantage is a large amount of centralized shared disk storage. A microcomputer network will not decrease the number of microcomputers a CBI program must purchase.

Stand-Alone Microcomputers

Stand-alone microcomputer systems are the major hardware type supporting CBI across the country today. They are extremely versatile and offer computing power to educators that was available only on mainframe computers a few short years ago. These microcomputer systems are available at a fraction of the cost of mainframe computers.

Because of the prevalence of microcomputers in education, the specific guidance provided in the rest of this unit will emphasize the procurement of microcomputer systems. However, general principals are provided that can apply to the procurement of any type of computer system.

Once the general type of computer system has been selected, analysis of CBI software available for that type of computer system must occur. The analysis of software is the most important step in the overall procurement process for CBI computer systems.

SOFTWARE EVALUATION

How should a computer committee approach the analysis of software to support CBI? If the CBI functions throughout a school, these evaluations may consume an immense amount of time. For example, assume that the purchase or use of an existing minicomputer has been chosen. The search for software needs to be directed to applications which may be run on this system. An instructor may find that 90% of the CBI applications can be supported on this system and that stand-alone microcomputers must be purchased to support the remaining 10%. Furthermore, instructors may realize that, although the use of an existing minicomputer is a good idea, it is operationally untenable. Findings such as these may be initially frustrating, but may help educators avoid the purchase of inappropriate computer systems.

Software can be grouped into three broad categories:

1) Operating System;

2) Utility or Library Programs; and,

3) Applications Programs.

Operating System

The operating system is software that tells the computer what to do, when to do it, where information necessary to perform a task is stored, and where to place processed information. The operating system is probably the most important piece of software that instructors will purchase. A problem common to operating systems is that they are machine-dependent (i.e., they will only run on a specific brand of computer). However, contemporary microcomputer designs run vendor-designed operating systems or general industry standard operating systems such as CP/M or MS/DOS. Instructors should select hardware which support a standard operating system. A greater amount of software is written for standard operating systems than for vendor/machine specific operating systems. A word of caution regarding industry standard software (such as operating systems) is that not all versions are the same; some require slight modifications to run correctly on a given brand of microcomputer (Smith, 1984). Additionally, some applications software written for standard operating systems do not execute flawlessly on all versions of those operating systems (Matthews, 1979). It is imperative that software for CBI be verified to run correctly on a given computer and operating system **as a condition of purchase**.

Utility or Library Software

Utility or library software is specialized software that will perform a general function on a computer. Renumbering or resequencing routines, intrinsic functions, directories, or edit routines are examples of utility or library software. Generally, compilers, interpreters, and assemblers deserve distinct categorization. At the risk of oversimplification, they are grouped with utility routines in this unit. Utility software is generally a function of the computer system purchased. Often, a buyer has minimal control of utility software other than purchasing another model of the same type of computer or another brand of computer. However, three factors should be considered before an instructor discounts the effect of utility software on the decision to purchase a particular computer system:

1. Whether to buy an interpreted language or compiled language;
2. The importance of multiple language capability; and,
3. The ease of editor operation.

The choice of interpreted language as compared to compiled language should be influenced by the intended application of the computer system. Some microcomputers only support interpreted BASIC language while others support interpreted and compiled BASIC, compiled FORTRAN, COBOL, other high level languages, and a low level assembler language for the particular microprocessor.

Generally, a compiled language is preferable to an interpreted language. Programs written in a compiled language will execute much faster than those written in an interpreted language. However, an interpreted language has a distinct advantage for beginning programming because program code errors can be immediately found rather than being found after the entire program has been written. This helps reduce the anxieties of beginning programming students by showing errors as they happen rather than allowing the errors to become imbedded in many lines of code.

Programs written in assembler language execute very fast and are optimized for a particular microcomputer. However, there are several problems with assembler language programs. First, they are tedious to program and should not be attempted by inexperienced programmers. Second, their portability to other microcomputers, even of the same type, is very limited. Because assembler programs specify exact storage locations within the computer, an upgrade (e.g. more memory, a RAM chip graphics package, or operating system change) to the microcomputer could cause execution problems with the assembler program. (For further information regarding interpreters, compilers, and high and low level computer languages, consult any introductory book of data processing or computer science. Two such books are listed in the reference section of this unit.)

A computer system that supports multiple high level languages is the most desirable system. Although many general purpose languages exist (e.g., BASIC, FORTRAN, PASCAL, and COBOL), certain applications are performed easier and more efficiently by certain languages. For example, numerical calculations are performed very efficiently by FORTRAN while report generation and list processing are better handled by COBOL. Conversely, COBOL is awkward to use for extensive mathematical applications while FORTRAN generally loses efficiency with character manipulations. Selecting a microcomputer system which supports multiple languages will permit instructors to maintain hardware compatibility while supporting diverse applications.

An editor is a type of software that permits users to write and change text within the computer memory. The editor is not limited to usage by programmers. Instructors or other non-programmers can apply it to enter data and build data files or text files. The editor is extremely important to the overall user efficiency of a computer system. A general recommendation for vocational teachers is that if all factors for selection of a computer system are relatively similar, the computer system with the best editor should be chosen. When evaluating a system editor, instructors should look for which one is easy to learn to use, does not require multiple keystrokes to accomplish simple evolutions (such as **insert** and **delete**), and implements a large number of functions with special purpose keys or function keys.

Applications Software

Applications software is what most people refer to as a "computer program." In general, this description is true; however, opposed to traditional concepts which view a program as a means to solve one distinct problem, contemporary software consists of many distinct programs within one software package which are intended to solve many general problems. Modern applications software still contains individual programs; however, the fact that these software packages involve individual programs to do a variety of tasks may not be known to the user. For example, a spreadsheet software package helps provide specific answers to general problems. The user does not need to realize that task selections made from the menu actually call one or more programs and/or sub programs to accomplish the task.

Database management systems can be viewed logically as a software package of software packages. It is not unusual for database management software on a minicomputer or mainframe computer to reside in several megabytes of memory and cost thousands of dollars. Most database management systems for microcomputers cost between $300.00 and $1,000.00.

Starting the Software Evaluation

How should instructors begin the software evaluation process? Appendix A contains a synopsis of general criteria for evaluating CBI software. This appendix can be modified by a computer committee to form an evaluation instrument. Such an instrument can be used to evaluate whether a particular piece of software meets the objectives of a CBI program.

Standard software evaluation forms have been created by local schools, universities, and commercial vendors. An excellent source of standardized evaluation forms is *Evaluation of Educational Software: A Guide to Guides*, produced by the Southwest Educational Development Laboratory (Jones, 1983). Computer periodicals and educational computing journals are additional sources of software evaluation checklists (Barden, 1983). These software evaluation forms should not be considered end products. They are starting points for a computer committee in the development of a specific evaluation form which meets the committee's program needs. This refining process may encompass several weeks of committee time. However, a well designed evaluation document can help prevent the purchase of a costly, well designed software package which does not meet the needs of the vocational program.

What should instructors consider in a software evaluation? The software's technical attributes, which accomplish specific functions, will be a major consideration. However, an often overlooked yet vital consideration of the applicability of educational software is program congruence. Congruence is a general term describing how software meshes with user/instructor expectations, vocational curricula, and instruction (Holznagel, 1983). A software package that does an exceptional job of processing data but is conceptually beyond the users understanding will prove to be inadequate for educational computing.

The initial selection of software is a partial fulfillment of the evaluation process. A crucial test is whether students and instructors find educational value in the software. These two groups often form varying perceptions of software. It is common for students to be more critical of software than instructors (Signer, 1983).

To date, much of the current educational software focuses on drill-and-practice concepts. Extensive, documented field testing in schools is needed to create high quality software for education. This new, higher quality educational software should feature enhanced interactivity with users to optimally utilize the speed and computing power of the new generation of advanced microcomputers (Ploch, 1984).

Sources of Educational Software

A commercial vendor may be viewed by instructors as the logical source for educational software. Actually, commercial vendors may not be the best answer for vocational educators. Commercial vendors rely on mass marketing to recoup development costs. This marketing approach shifts educational software development toward the larger markets of elementary education and the general, scientific, and mathematics portions of secondary education. Unless vocational programs can implement general software packages (i.e., spreadsheet, planning/scheduling, graphics, or word processing), instructors may consider commercial vendors to be at the bottom of the software procurement list. Possible sources for vocational education software are non-profit educational agencies which service particular segments of vocational education. Occasionally, these agencies sponsor the development of software for specific vocational areas. This professionally produced software is accompanied by adequate documentation which explains its design and use.

Public domain software should be another consideration for vocational educators. Public domain software is software written for specific computer systems by single or small group users. This software is available free of charge, but it offers no guarantee of quality and provides minimal documentation (Williams & Shrage, 1983). Providing this documentation from the code can be difficult, time consuming, and costly for the end user.

A final software consideration for vocational educators is in-house development. This category includes software consultants who can design software specific to the needs of a vocational program. In-house software development can be an option beyond the capabilities of many vocational schools that may have personnel who possess the required programming expertise, but cannot release those persons for the time necessary to complete a major software development soon enough. Often the result of an in-house programming effort for a major software project is a substandard product or a completion time considerably longer than was planned. In-house software development should not be deleted as an option, but the scope of the project, availability of the programmers, and required implementation date must be evaluated. Securing a software consultant is recommended if the project scope is beyond the capabilities of resident programmers or has a short lead time requirement. Consultants are expensive, but can prove to be worth the expense to gain high quality computing applications.

Some computer vendors offer program development software which produces computer code from "English-like" statements entered by the user. Program development software can be useful for developing elementary drills and tests, but has limitations which make the development of sophisticated programs difficult.

Purchasing Commercially Available Software

It is good advice for vocational instructors to buy as few software packages as possible. Each software package has a unique learning curve. Vocational students are enrolled to learn a specific vocational discipline, not a multitude of software products. If instructors decide to adapt more general software to their programs, then these packages should be tailored specifically to vocational applications. Teachers will need to rewrite the documentation to include only that information specific to educational computing. Suggestions for revising documentation are provided in unit C.8.

Vocational teachers should purchase software written in assembler or machine language whenever possible because these programs execute much faster than those written in high level languages. Programs written in interpreted language should be avoided because these programs execute very slowly compared to assembler language programs. Software should also be avoided which cannot be backed up (Barden, 1983), which means the ability to copy the programs from the master disk on another disk called the "working disk." This process ensures that the master copy of the software does not become ruined through use.

Vocational instructors need to be aware that legally they are not purchasing a piece of software, but a license to use it for one computer. Special licenses may be available to use software on multiple computer installations. However, this option is usually reserved for minicomputer and mainframe installations. What this means is that several working copies for several machines cannot legally be produced from a single master copy. A separate master copy must be purchased for each microcomputer on which the software will be run. Upon backing up the master disk, vocational teachers should store the master disk in a safe place removed from the computer area to ensure that students do not accidentally use the master copy as a working copy. If it is not possible to back up a particular piece of software that is essential to a vocational program, the instructor should seek a written agreement from the vendor to provide a replacement copy for minimal cost or free of charge. Many software vendors are utilizing copy protection in an attempt to stem the current rise in software piracy. A vocational school must reach agreement with a software vendor to support backup and rapid replacement of protected software. Some of the protection schemes currently in use can cause intermittent operation problems with the computer operating system. Care in software selection must be exercised to prevent your CBI program from being at the mercy of some copy protection scheme. An overview of preparing purchased software for classroom use is provided in units C.5 and D.7.

It is important for instructors to see specific software demonstrated on a computer prior to the purchase of hardware or software. The buyer should not settle for a high-powered sales demonstration. Demand a demonstration that shows the real capabilities of the systems. Instructors should also not settle for a monitor demonstration alone, but should require a printout (i.e., hardcopy) of the program output from the printer. Surprisingly, some software looks great on the video screen, but looks jumbled in hard copy. This is due to the format differences between the video display (i.e., CRT) and the printer.

