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ABSTRACT

The Appalachia Educational Laboratory (AEL) conducted an assessment of microcomputer-related needs for basic mathematics in the four-state areas of Kentucky, Tennessee, Virginia, and West Virginia in 1984-85. The primary input came from teachers from each of the states who participated in a needs conference in their home state. When each of the 344 needs statements generated during the conferences was rated on a scale of 0 (low) to 5 (high) by all of the conference participants, it was found that many top-rated concerns were common for the entire region: access to hardware for teachers and students; information about software sources and reviews of software; high quality software; software that addresses topics of concern to teachers; methods of integrating computers into classroom activities; and training in computer operations and instructional uses. In addition to a description of the DAP Process of needs assessment, which was used to conduct the study, and a report of the results, this document contains four papers suggesting strategies for addressing identified needs: "Software Issues and Answers for the '80's" (M. D. Roblyer); "Hardware Issues in Using Microcomputers in Education" (Charles R. Sanders); "Computer Training for Teachers" (John Cook); and "Computer Planning and Integration Issues" (Jose Mestre). Three appendices contain a manual for the needs assessment process; lists of need statements from the state conferences; and descriptions of 10 brochures addressing priority needs of classroom teachers. (CJR)

A Model for Assessing and Meeting Needs in Instructional Computing:

Procedures and Results of a Multi-State Needs Assessment

Appalachia Educational Laboratory
Charleston, West Virginia

A Publication of
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A MODEL FOR ASSESSING AND MEETING NEEDS IN INSTRUCTIONAL COMPUTING: PROCEDURES AND RESULTS OF A MULTI-STATE NEEDS ASSESSMENT

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Preface

Revolutions are not characterized by careful planning, and the flurry of technology-related activity known as the "microcomputer revolution in education" has been no exception. But after the initial excitement of innovation, a great deal of hard work and careful planning must go into making revolutionary ideas practical and useful in everyday life. Providing the vital information to make this possible for instructional computing was the aim of a skilled group of individuals who worked with the Appalachia Educational Laboratory's (AEL) "Technology and Basic Skills Program." Under a contract with the National Institute for Education (NIE), AEL completed an assessment of microcomputer-related needs for the four-state area of Kentucky, Tennessee, Virginia, and West Virginia. The activities and results described in this booklet are products of the creative and dedicated efforts of AEL staff and teachers from the four states.

The AEL Needs Assessment was accomplished over a six-month period during 1984-85 and consisted of several phases of information-gathering and analysis. This booklet describes the procedures and results of this activity in the following sections:

Section I: INTRODUCTION — An overview of a procedure called the DAP method, a structured way of gathering information for a needs assessment.

Section II: RESULTS OF THE AEL NEEDS ASSESSMENT — A summary of data from the needs assessment conferences, gathered from teachers in the four-state area.

Section III: SUGGESTIONS FOR ADDRESSING IDENTIFIED NEEDS — A set of papers which synthesize and comment on the needs expressed during the conferences in the areas of hardware, software, planning, and integration, and teacher training.

The Association for Educational Data Systems is indebted to C. Todd Strohmenger, the Director of AEL's Technology and basic skills program, for allowing AEDS to publish the strategies and findings of this important activity. We are also indebted to AEL staff members Berma Lanham for conference planning and support, Pat Cahape for brochure designs, Patricia Penn for editing the position papers, and to the teachers for their part in accomplishing the needs assessment conferences: Peggy Hissom and Lou Spencer (Kentucky); Rita Powers and Bob Evans, Tennessee; Phyllis Argento and Joe Soldan, West Virginia; and Bernadette Burroughs and Richard Jones, Virginia.

M. D. Roblyer, Editor
January 1986

The Appalachia Educational Laboratory (AEL)

The Appalachia Educational Laboratory (AEL) is located in Charleston, West Virginia. Its mission is to improve education and educational opportunity for persons who live in the primarily non-urban areas of its member-state region. AEL accomplishes its mission by:

- Documenting educational problems of the region and sharing the information with both member states and other research and development (R & D) producers;
- Providing R & D technical assistance and training, which may include adapting existing R & D products, to lessen documented problems of the region, and
- Continuing to produce R & D projects of national significance in the areas of career guidance, lifelong learning, technology and basic skills, and others that may be identified.