If a software demonstration is not possible, instructors should use the software documentation as a guide. The documentation is the printed material that accompanies the software and explains how to run the software; it describes various on-line prompts (i.e., messages during program execution) such as acronyms used, error messages, and descriptive or informational prompts. Further, the documentation provides technical information regarding variables, data structures, and program limitations. Historically, documentation has been inadequately conceived and developed; however, software documentation is gradually increasing its usefulness to the non-programming user. If the documentation is well presented (e.g., typeset and well formatted), simple to understand, and properly designed to educate an uninformed user in its use, it probably represents quality software. Generally, vendors do not expend precious time on superior documentation for a poor software package. However, be aware that some excellent software is poorly documented.

For instructors, another important consideration for software purchase is the cost of the package. Generally, expensive software performs the most functions and runs more smoothly than a cheap software package. Two notes of caution are required with the preceding generality. Each software package must be evaluated on its own merit. Packages in the same price range do not necessarily adhere to the "most expensive performs best" thumb-rule. Careful evaluation could save a vocational school hundreds of dollars. Instructors must recognize that although one software package may perform better than a cheaper one in general, minor performance advantages may not be worth the extra cost. Appendix B contains a checklist for purchasing commercial applications software.

Selecting the Hardware

At this point in the procurement process, an instructor should know what general type of computer system is necessary, and have documented the software specifications. The instructor may have already made most of the specific software package selections for the program.

Because purchase of a mainframe or minicomputer requires a great deal of experience in the computer field, the remainder of this unit concerns selection of a microcomputer. However, many general principles are developed in this unit which may apply to the purchase of any computer system.

The general approach a computer review committee should take includes a review of recently published material from several sources. First, the committee should identify companies which provide computers that meet specific needs. Experienced microcomputer users on the committee can help in this area as long as the effect of personal bias for or against a particular microcomputer is minimized. The software selected for the program will help narrow the field, since some software packages will not be supported on certain microcomputers. Once a list of potential computers for specific applications has been developed, instructors can write directly to vendors for technical information regarding the respective systems. In most instances, more and better quality information can be obtained from vendors than can be secured from published brochures that are available in computer stores (Matthews, 1979).

The committee should research industry reviews of the computers on the list. The best source for this information is general computing magazines. The committee should be leary of vendor published magazines which promote one or more brands of microcomputers and tend to minimize the negative points of a particular system. Industry reviews may help eliminate some computers. Educational periodicals written for the computer educator are another good source of information. These periodicals are especially good for tips on how to purchase a computer system. However, three points of caution are in order regarding these types of articles. First, many "how to" articles are directed toward what one school district did for a specific computer installation. Instructors should make inferences from the positive points and problem areas noted in the article to provide generalized information to the committee. Next, instructors should disregard articles which insist that the author has discovered "The computer for educational purposes." Many of these articles are written for elementary and general secondary education applications. Computers that are very desirable for these applications may be totally unacceptable in vocational school applications. Finally, instructors should use only the most up-to-date articles to obtain information about computer hardware. Specific hardware information which is more than two years old will be of little value to the committee. Information published within the last year should be obtained to ensure accuracy.

Determining the Hardware Specifications

Once the number of potential computer systems has been minimized, systems must be ranked to determine which ones best suit instructional needs. A detailed list of hardware requirements necessary to support CBI applications should be generated which contains a set of weighting factors used to evaluate the hardware in critical areas. Two weight factors should be applied to each requirement. One factor indicates the relative importance of each requirement to CBI applications and the other factor indicates the ability of each computer system to satisfy each requirement. Appendix B provides a sample form which can be used to develop a technical evaluation form. Three copies of the technical evaluation form should be used for each system that is evaluated. One should be used to rank the system based on review of technical information and specifications of the system. The second form should be used to rank each system during an actual system demonstration. The final form should be used to rank each system based upon vendor bids.

Six general areas of hardware capabilities must be evaluated to ensure that a computer system will meet instructional needs:

1. General System Considerations;
2. Central Processing Unit (CPU);
3. Video Monitor (CRT);
4. Auxiliary Storage Devices;
5. Input/Output (I/O) Devices; and,
6. Intrinsic Software/Firmware Capabilities.

Some overlap of these areas is inevitable in an integrated system. However, these six areas represent a logical approach to studying the technical specifications of a computer system.

General System Considerations

One of the prime considerations for any educational computing procurement is cost. Cost may very well be the overriding consideration for most vocational schools. Several key points must be evaluated with respect to cost.

First, Braun (1981) points out that it is not prudent to get locked into the lowest bid, especially if that bid is far below other bids for comparable systems. The option should be maintained to weigh exact system specifications against the bid price to determine the best buy. A school should not purchase a system solely on the basis of price; it should consider the maintenance service available and the technical help that will be provided by a local dealer. For these reasons, instructors should eliminate consideration of mail-order companies for all but isolated peripherals. The cost savings will be neutralized by the unavailability of maintenance for computers (Auten, 1982; Braun, 1981).

Some relief from fiscal problems is being provided to schools by some computer vendors. Several computer manufacturers are providing advanced microcomputers to schools free or with significant discounts (McCandless, 1983; Ploch, 1984). Schools are still responsible for providing certain peripherals (e.g., printers and disk drives) and software, but the overall cost savings to schools are great. Computer vendors that have provided free or discounted microcomputers to schools are Apple, Apollo, Digital Equipment Corporation (DEC), IBM, and Zenith (Ploch, 1984).

Instructors may consider saving money by buying the absolute minimum system and upgrading it as funds become available. However, instructors should not defeat their educational objectives while trying to save procurement costs. One excellent method of saving money is to buy a minimal system from the direct vendor and upgrade it immediately with equipment and memory from original equipment manufacturers (known as OEMs). OEMs produce a wide range of high quality hardware, such as memory boards, barcode readers, and auxiliary storage devices at a fraction of vendor costs.

These cost considerations indicate the necessity for a computer review committee to be creative when planning the computer system. The computer committee should look for local computer stores with a knowledgeable staff to assist in getting the most computer system for the least money (Auten, 1982).

Two other factors for the committee to consider are portability and special environmental conditions for operation. These two considerations are inversely related; a computer system that requires special environmental conditions for operation (such as air conditioning or ventilation) will not be portable. If the computer system must be highly portable, a microcomputer is probably the best choice. However, minicomputers and mainframe computers can achieve a high degree of pseudo-portability through the use of state-of-the-art terminals and data communications. Modern terminals exist which can drive a printer and communicate with the host computer via a modem. Most minicomputers can operate without special environmental conditions, but mainframe computers still require special environments which include large air conditioning systems and false floors for cabling. Although microcomputers do not require a special operating environment, two important devices should be considered to prolong the life of the microcomputer. A static mat for the work station placed directly under the microcomputer will protect it from static electricity charges. These charges can damage microcircuits or cause a loss of data. A surge protector is also desirable to protect the microcomputer against line voltage surges in the 120 volt power supply. Such surges can damage microcomputer circuits. The combined cost of these two devices is approximately $200.00 per microcomputer; it is a worthwhile expense over the long term.

One final general consideration for the purchase of a microcomputer is its ability to operate as a mainframe or minicomputer terminal. This ability, known as terminal emulation, is very important if the school owns a large computer. Terminal emulation allows microcomputers to operate as stand-alone computers or as terminals connected to a larger system. This capability minimizes the cost of separate terminals for the large system.

CPU Considerations

An important consideration for selecting a microcomputer is its memory capacity. Microcomputer memory is implemented with two different memory concepts: ROM and RAM.

ROM is an acronym for read-only memory. As the name implies, information stored in ROM can only be read during program execution. No data can be written to ROM by the computer user. ROM is used to store important functions, such as the operating system, the BASIC language, some graphics capabilities and other commonly used functions.

RAM, or random access memory, can be read from or written to during program execution. The amount of RAM which the microcomputer contains is important when the overall use of the computer is evaluated. There must be enough RAM contained within the microcomputer to store the largest application program and its data that will be used in the CBI program. This is not a simple evaluation because many other functions can be stored in RAM in addition to the application program (such as special graphics and language compilers). Experts agree that the absolute amount of memory that a microcomputer possesses is not as important as the amount of memory available for user functions (Matthews, 1979; Schilling, 1983; Smith, 1984). Usable memory is that memory which is available after language compilers, the operating system and operating system dynamic memory requirements (screen memory, I/O mapping, etc.), graphics, and other ancillary functions are loaded into RAM.

Purchasing a microcomputer with the needed amount of memory is not as difficult as it was in the past. Due to advances in microchip technology, larger memory capacity chips are available for less cost than the small capacity chips of several years ago. Thus, manufacturers are equipping microcomputers with a greater amount of standard memory. In addition, many commonly used functions, such as operating systems, graphics, and some applications are available on firmware. **Firmware** is a term applied to software packages loaded on ROM chips and installed by the user in the microcomputer. Firmware will add enhancements to a system without using up vital RAM. Some firmware packages are a ROM/RAM combination and do not affect available memory, even during graphics operation.

Although Botterell (1982) believes that microcomputers should be evaluated on the basis of how well they meet educational applications needs rather than on the basis of the amount of memory, there must be room for future expansion within the microcomputer's memory capacity. Expanding the capacity of a computer is the most cost effective way to support new applications which inevitably will be required.

Execution speed is an important factor when considering the adequacy of a microcomputer to perform a task. The design of a particular microchip CPU will determine the speed at which information can be processed. However, the overall system performance is more important than the performance of the CPU in most CBI applications. The CPU is the system component with the fastest operating speed; system performance will be limited by peripheral devices such as disk drives and printers. For example, a non-buffered serial printer will limit the fastest CPU available to a speed which is barely acceptable to users. In this case, the addition of a buffered parallel printer would change an apparently inadequate microcomputer system into one that is very desirable. Tests known as benchmarks can quantify the performance of individual system components. However, the bottom line of system performance is how fast that system as configured can process the needed applications (Marvit & Nair, 1984). Since benchmark tests are presently used extensively to rate various system components, they merit a short analysis of their proper use.

Benchmark Tests

Barden (1983), Cerveny & Knight (1983), and Muntz (1983) provide benchmark test procedures for specific components of a computer system. These tests are general in nature and are subject to much variance in results. Proper evaluation of benchmark results requires a person who possesses specific information regarding the parameters under which the hardware was tested (Marvit & Nair, 1984).

Some generalizations can be made to aid vocational educators in evaluating benchmark data generated during system demonstrations. Benchmark tests exist for CPUs, disk drive systems, and printers. Printer benchmarks are generally not useful because too many variables can affect print speed for the same type of printer (e.g., bit transfer rate to printer, enhanced printing, bold printing, and proportional spacing). When performing benchmark tests on a computer system (i.e., CPU and disk system) the following guidelines should be followed:

1. Test each system as closely as possible with the same hardware configuration (e.g., same amount of memory, same number of disk drives, and same printer);
2. Try to use the same benchmark program on all computers tested. This may be difficult on some microcomputers due to differences in the BASIC language;
3. Compare the same degree of precision for numeric routines;
4. Avoid screen printing as much as possible unless the actual applications will have large amounts of screen printing;
5. When performing disk related benchmarks, start with a clean disk; and,
6. Make the benchmark tests run as long as possible (i.e., several minutes) so that minor performance differences will show up.

With the preceding cautions, benchmark tests are a viable tool in the total evaluation process. They should not stand alone, however, because the end results are easily misinterpreted. The ability of the microcomputer system to service an entire CBI program should be the primary criterion for acceptance.

Video Monitor Considerations

Selection of a video monitor is a fairly straightforward process. Monochrome or color monitors are available and instructors should choose the one that best fits a program's needs and budget. Generally, a standard monochrome monitor has better resolution than a standard color monitor, and the monochrome monitor costs less. However, for color graphics applications, enhanced graphics color monitors are available for a reasonable price. Monitors with pressure sensitive screens (called touchscreens) are also available for some microcomputers. Touchscreens are useful in special needs applications because they allow limited system operation by touching menu options printed on the screen.

When selecting a monitor for the system, instructors should not select one with less than 80 columns and 24 lines of display. Choosing an 80 column monitor will permit more general use of the monitor.

Auxiliary Storage Considerations

Auxliary storage is a term used to describe long-term memory devices which can store large amounts of data. There are two basic types of auxiliary storage for microcomputers—magnetic tape and magnetic disk.

Magnetic tape is a serial device and therefore relatively slow because only one bit is transferred at a time. Magnetic tape storage is usually implemented via cassette tape on microcomputers. In addition to the slow speed of data input and output, cassette tape only allows sequential file access, which again is slow. With sequential files, all data prior to the data one desires to use must be read to get to the desired data, causing significant loss of operating speed when files are not actually processed sequentially. Nevertheless, there are many applications in data processing for which sequential file structures are very desirable. However, most CBI applications lend themselves to the higher speed of random access file structures because sequential file access may cause a rapid loss of student interest, especially with applications requiring frequent access to auxiliary storage devices. The main advantage of cassette tape data storage for microcomputers is the low cost of the equipment. Also, special higher speed tape units are available to use to back up a magnetic disk. These are available at a relatively low cost compared to purchasing a second disk drive unit.

Magnetic disks are available in two forms: soft media and hard media. Soft disks called **floppy disks** are much faster than tape storage because they are parallel data transfer devices. Parallel devices transfer an entire computer word at once instead of one bit at a time. On most microcomputers, a computer word is either 8 or 16 bits long. Floppy disks can also store data in either random access or sequential access files. For CBI applications, two floppy disk units per microcomputer are highly desirable. Experience has shown that the operating advantages of using dual floppy disks outweigh the extra cost involved. If budgetary constraints mandate only one floppy disk drive, provisions can be made to operate with one floppy disk drive.

Hard magnetic disks operate according to the same principle as floppy disks. However, hard disks are much faster and can store more information. It is not uncommon to use as many as 25 floppy disks to copy the data from a single 10 megabyte hard disk when backing up the data. This process is slow, but is usually done by the instructor or a student helper rather than individual students. Large computer systems use hard disks to backup the main disk storage, but this is not cost efficient with a microcomputer system. One viable option from both a cost and a processing speed perspective is the special magnetic tape backup systems previously mentioned. These systems are faster than floppy disk backup, cost less than a second hard disk system, and can store the complete contents of the hard disk on one tape. Hard disk drives are cost effective for applications requiring more than 300 kilobytes of storage because this will generally require more than one floppy disk, which may confuse the student and minimize CBI gains. The high operational speed of hard disks make them highly desirable for applications requiring a large number of I/O operations. The cost of hard disk media is about one third of the cost two years ago, thus making hard disks desirable for a larger number of users.

Video disks are a futuristic type of storage device for general data processing applications. Although not presently available for microcomputer, videodisks will be vital to CBI applications in the future because of the extremely large amounts of data that can be stored and their virtually unlimited branching capabilities (Hirschbuhl, 1980).

I/O Device Considerations

Many different I/O devices are available for microcomputers. The most common input device is the keyboard. Microcomputer keyboards are produced in many configurations, from the standard typewriter-type QWERTY keyboard to some very non-standard configurations. The main keyboard section should be the standard QWERTY format, especially if the microcomputer will be used for word processing. Uppercase and lowercase letters are a necessity and not all microcomputer keyboards have this capability.

Beyond the standard keyboard considerations for typing, special features to simplify operation should be evaluated. Programmable function keys need repetitive operations and minimize keystrokes to perform a multi-key operation. Function keys are essential for efficient operation of some commercial software. Special purpose keys for special applications also enhance the capabilities of a computer. Good examples of these special keys are curly brackets ({}) and square brackets ([]) used extensively in PASCAL. For applications requiring a large amount of numeric data entry, a numeric keypad will aid in rapid data entry. Special keyboards also exist to support processing in foreign languages.

The standard output devices are the video monitor or CRT, which was discussed previously, and a printer. Several types of printers are available, including letter quality impact printers, dot matrix printers, line printers, and laser printers. Letter quality impact printers produce print that is acceptable for formal written communications, but they are very slow (10 - 80 characters per second) and relatively expensive (i.e., several hundred to over one thousand dollars). Dot matrix printers are also impact-type printers, but are much faster than letter quality printers and are also capable of producing graphics. Dot matrix printers have a wide price range, from several hundred dollars for slower low print quality printers to several thousand dollars for fast near-letter quality printers. A near-letter quality dot matrix printer may be the best choice for the CBI classroom because it is versatile enough to produce excellent graphics and draft quality printing at approximately 200 characters per second, and near-letter quality printing at 50 to 100 characters per second. "Near-letter quality" may be a misnomer because the more expensive near-letter quality printers produce print that is actually more visually appealing than print produced by a letter quality printer.

Line printers are so named because their output speed is rated in lines per minute. Line printers are generally not available for microcomputers, but, if they were, they would be cost prohibitive for average CBI applications.

For many years, laser printers were too expensive for all but the most expansive computer operations and were very large and cumbersome. However, in 1984, several vendors introduced desktop-sized laser printers for as low as $3000. Laser printers are so fast that they are rated in pages per minute. The $3000 model is slow by laser standards, but it will still print eight pages per minute. The economical benefits of one $3000 laser printer in a CBI laboratory may not be immediately obvious. One laser printer at eight pages per minute output rate would equal approximately three of the fastest dot matrix printers. The laser printer produces outstanding graphics and its printed output is letter quality. Since small laser printers are new to the computer market, higher output and lower cost laser printers can be expected in the near future. For the first time since the inception of the computer, printed output will be limited by the capabilities of the computer, not the capabilities of the printer.

Special Purpose I/O Devices

Many special purpose I/O devices exist, most of which are available for microcomputers. A larger number of special input devices are available compared to the number of special output devices. Many of the special input devices are adaptable to serve special needs students in computer applications.

A fairly common input device that has received much publicity is the mouse, an analog-to-digital converter which utilizes a wheel or ball device or infrared light grid to convert the motion of the mouse into a digital signal. A mouse may be used within the operating system to control cursor movement and to function as a return key. It is used within some programming languages, such as LOGO, to design graphics displays without the tedious calculations normally associated with graphics programming. A mouse is well suited for spe[illegible] students with inadequate tactile coordination for keyboard operations. A mouse enters data for cursor coordination for keyboard operations by calculating the relative motion of the mouse from a point of origin. The mouse can be used on any flat, hard surface.

Two more analog-to-digital converters are available: the graphics tablet and the light pen. Many types of graphics tablets exist, but they all digitize data on a coordinate matrix system. Graphics tablets are an excellent method of entering complex graphics, such as drawings or maps, accurately and relatively quickly. Basically, one places the graphic to be entered on the graphics tablet and traces it with the graphics pen or digitizing arm to input the data to the microcomputer. The image may then be manipulated within the capabilities of the graphics software available on the computer. A light pen works similarly to the graphics tablet, except that the light pen writes directly on the CRT screen. Both of these data entry methods can provide limited computer access to special needs students.

Another commonly used input device is the barcode reader. A barcode reader translates a pattern by varying width bars into characters that can be processed by the computer. Barcode readers are used extensively in retail sales applications or inventory control and as such, may become a necessary part of select CBI curricula.

Although dot matrix and laser printers have graphics capabilities, another commonly used device for graphics output is the graphics plotter. Graphics plotters produce higher quality multicolor graphics than is possible with a dot matrix printer. Currently, laser printers do not have multicolor capability.

Another type of I/O device is audible input and output. Audible input and output support special needs students, but the state-of-the-art devices are inadequate. Voice synthesizers for output have been available for several years, but they have been used mostly in game software. Audible input exists in some experimental systems, but there are still technical problems with voice recognition algorithms. The main problems can be attributed to language dialects and local accents. Limited success has been achieved with audible input devices, but considerable research and development must be accomplished before these devices can be widely marketed.

Software Capabilities

Specific desirable software capabilities were previously discussed in this unit. The concerns of the computer committee should now be directed toward software bid specifications to be included in the request for bid proposal to potential vendors. Several questions must be considered when writing software specifications. Should the instructor seek a bundled software bid or a separate price for each software package that is to be purchased? Will the instructor negotiate a multiple computer software license or buy a license for each microcomputer? The specific software packages that the computer committee has approved should be reassessed to ensure they meet all the requirements of the CBI program. Any changes to a packaged agreement will cost considerably more than they would have with the original agreement.

Preparing the Request for Proposal

The exhaustive research performed up to this point should culminate in a very accurate set of specifications for the CBI computer system. This set of specifications should be set forth in a formal document known as a request for proposal (RFP). Since it is probable that some or all vendors cannot meet the exact specifications, system requirements should be classified into those that are essential and those that are desirable. In addition, acceptable values of deviation from each specification should be determined. For example, the RAM specifications may be 256 +64 −0 KB meaning that the committee desires a minimum of 256 KB of central memory, but will accept configurations up to 320 KB. Instructors should not list a deviation tolerance for the convenience of vendors where one does not exist. For example, if the CBI application requires access to a full set of ASCII characters, instructors should not accept a bid with a subset of ASCII characters. Lientz (1983) provides some general guidelines for providing a good RFP to vendors. To ensure accurate bids and fair bid practices to all vendors, the RFP should include as a minimum:

1. Specific system requirements;
2. Allowable deviations from specific requirements if applicable;
3. Schedule for bid submittal and award of contract;
4. List of other pertinent information needed for evaluation; and,
5. The method of evaluation used to judge the proposals.

Initial RFP Evaluation

The initial RFP evaluation should eliminate those vendors that do not meet specified deadlines, fail to provide mandatory functions, or have financial instability to a degree that could negatively affect the CBI program. The hardware evaluation checklists developed earlier should be used to evaluate each vendor's proposal. Each committee member should evaluate each proposal without consultation and the committee results should be tabulated to determine the vendor finalists. Unsuccessful vendors should not be informed until the selection of the winning proposal is made.

Detailed Evaluation of Finalists' Proposals

After the finalists have been identified by the initial evaluation process, the committee should complete the evaluation process as one group. At this time, each remaining vendor should be discussed in detail and a list of questions should be made regarding the specific capabilities provided by each vendor. This list of questions should include matters not explicitly or completely covered by the vendor's proposal.

Computer System Demonstration

After the detailed proposal evaluations are complete and a list of questions has been developed for each vendor, the part of the procurement process with which most people would like to start should occur—the computer system demonstration. The computer system demonstration is a critical part of the selection process and, if handled incorrectly by the computer committee, could negate all the carefully executed preliminary research.

Smith (1984) cites several principles which are directly related to microcomputer systems. Most of these principles are also true for computer system demonstrations in general. For microcomputer systems, the demonstration should take place at the school facility. Minicomputer and mainframe computers will require the committee to travel to the vendor's facility or some local facility that has the same equipment. When planning to purchase a minicomputer or mainframe computer, the buyer should not settle for a modem-equipped terminal demonstration to a remote machine. The committee needs to see the physical configuration of the system as well as its performance.

Prior to the demonstration, each vendor should be provided with a list of the specific items that should be demonstrated. Also, information should be provided to the vendor regarding the level of expertise of the people who will attend the demonstration. Each vendor should identify the number of systems in place in educational environments and list the names of the people in charge of them. The committee should contact some of these people prior to a system demonstration. The committee should add concerns voiced by this group of users to an existing list of questions for the vendor (Smith, 1984).

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The committee should not permit the demonstration to deteriorate to a canned sales pitch. The group should refer to its list of specifications and ensure that each feature is demonstrated. The committee should assume that any feature that is not demonstrated does not exist, and should make sure that the system being demonstrated falls within the specification guidelines, including the specification tolerances. The group should beware of a machine configured significantly above the committee's specifications "for demonstration purposes only," because it may be able to perform functions that the purchased computer cannot perform.

During the demonstration, members of the committee should operate the computer by themselves as a test of its user friendliness. The user manuals should be carefully inspected for ease of use. Software from the CBI program should be test run to check for compatibility. The committee should identify hidden costs which accompany the system, including possible site modifications prior to installation.