The brochures described in Appendix C and other information about AEL projects, programs, and services is available by contacting the Distribution Center, Appalachia Educational Laboratory, P. O. Box 1348, Charleston, West Virginia 25325.

The project presented here was performed pursuant to one or more contracts and/or grants from the National Institute of Education (NIE), the U. S. Department of Education. However, the opinions expressed do not necessarily reflect the position or policy of AEL or NIE, and no official endorsement by AEL or NIE should be inferred.

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Section I: INTRODUCTION

How a Needs Assessment Can Help

To many educators and administrators, instructional computing in the 1980's is a confusing array of computer products, procedures, and priorities. The scope of problems involved in implementing computers — as well as the assortment of solutions which could be used to solve these problems — is growing daily. Even educational organizations who began with "Master Plans" for implementing computers in their schools are finding that they need more specific information on computer-related problems and viable solutions in order to insure that computers are being used to maximum effectiveness in schools. Clearly, strategies are required to identify priority needs in instructional computing and to isolate effective methods for meeting these needs.

To provide the comprehensive, reliable information required for planning instructional computing use in the four-state area it serves (Kentucky, Tennessee, Virginia, and West Virginia), the Appalachia Educational Laboratory (AEL) decided to perform a needs assessment with primary input coming from teachers in each of the states. This method was seen as a systematic strategy for accomplishing the following objectives:

- Generating specific statements of present and desired conditions relating to computer use in schools.
- Prioritizing needs by state and by region.
- Analyzing needs and deciding upon strategies for meeting them.

Although AEL's needs assessment focused on computer needs relating to basic mathematics in the Appalachia area, the procedures and findings from this effort should be of interest to computer-using educators and planners in all content areas and in other parts of the country for several reasons:

1) Teacher-perceived needs — The personnel selected to participate in the needs assessment conferences were classroom teachers who had been using computers with students for some time. The needs identified and summarized here are therefore the perceptions of those most knowledgeable in the day-to-day problems of implementing computers in school settings.

2) A coordinated multi-state effort — Four states in the Appalachia Region participated in the needs assessment. This indicates that cooperative efforts among states are not only workable, but extremely practical in terms of saving time and costs associated with instructional computing activities.

3) Emphasis on specifics — Primarily as a result of direction from the AEL staff, the teachers focused on specific needs, rather than global recommendations. The results of this activity are immediately useful to those planning for and funding the use of computers in schools. Most of the needs statements were not only applicable to mathematics, but, if addressed, could have an impact on all aspects of instructional computing use in schools.

4) Generalizability of results — Although results of similar needs assessments conducted elsewhere could be expected to vary somewhat from state to state, it could be expected that many of the results found here would also be found to be priority concerns everywhere. Part of the process involved a review of nation-wide needs expressed in the literature. This review confirmed the perspective that the "microcomputer revolution" has generated similar problems for everyone. Only the prioritizing of the problems seems to differ to any degree.

A Model Needs Assessment Method: The DAP Process

The strategy used to accomplish the AEL needs assessment is referred to by an acronym: DAP. This stands for the three kinds of information addressed in the needs assessment:

D — Designative information, or statements of what is currently happening.

A — Appraisive information, or statements of what is preferred.

P — Prescriptive information, or suggestions of what to do when discrepancies are identified between "what is" and "what is preferred".

The DAP process of needs assessment was developed by Drs. F. Lee Brissey and John M. Nagle at the Center for Educational Policy and Management, University of Oregon. It is described by Nagle and Balderson (1974) as a set of structured concepts and procedures that members of any group can bring to bear on the real-life, day-to-day needs of the group. AEL used an abridged DAP process within the framework of the following steps to examine teacher perceptions of needs in instructional computing:

STEP 1: Develop a process manual — This document, shown in Appendix A, was developed to structure both (a) the process of training teachers in how to write useful statements of need and (b) the actual generation of statements by teachers.