During the demonstration, another set of hardware specification checklists should be individually completed by the committee members. A compiled rating should be developed based solely on the system demonstration. When all finalists have provided the committee with a demonstration, the committee should meet to determine the vendor that will supply the computer system. The committee should have three independent quantified evaluations of each system based upon preliminary research, bid proposals including technical specifications, and the actual demonstration. The committee can then be confident that the purchased system is the best one for CBI needs commensurate with available funding.

Negotiating the Computer System Contract

The actual negotiation of a contract for computer system hardware, software, and maintenance is not a job for untrained individuals. If possible, a school lawyer should negotiate an adequate contract which protects the school system's rights. However, computer law is a very specialized area in which many lawyers lack experience. The computer committee must ensure that several questions are answered to its satisfaction and included in the negotiated contract. Contractual questions fall into five distinct areas:

1) Maintenance and warranty;

2) Software updates, especially with regard to the operating system;

3) Hardware support during and after installation;

4) System acceptance; and,

5) Training for system operators.

Topics within the maintenance and warranty areas include who will fix the system, when and where it will be fixed, the length of time of the warranty, how the warranty is affected if system modifications are made, and the availability and terms of maintenance agreements. Depending upon the vendor, system maintenance can be performed on-site, in a local repair shop, or at the factory. The location of repair service, the service response time, and responsibility for performing repairs are all part of the service agreement.

Service agreements for both minicomputers and microcomputers can be expensive. Minicomputer maintenance contracts for large systems can cost as much as $3,000 per month for hardware and $800 per month for software, depending upon the level of maintenance. Vocational schools do not have the system requirements of many industries and therefore do not require top-of-the-line maintenance contracts. A very good service contract for minicomputers, including single shift weekday and 24 hour response time can be negotiated for a reasonable price. CBI applications will not require the high-priced, 365 day per year, multi-shift, short response time maintenance contracts that many industries require.

Microcomputers maintenance contracts are also fairly expensive, costing several thousand dollars per year plus all parts and labor. A good thumbrule for cost is 1-2% of the purchase price per month for carry-in service at the local sales outlet or mail-in service direct to the factory. On-site maintenance, if available, is much more expensive (McGonagle & McClain, 1983). Most microcomputer warranty periods are 90 days and are voided if the system is modified by the user. Most local vendors will provide warranties similar to the manufacturer's if that vendor makes the modifications. An example of desirable modifications such as the installation of OEM multi-function memory boards.

Software update is another area in which cost savings for the school can be negotiated. Multiple licensing fees can reduce overall costs by allowing software to be used on more than one computer. Microcomputer software vendors do not provide multiple licenses routinely, but some will give special consideration to large volume purchases on a case basis. The school should be sure to include operating system updates in the contract. With software for larger machines (i.e., minicomputers and mainframe computers), the school should ensure that software modification rights and exclusivity rights are explicitly defined. Some vendors will not allow any modifications to their software users; others allow modifications with the stipulation that the software be returned to its original state upon the expiration of the license; and others will pay for the right to incorporate recommended modifications for all users if the modifications produce a definite improvement in the performance or capability of the software.

Hardware support during and after installation is a gray area between maintenance and warranty provisions, and system acceptability criteria. This area should include informal communications with the vendor for minor problems during the break-in period. These communications should include clarification of the documentation if necessary.

Definitive system acceptance criteria should be established in the purchase contract. This not only includes criteria for tasks that the computer system must perform, but also for deciding who is responsible for establishing the criteria, collecting the data, and performing the evaluation. The duration of the acceptance period must also be considered.

The final area that must be considered is operator training. Will the training be performed live on-site for all staff personnel, by videotape with tutorial assistance for all staff personnel, or will key staff members be sent to the vendor's school and subsequently train the rest of the staff? For microcomputer systems, on-site live training is generally preferred. For minicomputer and mainframe systems, vendor schools for key staff members are more beneficial, especially if several videotapes providing refresher training are also purchased.

After all the methodical selection processes are completed, the success of the selection project is only as good as the purchase agreement. The committee should recognize that agreements that are not in writing do not exist.

SUMMARY

The potential success of CBI in a vocational school is influenced by the method of hardware and software selection used to establish the CBI program. The first step in the process is to establish a committee of experts to guide the procurement project. If the required expertise does not exist completely within the faculty, the school should draw from resources available within the community. Next, it should be determined which is the general type of computer system that can be utilized for CBI applications. This decision is usually made on the basis of existing equipment and available funding. The most important aspect of the selection process is to determine what software is necessary and available to support CBI needs prior to the drafting of specific hardware specifications. Evaluation guidelines from several sources should help the committee design a software evaluation form for its specific applications. The evaluation form should be used as an unbiased assessment of software packages. The committee should select computer hardware that best supports the required software and other requirements, such as special I/O devices, within the CBI program. The committee should seek a solid purchase agreement, paying particular attention to software and hardware specifications, acceptance criteria, warranty and maintenance of hardware and software, and operator training.

ACHIEVEMENT INDICATORS

1) Based upon real or fictional funding figures and existing computer system capabilities within your school, determine which general type of computer system would be necessary to support CBI in your subject area.
2) Develop a list of available software to support CBI in your subject area. Discuss any modifications that would be necessary to support your application with local computer experts.
3) Develop a hardware evaluation form similar to that in Appendix B based upon hardware specifications necessary to run the software in your list developed in number 2 above.
4) Obtain technical information on several microcomputer systems that meet your general specifications in number 3 above. Use the evaluation form to select the most appropriate system.
5) Plan a performance demonstration for at least one of the microcomputer systems that meets your hardware specifications.

APPENDIX A

Computer Software Evaluation

A. **Hardware interface requirements**

1. Will it fit in the RAM of your microcomputer?
2. Is it written for your machine or will it need to be adapted?
3. Is it adaptable?

B. **Reliability**

1. Can the program code be read easily or is it assembler or machine code?
2. Does the program contain self checks? Does the program perform data error checks?
3. How completely has the program code been checked by the author? What data parameters were used to check correct code execution?
4. Is the program code well documented?

C. **Usability**

1. Does the program write back a reasonable amount of input and critical intermediate results as well as the final solution?
2. Is input data entered by DATA statements from the keyboard, or input from data file? (Data statements are the least desirable from a user standpoint.)
3. Is the data well identified with units (psi., cc/kg, etc.)? Do you have a choice of English and SI units?
4. Is output presented in a clear format?
5. Is there a user-controlled option for partial printout of summarized results?
6. Is execution speed acceptable?
7. Can printout be directed to a printer, screen, disk, etc.?
8. Is it written in all BASIC, all Assembler, all machine language, or a combination? Can it be user modified?
9. Can working copies be made to protect the master copy?

D. **Costs**

1. Does price include full documentation?
2. Do you get a disk or tape replacement if original is damaged?
3. Will additional hardware be required to use program? (e.g., multifunction board, plotter, mouse, etc.)

APPENDIX B

COMPUTER HARDWARE EVALUATION (1)
Computer System________________

CAPABILITY	IMPORTANCE RATING	RATING (3)	QUALITY RATING (4)
Central Processor	(2)	1 2 3 4 5 6 7 8 9 10	
K RAM (MIN)		1 2 3 4 5 6 7 8 9 10	
Expandable to K RAM		1 2 3 4 5 6 7 8 9 10	
Bit Addressable Graphics		1 2 3 4 5 6 7 8 9 10	
Several High Level Languages Available		1 2 3 4 5 6 7 8 9 10	
Video Monitor Color Capability		1 2 3 4 5 6 7 8 9 10	
Touch Screen		1 2 3 4 5 6 7 8 9 10	
Auxiliary Storage Support for two floppy disk drives		1 2 3 4 5 6 7 8 9 10	
Support Hard Disk Drive		1 2 3 4 5 6 7 8 9 10	
I/O Devices Standard Qwerty Keyboard		1 2 3 4 5 6 7 8 9 10	
Numeric Keypad		1 2 3 4 5 6 7 8 9 10	
Programmable Function Keys		1 2 3 4 5 6 7 8 9 10	
Graphics Tablet		1 2 3 4 5 6 7 8 9 10	
Upper/Lower Case Alphanumerics		1 2 3 4 5 6 7 8 9 10	

Total Quality Rating (5) ____________

(1) This is a simplified form. The actual form must be a very detailed listing of all desired specifications.

(2) Relative importance when compared with other capabilities.

(3) Use one value to rate this criterion on this machine.

(4) Quality rating = Rating X Importance Factor

(5) Sum of Quality Ratings

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Unit 6

Implement a Plan to Apply Computer-Based Instruction to Vocational Curricula

UNIT OBJECTIVE

Upon completion of this unit, the learner will be able to implement a plan to apply Computer-Based Instruction to vocational curricula using a systems approach. The learner will demonstrate this ability by utilizing CBI materials as described in the CBI curriculum model of unit B.3, and through completion of the achievement indicators at the end of this unit.

SPECIFIC OBJECTIVES

Upon completion of this unit, the learner will be able to:

1) List the steps to follow in establishing a CBI implementation plan in vocational programs.
2) Delineate seven student related attributes which can affect the CBI implementation plan.
3) Identify job-specific applications of CBI which pertain to a local vocational program.
4) Identify specific educational applications of microcomputers to be incorporated in vocational curricula.
5) Develop a set of student objectives for CBI which pertain to one of the job-specific applications identified above.
6) Prepare or select instructional material to be used with CBI which support the achievement of objectives.
7) Develop and validate criterion referenced tests for CBI.
8) Demonstrate the ability to execute a CBI program.
9) Evaluate the results of utilizing a CBI process in vocational curricula.

Implementing a Plan to Apply Computer-Based Instruction to Vocational Curricula

BY: DONALD ESHELBY

STEPS USED IN IMPLEMENTING A PLAN TO APPLY COMPUTER-BASED INSTRUCTION

There are eight key planning steps to follow when the teacher seeks to incorporate CBI in a vocational program. These steps need not be followed in the exact order presented, but all must be addressed to achieve successful implementation:

1. *Identifying* or *assessing* student microcomputer needs.
2. *Identifying* or *assessing* job-specific applications of microcomputers.
3. *Identifying* and *assessing* educational applications of microcomputers to be included in vocational curricula.
4. *Developing* student objectives to meet student needs.
5. *Preparing* or *selecting* appropriate microprocessing instructional material.
6. *Constructing* and *validating* criterion referenced tests to attain microcomputing objectives.

7. *Executing* the CBI application in the targeted vocational program.

8. *Evaluating* progress and success of the CBI application.

In the next sections of this unit, each of the above eight steps is defined.

Assessing Student Needs

Student needs are a central consideration of each educational program. A first priority for teachers is to determine student abilities and needs as they relate to the content of each course, the sequence of courses in the total vocational program, and Computer-Based Instruction. Identified needs include the learning style, reading level, career expectation, and readiness of each student. Interest in the course content and grade level are also contributing factors in determining student needs.

Expected student microcomputing outcomes, formulated in the vocational program description and constructed using needs assessment, should define the learning path toward particular careers. These outcome statements are most useful when presented in measurable terms. The continued evaluation of student progress toward expected outcomes serves further to delineate student needs Such progress evaluation is best used when criterion referenced testing methods are employed by teachers.

Additional information to use in formulating expected student microcomputing outcomes can be obtained through surveys of parents, instructors, students, and business or community representatives. Surveys can be used to determine the validity of course content. They can be extremely valuable in gaining insight into local community mores and societal expectations. The curricular problems confronting an instructor can be more accurately resolved when a survey is used to determine the depth and extent of related concerns among the various vocational audiences. Some "needs" which seem quite plausible in the instructor's mind may turn out to be unfounded.

A systems approach to needs assessment considers every element of the educational environment in order to properly determine the correct approach to incorporating CBI. Teaching strategies, instructional materials, technical equipment, other instructors, and evaluative techniques are a few of the necessary elements that might be included in the survey. School resources and policies will likewise play an important part in the process. Educational effectiveness is defined in terms of student behavior or expectations. The degree of success of CBI will be directly related to the individual student's achievement of stated objectives within the resources of the school system.