STEP 2: Identify participants — Teachers from each of the participant states were selected by their school systems to participate in a needs assessment conference in their home state. Some 90 educators with experience in using microcomputers in their classroom were recommended by an official of the state's department of education for this activity. Tables 1 and 2 show the characteristics of these participants and the kinds of microcomputer products and activities with which they had experience.

STEP 3: Hold series of conferences to generate needs statements — Four conferences were held, one in each state, with 18-24 teachers participating in each conference. A total of 90 teachers attended these conferences. They received $100 per day plus expenses for their participation. Using the process manual shown in Appendix A, the AEL staff trained the teachers to write good needs statements and then guided them through the process of generating statements representing needs in their individual states. The statements resulting from these conferences are shown in Appendix B.

STEP 4: Hold follow-up conference to analyze statements — From the original group of 90 teachers, two teachers from each state were selected to participate in a follow-up conference to examine the needs and conceptualize strategies for dealing with them. Since each of the needs seemed to fall into four general categories (software, hardware, planning and integration, and teacher training), a consultant specializing in each of these areas was selected to work with the teachers in groups. Each group accomplished the following tasks:

a) Clarifying the cluster of needs/problems — A descriptive heading for the group of problems was assigned, and a listing of the various categories of needs, including illustrative need statements, was developed for each heading.

b) Identifying solutions to the needs/problems — The groups brainstormed to develop solutions matched to each of the categories of problems and needs. Then solutions were evaluated for practicality and effectiveness and summarized.

c) Developing guidelines for position paper — The teachers, working with the consultants, developed an outline of information on the extend of the problem, as well as existing and proposed solutions, for the purpose of including this information in a position paper.

STEP 5: Develop position papers summarizing needs and methods of meeting them — After the conferences were completed, the consultants created position papers which summarized the needs and the existing and proposed solutions matched to the needs in each of the four areas of concern.

STEP 6: Hold follow-up conference — A final meeting of the eight teachers was held to review the position papers, recommend revisions, and develop an outline of brochures to summarize findings and to be disseminated to teachers in the four-state area. A listing of titles and brief description of the brochures is shown in Appendix C.

Section II: RESULTS OF THE AEL NEEDS ASSESSMENT

Summary of Results

Some 344 needs statements (shown in their entirety in Appendix B) were generated during the conferences: 101 from Kentucky, 57 from Tennessee, 95 from Virginia, and 91 from West Virginia. Each of the statements was numbered and received a code to indicate the state and group from which it came. Each statement was also rated in terms of its importance on a scale of 0 (low) to 5 (high) by all of the conference participants. The result is a statement which contains the components shown in the following example.

STATE
GROUP CODE
NUMBER OF ITEM FROM GROUP
ORIGINAL REFERENT
SUPER REFERENT
ORIGINAL "WHAT IS"

WV A 03 Training, specific prog
Teachers do not have skills in using
Computer management programs. ie grading, record keeping
Teachers do have skills in computer management programs
RATING 3.36
STANDARD DEVIATION 1.26

ORIGINAL "WHAT IS PREFERRED"

Participants generated the original statements of "what is" and "what is preferred" using an initial referent (a broad topic about which they wanted to describe a particular need). Because an abridged DAP process was used, there was no attempt at the time of the conference to collapse statements in order to remove redundancies. Consequently, "super referents" were later generated to facilitate discussing and analyzing the needs statements. Using these "super referents," the needs statements were then clustered according to their mean importance rating. Tables 3-6 show the need statement codes by-state for those items with ratings of 4.00 - 5.00. These are, therefore, the highest priority needs in each state.

Table 7 shows a summary of highest priority needs (rated 4.50-5.00) across the region, while Table 8 shows the frequency of top-rated concerns expressed in percentages. Table 9 lists the highest priority statements for each state.

Table 1
Participant Demographic Data
(Frequencies)

	WV	KY	VA	TN
Sex				
Female	13	13	11	9
Male	10	10	13	9
Total	23	23	24	18
School Enrollment (ranges)	170-1700	160-1600	500-2600	200-1300
Grade Levels				
High School	10	12	17	4
Jr. High	6	3	4	7
Elementary	6	6	1	4
Others (supervisors)	1	2	2	3
Communities				
Urban	5	2	9	4
Suburban	9	11	3	8
Rural	9	10	11	6
Missing	0	0	1	0

Table 2
Microcomputer Demographic Data
(Frequencies)

	WV	KY	VA	TN
Computers Utilized				
Apples	20	18	16	17
Apple only	10	11	8	11
Radio Shack	8	5	7	2
Radio Shack only	1	3	4	1
Commodore 64	3	3	4	2
Commodore 64 only	-	-	2	-
Commodore Pet	2	3	-	-
Commodore Pet only	1	-	-	-
Vic 20	-	2	1	-
Vic 20 only	-	1	-	-
IBM PC	5	2	1	1
IBM PC Jr.	-	1	1	1
IBM Sys 36	-	-	-	1
Franklin	-	1	2	-
Atari	1	1	2	1
TI 99/4A	-	2	-	1
TI PC	-	-	-	1
Ohio State Inst.	-	1	-	-
Plato	-	-	2	-
Hewlitt/Packard	-	-	1	-
Digital	-	-	1	-
Tec Tronics	-	-	1	-
Configuration				
Lab + Classroom	5	5	6	8
Laboratory only	5	9	14	5
Classroom only	13	9	4	5
Networked Lab	1	5	6	4
Independent Lab	8	9	16	9
Classroom use	18	14	10	13
Classes Using Computers				
Basic math	10	11	6	15
Computer math	2	3	2	-
Only advanced math	2	3	2	-
Only programming and/or computer literacy	7	4	12	1

Table 3
Referents of Need Items with Means = 4.50-5.00 Kentucky

N=23

Item	Super Referent	n	Mean	s.d.
KYC01	Hardware access, student	23	4.74	0.54
KYD09	Hardware access, student	23	4.70	0.56
KYD22	Software criteria	21	4.67	0.48
KYB03	Hardware access, student	22	4.64	0.58
KYA02	Software criteria	23	4.57	0.66
KYC12	Training, instruction use	23	4.57	0.66
KYD12	Hardware access, teacher	23	4.57	0.59
KYA08	Software preview	23	4.52	0.73
KYA13	Training, computer use	22	4.50	0.67

Table 4
Referents of Need Items with Means = 4.50-5.00 Tennessee

N=23

Item	Super Referent	n	Mean	s.d.
TNB13	Training, computer use	18	4.72	0.67
TNA01	Training, computer use	18	4.67	0.59
TNB04	Training, computer use	18	4.61	0.61
TNC03	Training, computer use	18	4.56	0.62
TNA16	Software topics	17	4.53	0.62
TNA18	Software access	18	4.50	0.71

Table 5
Referents of Need Items with Means = 4.50-5.00 Virginia

N=23

Item	Super Referent	n	Mean	s.d.
VAB18	Software topics	24	4.63	0.58
VAD06	Training, instruction use	24	4.50	0.58

Table 6

Referents of Need Items with Means = 4.50-5.00 West Virginia

N=23

Item	Super Referent	n	Mean	s.d.
WVB02	Hardware access, teacher	22	4.68	0.48
WVB10	Software preview	23	4.65	0.78
WVC04	Hardware access, student	23	4.65	0.57
WVD07	Hardware access, student	23	4.57	0.66
WVA10	Training, instruction use	21	4.52	0.75
WVD09	Software access	23	4.52	0.90
WVC08	Hardware access, student	22	4.50	0.74
WVD08	Hardware access, student	22	4.50	0.80