Identify Job-Specific Applications for Vocational Curricula

Microcomputers are relatively new tools for instructors in vocational classrooms. While this new tool will never replace the instructor, it can be utilized very effectively in a management role or as an aid to the learning process. The degree to which this tool is effectively used depends on the ability of instructors to understand the potential of the microcomputer and their willingness to undertake the challenge of redefining educational outcomes in terms of microcomputer usage. To be an effective tool in the classroom, the computer must be relegated to its most applicable role.

As an instructional aid, the microcomputer is theoretically boundless. However, it does have some practical limitations. Appropriate software or hardware are not always readily available to the instructor. In addition, while there are many uses of the computer, instructors must be certain to use the device in a constructive, creative manner. The microcomputer is capable of serving as more than a substitute for the textbook or workbook.

Industrial applic .ions of the microcomputer are varied and often complex. Computer-Based Instruction in a vocational program should be conducted in a manner which parallels industrial applications. It follows that if a computer is utilized in an industry, a computer is a logical piece of equipment for the classroom or laboratory of a vocational program which purports to teach that specific discipline. A strong determiner of whether or not a computer should be in a vocational program can be a validated task analysis from industry.

The identification of worker tasks specific to the use of computers or microprocessors should be the foundation of course content. For example, microcomputers as they are used in industry, could be identified in such courses as information processing or cash register training; industrial management computer applications can be taught ranging from electronic spreadsheets to inventory control. The repair of robots or the maintenance of microprocessing equipment would be yet another educational application of computer technology affecting certain vocational programs.

Identify Specific Educational Applications for Microprocessors in Vocational Curricula

Selecting software for vocational programs is directly related to the aforementioned factors of classroom environment and the needs of students and industry. The type of learning, as specified in the objectives of the program, can include tutorial, drill-and-practice, problem-solving, simulation, and/or gaming software applications. Student learning style will help dictate the type of skill building instruction needed. The selection of instructional material to be used in the vocational laboratory or classroom can be made more efficiently by obtaining information about the material through the electronic databases included in an upcoming section of this unit (DISC, SOFT, RICE, TECC). Additionally, software applications can be explored through discussions with industry personnel and the Advisory Committee for the vocational program.

Application selection problems may be illustrated through a few examples. Keyboarding skills require both speed and accuracy. Although a typing tutor would be inappropriate to develop speed and accuracy at the higher educational levels, it is an excellent basic skill development software application. Therefore, depending on your students' skill level, you may or may not want to use typing tutor software in your vocational program.

An electronic spreadsheet is an excellent tool to use in accounting classes after keyboard skills have been learned, but it does not have practical application for data base management.

Problem-solving skills can be practiced by using a gamelike program called Millionaire. This stock market game provides an opportunity for Marketing and Business students to determine the results of specific decisions in a relatively short period of time. Many such games exist which simulate business decision-making from operating a lemonade stand to managing a real estate office.

Recordkeeping for agribusiness applications are common in the realm of computer software. These tools can determine fuel costs, depreciation, storage capacities, and almost any information needed by the American farmer or business person. The educational objectives of the program must coincide with the results achieved by using a specific software program.

Further cautions must be noted in discussing software applications. There are packages available which, after asking the student to make a choice, do not provide any explanation of incorrect selections or any reward for correct choices. An instructor should look for software which offers some form of "branching" for incorrect responses. A branching program allows the student an opportunity to try again. Another useful type of package requires a student to use a pencil and paper or other form of equipment in addition to the monitor or keyboard. If a package does nothing but provide sequential page turning, it should not be selected for use in the classroom. The instructor gains little motivation if a student is reading the information on the computer rather than in a book. Speed reading packages, on the other hand, are very useful as both motivational devices and drill-and-practice tools.

Develop Student Objectives For CBI

The development of learner objectives for CBI is a critical process. Without objectives, no accurate measurement of the learning process exists. In the instructional process for CBI, competency-based objectives influence the type of instruction, equipment, timeframe, and teaching methods to be used. Criterion referenced testing should focus on these objectives as criteria. One teaches to the objectives and tests using the objectives as the unit of measurement.

A competency-based objective is comprised of four distinct parts. In developing an objective, one must first identify the learner and plan all activities toward that person. This is done in the first phase of this systems approach. The second component is determining the behavior to be exhibited. The third component is assessing the exhibited behavior. The fourth component is establishing the conditions under which the behavior is to be exhibited. The resulting statement of objectives generally sets the timeframe, tolerances, equipment, and level of performance to be expected.

Student objectives are derived directly from the task analysis or the performance objectives established by needs assessments, advisory committees, and the State Department of Education in the form of Program Standards or Guides. Each instructor is responsible for establishing student objectives. However, from this charge it does not necessarily follow that every teacher must develop a new set. Instructors should obtain a set of performance objectives and adapt or adopt those which are best suited to the program description and course outline that has been developed for their courses.

Computer-based objectives are formulated in the same manner as traditional teaching objectives. Many commercially developed software packages are readily available for instructors to use. When possible, a teacher should review a package before purchasing it to make certain that it is compatible with student objectives. The objectives must be stated in a manner which determines how the student utilizes the computer to solve a problem, to set up a simulation of a problem, or to complete a set of tasks (such as typing an error free document). Teachers need to stress objectives that determine what behaviors, conditions, and levels of performance are expected of students.

Prepare or Select Instructional Material to be Used with CBI

Preparing materials for CBI requires many hours of intensive work by instructors. Instructors can expend as much as 700 hours in the development of one software program. Many instructors are not prepared to write programs, but they may have the ability to modify simple applications of programs to meet their needs. Most instructors do not have the programming skills nor the time to create programs. A recommendation for vocational instructors is to select and/or modify appropriate material rather than to develop it.

There are several ways by which an instructor can determine how useful computer software will be to a vocational program. Major sources of information are the many computer periodicals and magazines which describe and evaluate software applications. In addition, several publications provide software evaluations specific to management, simulations, education, and other uses. Software evaluations are also available through databases such as Online MicroSoftware Guide and Directory (SOFT) and Texas Education Computer Cooperative (TECC). The Minnesota Education Computer Consortium (MECC) is an excellent source for obtaining educational software information. A database is also available which identifies articles for journals and periodicals by using the table of contents as a searching base (DISC).

A major criterion in the choosing of software must be the application for which it is intended. Instructors should not choose software which is primarily a page turning exercise—unless it is to be used as a motivational tool for slow learners or for students with learning difficulties. A word processing application might be an excellent tool to help students prepare a report after returning from a fieldtrip. Here, the intent should be to learn how to organize thoughts using a computer package, not how to use the computer package. Although a dual purpose may be served, it is critical that the teacher clearly sets the objective prior to the exercise in order for the learner to produce results without confusion or unnecessary frustration.

Should teachers decide to develop their own instructional material for CBI applications, it is critical that all steps in the process be documented. This will save instructors time and effort in later revisions and in debugging system errors during the final development phases. Two types of documentation are needed: 1) technical documentation and 2) user documentation. **Technical documentation,** the more complex of the two, exists primarily to explain to other programmers how the system runs or operates. It contains lists of program variables, file specifications, and additional technical information which more sophisticated users could find helpful if the program fails to operate properly. Also included would be helpful information such as the characteristics and capacities of the equipment needed to operate the program and programming flow charts. **User documentation,** in contrast, is information generally found in operator manuals and is directed toward the typical user of the program. It includes a description of the hardware needed to operate the program and provides step by step directions on the use of the program. Instructor directed documentation includes objectives, types of students to be served, an overview of the content, and other information which could be useful to teachers in setting up a microcomputing learning station around this program. Charts, examples, worksheets, and specific lesson flow instructions should be part of student directed documentation.

Develop and Validate Criterion Referenced Tests for CBI

The development and validation of criterion referenced tests is a simple process if the instructor has developed or adapted competency-based objectives. The criterion is the competency statement. The validation is based on the industry-based task utilized to develop the competencies. To develop appropriate tests, one must rephrase the objective without losing the intent of the objective. It is helpful to develop a test bank which contains several questions for each objective and various format types of questions such as true/false, multiple choice, fill-in-the-blank, and essay. This will help meet the need to vary testing to meet the learning styles of students without straying from the intended educational outcome as established in the objective. This permits instructors to administer a different set of tests depending on the circumstances (e.g., makeup tests for absent students).

Testing is merely a means of determining student progress. Tests must encourage students to work toward predetermined goals or to achieve predetermined standards for tasks identified in objectives. If the objective is to learn how to use a block plane, the test should be a measurement of the student's ability to use the piece of equipment. As another example, an objective to prepare a balance sheet should be evaluated on the accuracy of the balance sheet, not on how well the student uses the keyboard (unless the objective includes as a condition a statement which requires the student to complete the task in a predetermined period of time). A student should be evaluated on the basis of how well the task is completed, not on the basis of how other students accomplished the same task. Industry standards should be incorporated to determine the level of performance for job readiness. Performance levels which have been established by instructors should be used to provide a sequential learning curve which maps the progress of a student toward meeting industry standards.

While the validation of test content is based on industry standards, the subsequent development of test sequencing to measure levels of learning should be based on accepted educational principles and a hierarchy of learning. Tests must be prepared which can encompass both the needs of industry (in terms of the standards required to obtain and hold a job) and the abilities of the learner to progress efficiently through the educational program.

Demonstrate the Ability to Execute CBI Program

The execution of a CBI program can best be assured by following the steps identified in the plan. The most successful approaches have included a parallel system of instruction which allows normal instructional practices to be phased out gradually as the new system is implemented. The parallel system also creates a check and balance system so that, when one phase of the new system does not operate as planned, traditional methods can be employed so as not to interrupt the educational program. This system allows an opportunity to assess the relative effectiveness of both methods in achieving the same objectives. A parallel system can help the instructor discover which students learn best from what types of instruction.

Pilot exercises should be optional or upgraded until they have been proven to be substantially effective. Most students are willing to assist in a learning experiment as long as they are not adversely affected or threatened by it. Pilot tests which allow data collection on all intended types of materials are essential in the evaluation process.

Staff involvement should be considered very carefully when executing CBI. A willing helper is a great asset, but an unwilling helper will not offer much assistance. The substantial preparation of instructors is an essential part of ensuring success and reducing failures. The plan to implement CBI should provide enough lead time to prepare all persons who will be actively involved in the process. It should also include a procedure for informing other members of the staff about the program to assure a smooth transition and prevent possible interference from personnel who were not aware of the plans of the program.

Evaluate the Results of CBI Process

The implementation of CBI in vocational programs cannot be effective unless some form of evaluation is conducted. A basis for comparison must be the previous history or progress of the program prior to CBI. However, most programs do not retain accurate or detailed records of class progress, which is a problem. Progress records measured against no previous records provide no accountable success factor.

From the outset of the implementation phase, a written accounting of the time and costs involved should be maintained. The educational effects of the new program must be equal to or greater than those of previous programs or it need not be implemented. The outcomes of a vocational program must be acquired job entry skills. If these outcomes can be achieved with greater efficiency through CBI than through traditional methods, then the program is successful. Perhaps the evaluation suggests that greater resources should be devoted to acquiring software rather than to upgrading the equipment in the program. Computer-Based Instruction is different from instruction using electronic typewriters, calculators, or CNC milling machines used in programs which may be improved through a simple technological updating or upgrading of equipment. Computer-Based Instruction involves the use of instructional applications of computers in the classroom and this approach is improved most by better application (use) of existing equipment.

The evaluation process, under these terms, means that instructors should not measure the success of the program in terms of achieving the objectives of the instructional process. If the instructor is able to facilitate learning more effectively through CBI, this will be the strongest measure of success.