Table 7

List of Combined Need Items from the Region with Means from 4.50-5.00

Item	Super Referent	n	Mean	s.d.
KYC01	Hardware access, student	23	4.74	0.54
TNB13	Training, computer use	18	4.72	0.67
KYD09	Hardware access, student	23	4.70	0.56
WVB02	Hardware access, teacher	22	4.68	0.48
TNA01	Training, computer use	18	4.67	0.59
KYD22	Software criteria	21	4.67	0.48
WVB10	Software preview	23	4.65	0.78
WVC04	Hardware access, student	23	4.65	0.57
KYB03	Hardware access, student	22	4.64	0.58
VAB18	Software topics	24	4.63	0.58
TNB04	Training, computer use	18	4.61	0.61
KYA02	Software criteria	23	4.57	0.66
KYC12	Training, instruction use	23	4.57	0.66
WVD07	Hardware access, student	23	4.57	0.66
KYD12	Hardware access, teacher	23	4.57	0.59
TNC03	Training, computer use	18	4.56	0.62
TNA16	Software topics	17	4.53	0.62
WVD09	Software access	23	4.52	0.90
WVA10	Training, instruction use	21	4.52	0.75
KYA08	Software preview	23	4.52	0.73
WVD08	Hardware access, student	22	4.50	0.80
WVC08	Hardware access, student	22	4.50	0.74
TNA18	Software access	18	4.50	0.71
KYA13	Training, computer use	22	4.50	0.67
VAD06	Training, instruction use	24	4.50	0.58

Table 8
Frequency of Top Concerns (Rated 4.00 - 5.00) Within States

Topic	WV #	WV %	KY #	KY %	VA #	VA %	TN #	TN %	TOTALS #	TOTALS %
Computer Literacy	0	0%	0	0%	0	0%	0	0%	0	0%
Funding	1	4%	1	2%	0	0%	0	0%	2	2%
Hardware access, student	8	33%	6	13%	6	35%	3	14%	23	21%
Hardware access, teacher	3	13%	1	2%	0	0%	0	0%	4	4%
Hardware repair	0	0%	0	0%	0	0%	0	0%	0	0%
Hardware security	0	0%	0	0%	0	0%	0	0%	0	0%
Integration	1	4%	2	4%	2	12%	6	29%	11	10%
Planning/direction	1	4%	9	20%	1	6%	0	0%	11	10%
Software access	1	4%	4	9%	1	6%	2	10%	8	7%
Software criteria	2	8%	4	9%	1	6%	1	5%	8	7%
Software preview	2	8%	1	2%	0	0%	1	5%	4	4%
Software reviews	0	0%	0	0%	0	0%	1	5%	1	1%
Software topics	1	4%	7	16%	2	12%	2	10%	12	11%
Teacher incentives	1	4%	0	0%	0	0%	0	0%	1	1%
Training, computer use	1	4%	6	13%	3	18%	4	19%	14	13%
Training, instructional use	2	8%	4	9%	1	6%	1	5%	8	7%
Training, specific program	0	0%	0	0%	0	0%	0	0%	0	0%
Other	0	0%	0	0%	0	0%	0	0%	0	0%
TOTALS	24	100%	45	100%	17	100%	21	100%	107	100%

Table 9
List of Needs Statements Rated 4.50 - 5.00 by Teachers in the Four States

Kentucky:

Many schools do not have computers.	4.74
There is not enough equipment in the individual schools.	4.70
The organization and direction of computer programs is set up by non-computer people.	4.67
Many teachers have limited access to hardware.	4.57
Software appears designed by non-educators.	4.57
Many teachers do not have adequate knowledge about computers and their use in the classroom.	4.57
Teachers choose software by word-of-mouth or advertisement.	4.52
Many teachers don't know how or are afraid to use computers.	4.50

Table 9 continued

Tennessee:	
There is a general inadequacy of teacher computer knowledge/training.	4.72
Teachers are not adequately trained to use the microcomputer.	4.67
Teachers have varying levels of "computer anxiety."	4.61
Teachers view computers with some anxiety.	4.56
Quality software is not available to fit state and local math programs.	4.53
There is much public domain software which teachers are unaware of or unable to obtain.	4.50
Virginia:	
There are limited simulation programs available.	4.63
Many math teachers are not knowledgeable in how to use computers in teaching math.	4.50
West Virginia:	
Few teachers have access to an adequate number of computers for instruction.	4.68
Teachers do not know how to add computer use to their classrooms.	4.52
There is a lack of equipment in schools.	4.57
There is a limited amount of available software in each school.	4.52
There are not enough computers available to meet student needs.	4.50

Analysis of Results

As Tables 8 and 9 indicate, many top-rated concerns were common ones for the entire region:

- Access to hardware for teachers and students — Simply obtaining enough computers of the appropriate kind for teacher and student use was the major overall concern. Teachers felt that, while not the answer to all problems of instructional computing implementation, having enough computers is a prerequisite for success in this area.
- Methods of integrating computers into school and classroom activities — Conferees expressed general concern that insufficient planning for instructional computing, both financial and logistical, is being done at the school, district, and state level. Teachers expressed the need for clarification as to what they are expected to teach in the way of computer literacy skills. They also seemed to feel that, for integrating computers into content instruction, it is essential that district and state-level curricular objectives be coordinated with specific software products. They felt that much good courseware is not used because teachers cannot easily determine from available information which packages are a good match for teachers' curricular objectives.
- Access to information about software sources and to reviews of software — Although much information exists about software and its quality, teachers seem to have difficulty locating the information. Ready sources of this information at the teacher level are needed. Teachers are forced to choose software by word-of-mouth and advertisement. Consequently, the software they select is often disappointing in quality and usefulness in meeting their needs.
- Access to high quality software — Even after teachers have located references to software they feel may meet their needs, it is often difficult to obtain

preview copies. Also, since high-quality software is often the most expensive, funds are frequently lacking to purchase the desired materials.

- Access to software which addresses topics of concern to teachers — Concerns were also expressed about the lack of software types which teachers considered of key importance. They want more simulations, tutorials, and programs that address problem-solving and higher-level skills.
- Training in computer operations and instructional uses — Finally, teachers felt that inadequate attention was being paid to training both teachers and supervisory personnel in computer use. They felt that such training was essential in the entire continuum of computer use, from basic computer operations to methods of integrating software into content areas.

Section III: STRATEGIES FOR ADDRESSING IDENTIFIED NEEDS

Introduction of Authors and Topics

After teachers in the needs assessment conferences identified specific needs related to instructional computing in their respective states, they suggested a variety of practical, effective strategies for meeting these needs. Four position papers were written to summarize and elaborate on their suggestions in the target areas of planning and integration, hardware, software, and training. The individuals selected to develop a summary position paper are recognized specialists in the area. A brief introduction to the authors is given below:

Software
M. D. Roblyer
Florida A&M University — Tallahassee, Florida

Currently an Associate Professor of Computer Education, M. D. Roblyer has written extensively on all areas of instructional computing use. Her latest major work is *Measuring the Impact of Computers in Instruction: A Non-technical Review of Research for Educators*. She has published a grammar software series with the Milliken Publishing Company, and has worked at all levels of education and in industry training. Her specialty areas include instructional design and evaluation of software.

Hardware
Charles R. Sanders
Governor's Educational Policy Unit — Tallahassee, Florida

Mr. Sanders work with computers is one aspect of his responsibility as an Education Budget Analyst for the Governor's Office, State of Florida. Retired from the military and with a Master's degree in Business Administration, Mr. Sanders specializes in identifying and analyzing the economics of using computers in education. He also teaches university computer courses to future teachers.

Planning and Integration
Jose P. Mestre
University of Massachusetts — Amherst, Massachusetts

Designing and teaching courses to develop problem-solving skills is one interest of Jose Mestre, visiting assistant professor of physics at the University of Massachusetts. He is also director of supplemental math instruction in the Dean's Office of Natural Science and Mathematics. Dr. Mestre designs mini lessons in math for a videotape resource library as well as educational software to teach problem-solving in mathematics.

Training

John B. Cook
Area Education Agency 6 — Marshalltown, Iowa

John Cook provides consultation in instructional computing, science, and mathematics to teachers and administrators in 21 Iowa school districts. His B.S., M.A., and Ph.D. degrees are from the University of Minnesota. He has taught at both secondary and university levels and has developed instructional computing software for publication. Among his intriguing software titles are "Evolve," "Legacy," and "Take It."

Software Issues and Answers for the '80's: Quality, Availability, and Access

M. D. Roblyer

Introduction: The AEL Study — The Nation in Microcosm

The 1984-85 Needs Assessment Conferences sponsored by the AEL Technology and Basic Skills (TAB) Program were held to gather data on specific needs and recommendations on microcomputer use from mathematics teachers in the four-state area. During this conference series, teacher-participants gave some clear indications of current instructional software needs and suggested strategies for meeting these needs. Three distinct types of software issues were identified:

- Quality — Ways of improving and assuring software's instructional soundness, ease of use, and responsiveness to teacher requirements.
- Access — Methods of locating proven-effective software with desired characteristics.
- Availability — Strategies for obtaining software for review, evaluation, and purchase, and ways of improving access to training in the optimal use of good software.