When implementing a plan to incorporate CBI in a vocational program, a first planning step should be to include a process for evaluating results. It does little good to determine what one wants to measure after the process has been implemented. Useful data regarding achievement, time, and effort are lost unless they are properly documented. Such documentation can be a vital component of the evaluation process. These data can be used in the subsequent refining of the program. The expectations must be established for the program prior to embarking on the venture. By establishing such parameters, success can be measured in terms of 1) time needed to accomplish the objectives of the overall process, 2) cost effectiveness, 3) instructional effectiveness, and 4) overall student accomplishments.

For example, the evaluation process might focus on collecting information in the following areas:

1. Time factors for: a) students, b) testing, c) developing material, d) preparing staff, e) instructors
2. Measurement devices for: a) student achievement, b) class progress, c) time on task, d) teaching time, e) objectives, f) grading and scoring, g) overall program outcomes
3. Selection of materials and usefulness of materials
4. Type and amount of instructional supplies, reading level of texts and material used, maintenance of equipment
5. Methodologies used, types of students involved, learning styles of students

While it may not be practical to keep comprehensive records on all of the above items, it is important to keep *accurate* records of those selected items for which it was determined that data should be kept. The only sound reason for implementing a new educational practice is to affect positive change. Without accurate data, there is no way to determine if the change was truly positive, nor is it possible to assess the degree of success achieved as a result of the change.

SUMMARY

Implementing a plan to provide CBI opportunities to students can be a very rewarding experience, but one which requires a lot of preplanning to ensure that the system is successful. Eight steps needed to implement a plan must be accomplished. A system of continuous monitoring should be established to ensure that each step is included. These eight steps are:

Step I Students' Need Identification

The assessment of students' needs is the first critical step in the process of implementing CBI. The needs for CBI are determined through the use of advisory committees, surveys of the community, involvement of other educators, industry input, and a critical look at the educational environment.

Step II Job-Specific Application Identification

Job-specific applications of CBI must be determined to complement the other needs identification taking place. While industrial applications are common, they are sometimes not easy to replicate in the classroom. Job-specific instruction is more definitive that occupational-specific instruction. Keyboarding skills are occupational-specific, while the repair of disc brakes is job-specific. For example, the mechanic may use keyboarding skills, as do many other workers, but a secretary will not generally repair the brakes on an automobile as a regular job function.

Step III Classroom Application Identified

Educational applications for CBI must be specific to the classroom or learning laboratory. If the laboratory is designed to parallel industry, then CBI should be directed to those activities which simulate industrial applications. Problem-solving activities can be used to great advantage in the classroom, as can gaming activities, if they are programmed to provide opportunities for the student to interact with the computer by posing questions or alternatives. The instructor must be certain to obtain material which provides for this branching.

There are many applications for the use of microcomputers in most vocational program areas. Agriculture and Agri-business spreadsheet applications are popular. Database management products can be used in most classroom settings, but would appear to favor the manufacturing or business programs. Tutorial material can be selected for remedial support or for skill building.

Step IV Student Objective Formation

The development of student objectives for CBI consists of matching software and computer applications to the needs of both industry and the student. The conditions under which the learner exhibits certain behavior and how this behavior is to be measured are all important components in written objectives. Material to be used in CBI to support objectives is often hard to obtain and, once obtained, may be difficult for the local teacher to tailor to fit the class. Course objectives and outcomes must be considered very carefully when implementing CBI to make certain that the process achieves the same objectives sooner and with greater results than traditional methods.

The most important consideration to remember is that good CBI objectives require that the student use the microcomputer in an application mode. Using an electronic typewriter to type a report is not typically CBI; it is basically the utilization of technically upgraded equipment. Learning how to use a computer or microprocessor in the classroom setting as an instructional tool is more clearly CBI. The student should interact with the tool, extract information from it, or use it to affect some change in the environment of the classroom or project. The instructor must develop student objectives in such a manner that this kind of involvement can take place.

Step V Selection of Instructional Material

Selection of instructional material to be used with CBI is the step which is perhaps the most demanding on the instructor's time. If good commercially developed software is available, use it. Software is not the only instructional material a teacher will need for CBI, however. Support workbooks and written material are necessary parts of the process. In making selections, it is important to document the individual steps in the selection plan so that one can go back to make the necessary adjustments to replace a vital piece of software should it be destroyed or lost.

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Many sources may be used to locate material for CBI. Much material can be discovered by using the various databases (DISC, RICE, SOFT, etc.) and by using the periodicals and magazines which abound in the computer marketplace. Material which provides clear documentation for user/learner activities and learner objectives is most beneficial.

Step VI Assessment of Objectives

Once a teacher has developed student objectives in a competency-based format and selected instructional material, it is a simple matter to create criteria by which an instructor can prepare test questions. In most instances, the tests can be rephrased objective statements. It is a good idea to develop a test bank of a number of similar questions in different formats. This will allow the teacher an opportunity to vary the questions for periodic quizzes and for student learning styles. The format can provide for true/false, fill-in-the-blank, or other formats, which then can be administered at a different time without changing the intent of the question or the criteria.

Step VII Executing the Program

Executing CBI is based on the total plan. Many checks and balances should be built into the plan, and the plan should be flexible enough to allow changes for unexpected events. Phasing out the traditional system over a period of time is one way to prevent the educational process from being interrupted. Modifications to the old practices can be made without major problems if a plan is provided to maintain a sequential pattern of instruction and classroom activity.

If a parallel system is available, it will soften the change and ensure a smooth flow of learning. Pilot exercises should be offered as optional or upgraded until they are proven to be effective as classroom activities. Staff involvement in planning is critical to all steps in the process, as is the preparation of personnel.

Step VIII Evaluating the Program

Continuous evaluation is a vital aspect of successful implementation of CBI. Each phase of the process should be evaluated and properly documented. Checklists should be utilized by all members of the planning team. Scrutiny must extend to an examination of the objectives and testing practices used. Properly posed objectives should exist for all phases of the project, including student, program, instructor, and school components.

Properly established timelines are a great assistance in determining how successful a project is and how cost effective it will be. The timelines should be established for student progress as well as for program progress. Student accomplishments must be measured against a predetermined standard in order to provide a measurement of success for the program. The use and effect of resources of the project must be controlled and documented as well.

ACHIEVEMENT INDICATORS

1) List the steps to follow in establishing a CBI implementation plan in vocational programs.
2) Delineate seven student related attributes which can affect the CBI implementation plan.
3) Identify ten job-specific applications of CBI which pertain to your vocational program.
4) Identify four educational applications of microcomputers for your vocational program and give two examples of how each can be used in the classroom.
5) Develop a set of student objectives which can be applied to one of the job-specific applications identified for your program.
6) Select four software packages which can be used in your vocational program for a) problem-solving, b) tutorial, c) reading, and d) spreadsheet applications.
7) Develop three sets of criterion referenced tests for each of the student objectives developed for your program and validate each by having it reviewed by an industry person.
8) Execute your implementation plan by following the steps you identified at the beginning of the exercise.
9) Evaluate your plan to implement CBI by reviewing the steps with other instructors and by establishing timelines for each phase using specific results identified as determiners of success.

Unit 7

Evaluate and Modify Applications of Computer-Based Instruction to Vocational Curricula Based on Innovations in Computer Technology and Work

UNIT OBJECTIVE

Upon completion of this unit, the reader will be able to evaluate and modify a plan to integrate Computer-Based Instruction into vocational curricula. Furthermore, the reader will learn how to interface this evaluation plan with innovations in computer technology and work to achieve continued growth within a program. This knowledge will be demonstrated through completion of the achievement indicators provided at the end of the unit.

SPECIFIC OBJECTIVES

Upon completion of this unit, the reader will be able to:

1) Define the terms formative and summative evaluation.
2) Define the terms internal and external evaluation.
3) Define the terms goal-directed and goal-free evaluation.
4) Define the terms comparative and non-comparative evaluation.
5) List and discuss the characteristics of good evaluation as related to evaluating CBI.
6) Discuss a summary of findings of select CBI research projects that have been conducted during the past twenty years.

Evaluate and Modify Applications of Computer-Based Instruction to Vocational Curricula Based on Innovations in Computer Technology and Work

BY: DR. RICHARD A. McEWING

All units in Category B direct vocational teachers in integrating Computer-Based Instruction into vocational curricula. The final two competencies of Category B, evaluation and modification, have been united into a single unit of instruction. This approach is taken because these two interrelated areas involve the two major questions a vocational teacher must face whenever program development is attempted. The first question is, "How do I demonstrate that this new approach is having a positive impact on my vocational program?" The second question follows from the first, "How can I ensure that innovations in computer technology and the world of work will continue to be positively incorporated into my successful program?" The answer to both questions is a well conceived program evaluation plan.

CONCEPTS RELATED TO EVALUATION

"Evaluation" is one of those words that is used so often that it is assumed that everyone clearly understands its meaning. However, the concept of evaluation is actively much more complex than one might first suppose. A discussion of evaluation must first include its definition. This definition can be broken down into four basic areas — when, who, what, and how.

When — Formative versus Summative Evaluation

A delineation can be made between two large categories or types of evaluation — **formative** and **summative** (Scriven, 1967). Calhoun and Finch (1982) suggest viewing these two concepts as process (i.e., formative) and product (i.e., summative) evaluation. For example, formative evaluation of Computer-Based Instruction transpires during each implementation stage. This permits modification of the process of integrating CBI into vocational curricula at the time the need/concern is identified. Summative evaluation, on the other hand, occurs at the conclusion of the unit of instruction, grading period, or overall program. Thus, summative evaluation allows instructors to observe needs/concerns of CBI as they relate to the overall effectiveness of vocational curricula.

Both of the preceding types of evaluation are extremely important and must be incorporated into any effective evaluation plan. Consider the significance of formative evaluation. The vocational instructor must be able to assess how well certain components are working to make on-the-spot corrections and modifications. These types of evaluations are discussed in the specific units (e.g., hardware evaluation, student progress evaluation, software evaluation and modification, instructional design evaluation) and the reader is referred to those sections for discussions of such formative evaluation techniques.

Summative evaluation has a potential impact quite apart from that of formative evaluation. Summative evaluation will be used not only to refine the program, as was the case with formative evaluation, but it will likely be used by administrators to make decisions about the nature and value of the total CBI program. Thus, the vocational instructor needs to be aware that the data produced during the summative phases of program evaluation will eventually be made available to, or be demanded by, a wider audience.

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Who — Internal versus External Evaluation

An outgrowth of the "when" question of evaluation is the "who" question. Evaluation can be dichotomized according to whether the process is carried out by someone inside the system (likely the vocational teacher himself/herself) or by someone outside the system. This dichotomy is often referred to as **internal** versus **external** evaluation. Blaine R. Worthen (1974) discusses the dichotomy as follows:

> There are obvious advantages and disadvantages with both of these roles. The internal evaluator is almost certain to know more about the project than is possible for any outsider, but he may also be so close to the project that he is unable to be completely objective in his view of it. There is seldom as much reason to question the objectivity of the external evaluator (unless he is found to have a particular ax to grind) and this dispassionate perspective is perhaps his greatest asset. Conversely, it is difficult for an external evaluator to ever learn as much about the project as the insider knows. (pp. 20-21)

What — Goal-Directed versus Goal-Free Evaluation

Most educators are familiar with goal-directed evaluation. This entire document has been constructed according to this type of model. This model established general objectives, defines specific objectives within each general objective, states the specific objectives in measurable terms, provides instruction to meet the objectives, and measures the extent to which these objectives are achieved. This goal-directed approach seems so obvious that we might be tempted to see this as the only legitimate evaluation approach. After all, shouldn't teachers know if they have achieved their goals?

The answer to the above question is, "Of course." But what if the program creates effects that exist outside the behavioral objectives that had been so carefully defined? It is quite conceivable that the "results" of a program may have consequences that instructors did not anticipate when they began their work. How can instructors evaluate these types of effects?

To get at these outcomes, Michael Scriven has introduced the idea of goal-free evaluation (1972). In this evaluation approach, the evaluator is **not** told the goals of the project. This has the effect of freeing up the perceptions of the evaluator. Instead of looking in places already defined by the project as key assessment points and areas, the evaluator may look in many places and consider many sources. In this way, it may be discovered that the project is having the impacts anticipated or it may be learned that there are other, perhaps more important, impacts that were unanticipated. The focus is on **actual** program effects rather than on program effects **purported** to be taking place.