While some of the issues and problems perceived by Conference participants were recognized as idiosyncratic to a particular State or the region, most were seen as indicative of teacher needs on a national level. Furthermore, the group agreed that these software concerns must be addressed quickly and effectively if educators are to see any substantial benefits from instructional computing. Finally, it was recognized that software needs must be addressed in concert with other areas identified as priorities during the Conferences, namely: financial and curricular planning, hardware acquisition and use, and inservice and preservice training. Thus, the findings of the AEL Needs Assessment Conferences have implications for more effective use of computers throughout the educational system and for improving education itself.

The purposes of this paper are to:

- Summarize and expand upon the software needs outlined during the Conferences,
- Document, as much as possible, the nature and extent of the three kinds of software problems, throughout the region and the nation, and
- Outline strategies, both those in current use in the country and completely innovative ones, for meeting present software needs.

Software Problems, Issues and Needs

Even before instructional computing became synonymous with microcomputers in the minds of educators, many forward-thinking practitioners predicted that the impact of computers on instruction would hinge upon software: its quality, its accessibility to schools, and its appropriate use by teacher. As early as 1968, during the Conference on Computer-Assisted Instruction and the Teaching of Mathematics held at Pennsylvania State University (NCTM, 1968), prominent computer educators in the field were acknowledging the critical importance of software and the problems involved with developing and using it properly. A common conference theme reflected the belief at the time that there would be a software revolution within the decade: an explosion of new, high quality computer-based instruction which would drastically improve the impact of computers on teaching and learning.

Now, more than 15 years later, it has become apparent that the revolution was not as much in software as in hardware. Availability of low-cost, high-reliability equipment, while still not optimal, has improved dramatically. Software design and use has changed, too, but experts are in disagreement that it has measurably improved. It is apparent that much work remains to be done to improve the usefulness of computer-based instruction for classroom teachers.

Need #1: Software Quality

One generally-agreed upon observation by AEL Conference teachers that "too much software is garbage" is a candid summary of a pervasive problem. A recent study conducted by the National Association of Elementary School Principals (Standards for Software, 1982) indicated that microcomputer users are much happier with their hardware than their software. While 50% of the respondents gave hardware generally good reviews, only 28% did so for software. There is little evidence in the literature that this perception has improved in the past three years. However, one reason for this perceived lack of quality may be the lack of consensus on what "good software" is. Several characteristics were identified to help define needs for quality software in the context of the current study. These can be summarized in the following five categories.

Minimum Requirement

Certain features were recognized as essential minimum characteristics of all software, regardless of purpose or type. Two which may be found in all software criteria checklists (Roblyer, 1983) are: technical soundness or the lack of programming "bugs" and breaks during program execution, and content accuracy or freedom from spelling, grammar, punctuation, and factual errors.

Desirable Instructional Strategies

Another agreed-upon important aspect of quality in software which is often inadequately addressed is instructional soundness in terms of effective teaching strategies. Baker (1985) observes that current software developers tend to rely on their own experience rather than depend on theory. While identifying whether or not a given strategy works, we know some things from learning theory and practice which can direct us in ascertaining software quality. For example:

1. Concrete examples — Instruction for many mathematics concepts at pre-college levels is most effective if it includes graphic demonstrations along with the more abstract verbal explanations.

2. Hierarchical sequence — Building on a simple-to-complex skills sequence is essential to most math software of a drill or tutorial nature.

3. Allowance for short-term memory — Students should not be asked to remember many screens-full of information in order to solve a problem or answer a question.

4. Concept learning — Although not enough is known about efficient methods of teaching problem-solving, a great deal has been well-documented about effective strategies for teaching both concrete and defined concepts through attribute isolation (Merrill & Tennyson, 1977).