Goal-free evaluation would likely need to be linked with external evaluation. This combination may prove to be threatening to the vocational instructor because it seems to place all control of the process "outside" the

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purview of the program directors and instructors. The question is, however, do vocational teachers want to know the overall potential effects of the program or do they not?

How — Comparative versus Non-Comparative Evaluation

The final consideration to be presented in this section of program evaluation is the question regarding comparative versus non-comparative evaluation. In comparative evaluation one attempts to find a program with similar goals, expectations, and objectives. Then the instructor administers common evaluation approaches to see which case/program came out ahead on which measures. This information can be very useful in giving exact directions to a "go or no go" decision.

Often, however, such comparison studies are problematical. It is difficult to identify programs which have found exactly the same specified goals. Even if such programs are found, there are often unique program-specific constraints that color the comparisons. In addition, there seldom is such a clear-cut "this program is better" conclusion. Some programs are slightly better at this and slightly weaker at something else.

Non-comparative program evaluation is often the only avenue available to vocational instructors. Such evaluations are usually tied to goal-directed approaches since it can then, at least, be demonstrated that the program does or does not achieve what it says it does.

Concepts Related to Work

Vocational educators are in the position of aiding youth in their search for a life's accomplishment through work. Theirs is a pivotal position that links a student's vocational training to entering the workforce. Vocational teachers impart skills and knowledge that students can carry with them to their first jobs. Certain basic skills may stay with a student for his or her lifetime.

Vocational teachers face the challenge of developing skills and knowledge for a changing workforce. The employment needs of the national economy are being redirected by shifts in the types of products and services being produced by this country. The labor force will be requiring new levels and ranges of skills of vocational students as compared to past generations. Productive workers of the labor force will be expected to modify, upgrade, and update their knowledge and skills in response to a very fast pace of technological change (Sherman, 1983). Program evaluation must interface with these ever-changing expectations.

The implications of technology for vocational education are complex and numerous. Technology will create change in vocational education, but it is difficult for vocational educators to project the direction of that change. For example, it is evident that a revolution in information processing has begun, but it is difficult to predict the range of applications, the speed with which they will be adopted, and the skills that workers will need in the new industries that this revolution is creating. Essentially, the revolutionary changes will be rapid, and their precise direction will be difficult to predict (Sherman, 1983)—all the more reason to use evaluation to provide input into the program.

This project focuses on one arm of the technology revolution—computer technology. The combination of computers and education is a promising venture for the training of vocational students for the information age. Although Computer-Based Instruction is not new, the revolutionary changes of the microcomputers of today and tomorrow will give new meaning to vocational instruction and curriculum. Thus, the evaluation of Computer-Based Instruction (CBI) in general will be examined from a historical perspective (and from a glimpse into the future with special attention given to its entwinement with vocational education) after a discussion of the characteristics of good program evaluation.

Characteristics of Good Evaluation

Carol Weiss writes, "The basic rationale for evaluation is that it provides information for action . . . unless it gains serious hearing when the program decisions are made, it fails in its major purpose" (Weiss, 1972, p. 318). In order for evaluation to get "serious hearing," it needs to perform well in a number of areas. Worthen (1974), drawing from his own work in the program development field as well as writings of Scriven (1967), Stake (1967, 1970), and Stufflebeam (1968), has created a checklist for general characteristics of good evaluations:

Conceptual Clarity
Clear Program Description
Representation of Legitimate Audiences
Sensitivity to Potential Political Problems
Specification of Information Needs and Sources
Comprehensiveness/Inclusiveness

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Technical Adequacy

Consideration of Costs

Explicit Standards/Criteria

Judgments/Recommendations

Reports Tailored to Audiences

In the sections that follow, each of the above categories will be discussed in relation to CBI evaluation.

Conceptual Clarity

A good evaluation plan must be clear in terms of the "who," "what," "where," and "how" right from the beginning. The evaluation plan must specify its type or combination of types. That is, is it to be formative, summative, internal, external, goal-directed, goal-free, comparative, and/or non-comparative? These clarifications need to be made before preceding with data collection—indeed, these decisions will guide data collection.

In evaluating the CBI integrated program, the vocational teacher chooses critical evaluation points and procedures based on this conceptual framework. For example, it may be decided that three evaluation strands would provide the kind of information most useful to the program. In one strand, the vocational teacher will use objective tests geared to the program goals at predetermined checkpoints. In a second strand, it is decided that outside evaluators will be hired to engage in goal-free evaluation to obtain an unbiased assessment of what's happening as a result of the program. In a third strand, the vocational teacher will ask an instructor in a similar program in another state to administer and compare standardized achievement scores.

Program Description

It is important that the program being evaluated be clearly described. The description can be drawn from the goal setting done in the early phases of integrating the CBI approach into the vocational program, but the description needs to be more than just goal statements. It concisely describes the nature of the program being evaluated. This description is especially important if outside evaluation is being considered, but is also important when the final report is submitted to outside audiences.

Consider the problem—a vocational teacher's administrator decides to use goal-free outside evaluation and contracts with computer specialists at the university to evaluate the program. The evaluator arrives and begins the program examination. At the end of the visit, the teacher discovers that the program has been criticized because students were not learning programming skills, **but the intent of the program had nothing to do with programming skill instruction.** This unfortunate result could have been avoided if the plan had been specified, giving the outside evaluator a concise, clear description of what the program in fact was.

Representation of Legitimate Audiences

Evaluation should consider input from people who have a legitimate stake in the program. In vocational education this group certainly includes practitioners and future employers of the students. Mechanisms which allow for this type of input also serve the function of updating the program based on information from state-of-the-art job practices. With the continued advances in computer technology, this approach is particularly critical to incorporate into the evaluation process.

Thus, part of the evaluation might include reports from program graduates and their employers, on-site visits by professionals reviewing equipment availability and recommending future purchases, and/or potential employer surveys on the needs of business and industry for the skills of your program. Other legitimate audiences include administrators, current students, and community members. Input from the most relevant of these groups should be built into the evaluation plan.

Sensitivity to Potential Political Problems

A major political consideration revolves around the answer to the question, "Who is going to use the evaluation data and for what purposes?" Part of good evaluation procedure specifies at the outset who has control over the data generated during the evaluation. Many people view "evaluation" with suspicion and fear; a clear statement of procedure and purpose will help reduce needless concerns, if not eliminate them.

In planning CBI evaluation, a good "political" idea is to build in a faculty review process. This part of the evaluation plan indicates how the information can be reviewed by affected faculty before the final submission. If there is a chance for internal review and clarification, factual misstatements and erroneous data can be eliminated at lower levels to forestall fruitless debates that might occur at the higher levels.

Reports are also made within a particular working climate. An evaluation needs to be sensitive to this climate. An evaluation, no matter how well done, which is politically insensitive to the larger educational environment is likely to be worse than no evaluation at all. Suppose, for example, that a school board is involved in a bitter controversy over a group of parents who charge that many teachers in the district refuse to keep current in their fields. A program evaluation then shows that the "older" teachers do not support CBI. The school board reads this and, sensitized to this "fact," demands to know who those teachers are so that they may take action to solve the problem identified by the parents and "confirmed" by the evaluation.

Being politically aware helps guide the evaluation so that the information can be presented in a manner which will ultimately prove most useful.

Specification of Information Needs and Sources

A good evaluation plan clearly delineates what information will be examined by whom, when, and where. Information sources are identified. If special permission or access is required to examine these sources, this permission must be obtained and verified in the plan. If certain pieces of information are sensitive, adequate safeguards must be built into the evaluation plan.

The first step in CBI evaluation would logically be the specification of the kind of data needed, i.e., the information needs. These needs will suggest source needs. These needs and sources should be listed. For example, it may be decided that the information needs revolve around answering the question, "Exactly how well do our students, using CBI, meet industrial standards as opposed to students not using CBI?" It is then determined that data sources are needed related to student achievement scores on unit examinations, scores of graduates and nongraduates on job entry examinations, on-the-job performance reports from supervisors, a report from a goal-free outside evaluator, and a comparison study with a similar program.

Now that the data needs and sources have been perceived, steps must be taken to complete the evaluation. The achievement instruments are specified; someone is charged with obtaining the scores (including obtaining permission to obtain the scores) and reporting them back; the name of the outside evaluator is specified and his timetable is set; appropriate supervisors are identified and the instrumentation and collection methodology are delineated. Again, permissions to proceed are obtained long before the actual collection begins.

Failure to be specific in this area is likely to lead to an incomplete evaluation. Without necessary groundwork, areas of concern are likely to be overlooked, or key areas may be identified while the means selected to investigate them are later discovered to be impossible to carry out. For example, consider the problem evaluation would encounter if it were believed that important evidence would be found in the work files of program graduates after they have been employed. Accordingly, this is listed as a key source of evidence to be considered. However, at the final meeting of the evaluation group, the person responsible for this area reports that the employer will not open these records to him. Suddenly the instructor is left in a difficult position—according to the individual teacher's plan, he or she is missing key information. It would have been much better if, in the planning process itself, this difficulty had been discovered so that an alternate avenue could have been planned to evaluate on-the-job performance.

Too many evaluation studies may look great on paper, although they actually lack initial specification in terms of achievable documentation.

Comprehensiveness/Inclusiveness

This category is related to decisions made in the previous section. In program evaluation, qualitative decisions must be made as to what types of information to collect. There are generally two types of information to collect: information central to the questions raised about the established purpose and intent of the program, and information which is "nice to know" but secondary in importance.

While it is difficult to conceive of an evaluation which includes too much data, it is less difficult to conceive of an evaluation which is much too narrowly defined. The CBI program which uses only student test scores would be such a narrowly defined evaluation mechanism. Most pieces of information provide insight into only a part of the larger picture. A major problem exists when teachers expect a definitive test or assessment to give all the information needed to appropriately evaluate a program.

Consider this case. It is discovered that the achievement test scores are not higher for a CBI class than for non-CBI classes. Because this was the only data source included in the evaluation study, vocational teachers decide to scrap CBI as an expensive innovation which does not outproduce conventional approaches. If, however, instructors had included student opinionnaires and follow-ups with employers, they might have discovered that CBI graduates felt more confident about their job related skills and had more favorable things to say about the relevance of their programs. In addition, employers might have reported that these graduates were far superior on the job than non-CBI graduates.

There is also a danger of being too data rich, but only if one fails to proceed as specified in the previous section in identifying needs and sources. A briefcase full of randomly collected data, collected without plan or purpose, will end up "telling" a program director very little. Given good planning, there is no such thing as "too much data." The data vocational instructors should have is the data specified as important to collect and analyze.

Technical Adequacy

Is the instrumentation adequate? Is the sampling plan reasonable? Is the planned analysis appropriate? Is the information obtained valid, reliable, and objective?

The answers to these questions can be provided only by evaluators who are familiar with the measurement, statistical and analytical tools of the evaluation process. In evaluating a CBI program, it might prove useful to obtain the services of a trained evaluator or technical advisor in these areas. It would be a terrible blow to have the final report destroyed by comments from later reviewers who suggest that the sample was biased, the goal-free evaluator was not objective free, or that a technique was used which violated some of the statistical assumptions behind the design. Worthen (1974) believes that more evaluations fail for these reasons than for any other.

Consideration of Costs

Consideration of costs affects program evaluation from two points of view: the cost of the program itself and the cost of the evaluation.

Certainly the cost of the program itself should be part of the evaluation study. It needs to be determined exactly what resources are involved in making the CBI program run. What are the hardware costs? What are the software costs? What are the projected hardware and software replacement costs? What are the structuring costs, e.g., improving an air conditioning system to keep computers cool, maintaining microcomputer security, or improving access? In addition to the costs, what was the payoff in the end? Were students able to ask for a higher wage based on their training? Were more of the students hired out of this program than non-CBI programs? How about training costs—are they increased, reduced, or about the same? The answers an evaluation produces to these questions will be of central interest to individuals and agencies involved in funding the operation of the program.

The cost of evaluation itself is similarly an important consideration. This cost should be built into the initial program cost projections. Many a good project has failed because all of its resources were put into the project itself and little into evaluation. It is during evaluation that the project can provide the evidence that it is indeed meeting its claims. A good evaluation plan can help spread the story of the successful program, helping it serve as a model for other approaches. Such evaluation plans are not produced as an afterthought on a small budget. Good evaluation requires expenses for instrumentation, consultation, travel and research time, and report developing. For example, look at the flow chart presented in Unit B.3 and reproduced for this unit.

Evaluation affects each area of the plan and needs to be funded accordingly.

Explicit Standards/Criteria

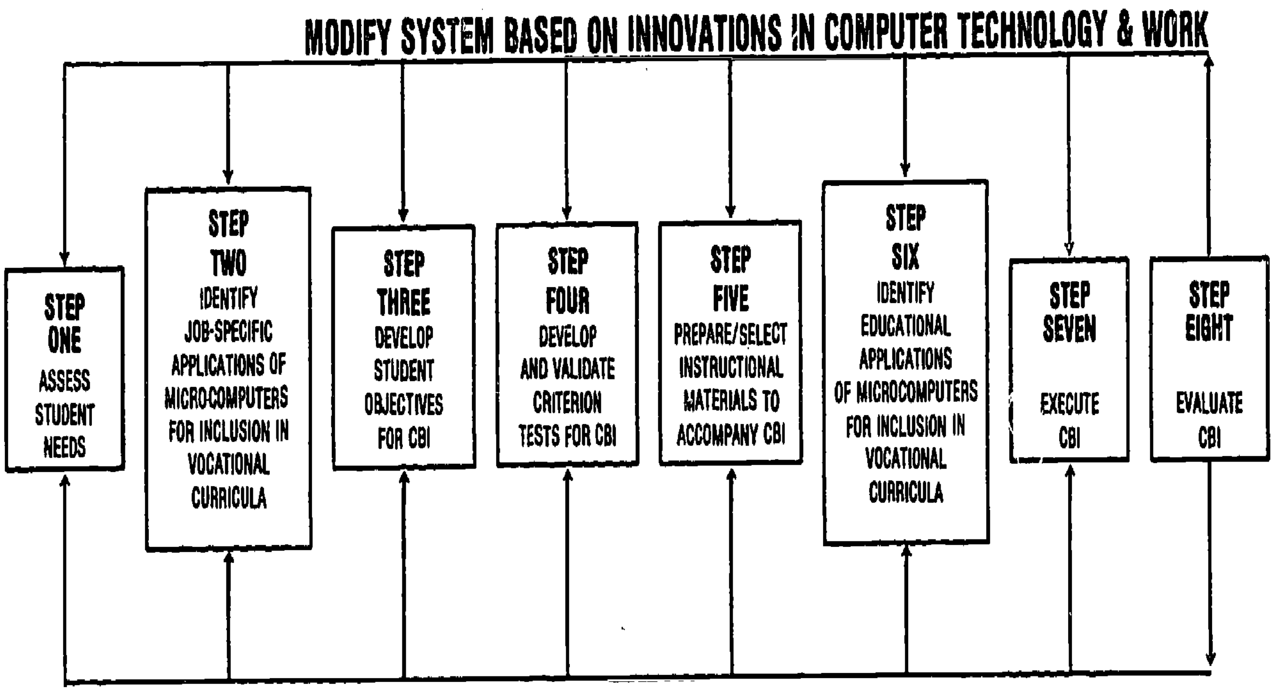
This part of the evaluation plan is the "so what" portion of the plan. For example, it may be decided to measure time-on-task during CBI. A trained observer is then asked to record time-on-task behavior; he reports that the average student spends 30 minutes out of every 45 minutes actively engaged with CBI. So what? Is this too much time? Too little? About right? What is missing are standards or criteria by which to judge the data.

The way to deal with this problem is to set the criteria within the evaluation plan. Thus, in the case outlined above, when it had been decided that this activity would be part of the evaluation, it should also have been decided what standards were desired. Criteria could have been set based on previous time-on-task studies or upon cross group comparisons. Once these are set, the information gathered by the researcher takes on meaning. Without these criteria or standards, no one is exactly sure what the data mean.

Many of these standards already exist. The first place to look is the original program objectives. The objectives are likely to specify competency levels to be achieved. Another source is the standards of the marketplace. How long does the employer expect that task to take? What level of entry skill does that industry require?

The overall point of this part of program evaluation is that data alone are not enough. Data are most useful when they are compared to predetermined standards.

INSTRUCTIONAL SYSTEMS DEVELOPMENT FOR COMPUTER BASED INSTRUCTION AND VOCATIONAL CURRICULA



MODIFY SYSTEM BASED ON STUDENT ACHIEVEMENT, TEACHER ROLE AND INSTRUCTIONAL EFFECTIVENESS

Judgments/Recommendations

When all the data have been compared to the criteria, vocational instructors will know whether or not the program has achieved expected results—so it would seem that evaluation is over. This is a faulty assumption.

Even after data have been compared to criteria, judgments need to be made about the overall program. Some aspects of the program may appear to be going well, others not so well, and still others may be unclear or borderline. Some pieces of data many contradict others.

The final aspect of CBI program evaluation is to look over all the pieces and make some specific, as well as general, judgments and recommendations. It may be that certain aspects are judged to be not working and should be abandoned; others may need a few patches here and there to increase efficiency. Other parts of the program may be achieving beyond expectations and should actually be drawn back. In the end, it is to these judgments and recommendations that most program directors, administrators, and boards turn first when considering action on a given program.

Reports which lack this important dimension allow data to be selected out of context, which may lead to selected components being highlighted at the expense of others. To avoid this distortion of data, the report itself must suggest the correct overall perspective.

Reports Tailored to Audiences

This last consideration is not related to the evaluation process itself, but to the delivery of the results of the process. Some decisions related to this area were made in a preceding section of this unit—particular audiences were identified and individuals receiving reports were specified. Costs are also related to delivery of results. One source suggests that as much as 30% of monies allocated to support evaluation be spent on dissemination (Salasin, 1978).

In addition to these considerations, the "look" of the final report should be tailored to its audience. A too technical report will not work well with a review board of nontechnicians. On the other hand, fellow CBI teachers will be interested in details beyond the generalities of cost effectiveness. The report may actually consist of multiple reports which address particular audiences with specific interests, all growing out of a larger volume containing the data tables and statistics. One useful reporting format is the executive summary which highlights those areas of most interest to decision makers.

The most grievous error that instructors can make in constructing an evaluation report is to attempt to cram all the information into one general document intended for all potential audiences. Such materials are much too detailed for most individuals and may end up turning away potential audiences because the findings seem too complicated and ponderous.

Suggestions Drawn from Previous CBI Evaluations

CBI has traveled a short yet fast-paced road during the past thirty years. Beginning slowly with the rudimentary CBI efforts associated with mainframe computers of the sixties, the CBI movement has gained momentum and is traveling at a heightened pace. During this time span, researchers have continued to examine the merits of CBI. These empirical efforts have contributed significantly to the lengthening strides that CBI is presently taking. However, as they attempt to peer far into the future, vocational teachers should recognize some of the "knows" of CBI that have evolved through 20-30 years of implementation and research.

Perspectives and Projections No. 1

Kearsley, Junter, and Seidel (1983) reviewed over 50 CBI projects, focusing on the practical and theoretical aspects pertinent to education. Eight categories of analysis were developed for the research review: development of prototypes, conceptual demonstrations, major implementations and evaluations, dissemination, authoring languages/systems, intelligent CAI, innovative environments, and new theory. The review notes nine major outcomes:

1. There are sufficient data to indicate that computers can increase instructional efficiency and effectiveness.
2. Educators possess limited expertise relative to individualizing instruction.
3. Educators possess a good understanding of the effects that instructional variables such as graphics, speech, motion, or humor have on learning.
4. Experience has taught educators a great deal regarding overcoming institutional and organizational inertia and resistance to change concerning the implementation of CBI.
5. There has been tremendous progress toward the development of authoring tools and techniques for CBI.

6. Dissemination mechanisms have evolved and are functioning well for distributing CBI ideas and courseware.
7. CBI is a focus of research throughout varied disciplines of education.
8. Federal funding has been instrumental in advancements of CBI.
9. Educators have merely witnessed a tip of the iceberg regarding future applications of computers in education.

Research efforts will become critical for vocational educators as CBI becomes increasingly intertwined with vocational instruction and curriculum. Vocational instructors need to be informed of CBI components that are successful when combined with specific programmatic features. Vocational education researchers must undertake exemplary CBI projects, track those successful CBI endeavors, and build a research database for educational computing. A solid database that documents the successes of CBI in vocational education will be a benchmark for applying computer technology to vocational curriculum and instruction in the future.

Perspectives and Projections No. 2

By taking a comprehensive look at the historical transitions of educational computing, certain trends begin to emerge. Although microcomputers are not the only arms of technology embracing educational change, these machines and their accessories are playing major roles in the transformation of what people believe about education. Educational computing—from its humble beginning, to the snowballing pace of the eighties, to the uncertainties and projections of the future—can be categorized by three phases (Berg & Bramble, 1983):

a. **The Experimentation Phase**—Beginning in the early 1960s, military trainers, college professors, and "computer nuts" explored the fascinating connection between mainframe computers and instructional methodologies. During this phase the beginnings of computer assisted instruction were forged with terminology and procedures.

b. **The Popularization Phase**—The seed of computer-based instruction lay dormant for many years. It began to sprout and grow during the late 1970s with the explosive entrance on the educational scene of microcomputers. These powerful yet relatively inexpensive machines increased access to computers for teachers, administrators, and students. Schools began sponsoring in-service programs on computer literacy for teachers, computer education journals were being disseminated, and commercially prepared educational software surfaced.

c. **The Transition Phase**—The transition phase is situated somewhere in the future. It is projected to begin in the mid-1980s and carry through to the 21st Century. What will be the role of the vocational teacher in the transition phase of educational computing? It should be a time for vocational educators to grasp technological products and put them to work for constructive reform in education. It may be a time for reversing the trends of declining educational accomplishment and achievement of recent students who have lagged behind the standards of preceding generations (Berg & Bramble, 1983). This phase will provide vocational educators opportunities to apply technologies to pursuits of excellence in curriculum and instruction, easing the transition for students from school to work.

The transition phase will bring a new meaning to the job title "Vocational Instructor." It will be a respected title because it will be recognized by society as a key role—a person with a major responsibility for the orchestration of technology with school and work. How well vocational teachers apply the technology link between education and work will ultimately direct the course of development of the nation's most powerful resource . . . the human resource.

In Closing

New technology will mean change for vocational instructors. Vocational curriculum and instruction will need to be amended according to changes that computer technology creates. Projecting those technical advances will be a tricky business. What technological changes can vocational teachers expect in the next decade? What innovations of the forthcoming transitional phase of educational computing will have the greatest impact on vocational programming? An examination of the recent literature relevant to educational computing has provided glimpses of how computer innovations of the future might affect the world of the school and of work.

SUMMARY

This unit has explored the concept of CBI evaluation—past, present, and future. The concept of evaluation is defined and the characteristics of good evaluation design are illustrated. Recent CBI evaluation studies are quoted and discussed to suggest current beliefs and future prospects. The link between evaluation and the larger world of work and technology is established.

It is now left to the reader to incorporate these ideas into an exemplary vocational educational CBI program evaluation design.

ACHIEVEMENT INDICATORS

1) Define the terms formative and summative evaluation.
2) Define the terms internal and external evaluation.
3) Define the terms goal-directed and goal-free evaluation.
4) Define the terms comparative and non-comparative evaluation.
5) List and discuss the characteristics of good evaluation as related to evaluating CBI.
6) Discuss a summary of findings of select CBI research projects that have been conducted during the past twenty years.

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