5. Cueing — There is evidence that, in many skill tasks, students profit from directing their attention to relevant aspects of a problem. This technique, called cueing, can often be effectively done with computer-based features.

Other aspects of instructional effectiveness are specific to certain skills. Some strategies for communicating difficult concepts to students have been developed over time by expert teachers, and software should reflect these. Finally, software, as with all instructional materials, should be free of misleading or obtuse explanations of concepts.

Responsiveness to Teacher Needs

Teachers in the AEL Conferences were most aware of what software COULD do for them as compared to what it is doing now. As Blaschke (1979) observed after a survey of software use, "The major bottleneck limiting the widespread and effective use of microcomputers in elementary and secondary schools is the availability of quality software which meets high-priority user needs." Defining quality in terms of ones classroom needs seems very pragmatic, since it doesn't matter how good the experts may think a product is if it lends minimal assistance with tasks assigned by the district, State, and/or society. The following features seem especially relevant:

1. Software types — Teacher observation that most software is of the drill variety is supported by a recent report of the Educational Products Information Exchange (EPIE, 1985). Approximately 63.5% of all software was drill-and-practice, 32% was tutorial, 19.9% game, and only 8% simulation. Teachers felt that, while drill software was often useful, they could also make good use of tutorial and simulations in many areas of their curricula.

2. Curriculum-specific — Teachers also see the need for software matched to the district and State-mandated objectives. At this time, much available software seems to have been designed without any specific curricula in mind. In his review of the software state-of-the-art, Becker (1982) concurred in this perception and said that "most educational software is written in short, disconnected modules that are unrelated to one another and are not clearly tied to other instructional activities or to specific textbooks." Baker (1985) writes that the "domain of existing software is populated by a random collection of rather narrowly conceived instructional entities rather than well-conceptualized sequences of instructional programs." Clearly, software will not be optimally useful until it is carefully integrated with other teaching responsibilities and resources. Cross-referencing of State-mandated SOL's with software is a key component of this need.

3. Higher-order levels — Another perceived quality-related need is for software which addresses higher-order levels of basic skills. Much software available to teach basic skills appears to stress low-level tasks, as opposed to problem-solving and application tasks. Since both are required on State-mandated lists, software should be available to address them.

4. Management systems — An efficiency feature which many teachers seem to feel is desirable is a capability within the software to collect data and provide reports on student progress. These computer-management systems should be both responsive to teacher date collection requirements and be as easy-to-use as possible within a classroom environment.

Cost-effectiveness and Efficiency

A continuing popular hypothesis regarding computer-based instruction has been that large-scale use of computers could be a very cost-effective means of delivering high-quality instruction (Norris, 1979). Some proponents of this philosophy believe that mainframe-based systems with terminals are required to achieve high cost-per-unit benefit. And, indeed, it is generally recognized that storing and presenting comprehensive curricula require more machine capability than stand-alone microcomputers can currently provide. However, teachers feel they can also benefit from microcomputer software which can be networked, copied, or licensed in order to make it more cost-effective to use the same product with many machines.

Documentation

Software, like all instructional materials, is most useful if it is accompanied by directions on where it fits in the teacher's curriculum and specific lesson plans. Some major national projects have even been developed to assist teachers in integrating software into their curriculum (DISC, 1983). Since figuring out how to use software in conjunction with other activities and media is a critical requirement for teachers, the usefulness of computer-based products could be greatly enhanced if they were accompanied by teacher manuals and other documentation which described how to implement the courseware in step-by-step detail.

Need Area #2: Software Access — Locating Desired Software

With instructional computing, it is appropriate to cite Goldberg's (1985) quote from Pogo that "We are faced with insurmountable opportunities." The hypothesized potential of computers in education is tremendous, yet access to information about available software is a major hurdle for computer-using educators. In a study of 10 large school districts between 1982 and 1984, Moskowitz and Birman (1985) report that "research and dissemination of information on appropriate instructional (computing) materials" and "surveys of hardware and software features" are two current primary needs. Goldberg (1985), in documenting the nature of computer-related calls to the Wayne County, Michigan School District, confirms that information about software to meet specific curricular needs is often the subject of the inquiries.

Teachers in the AEL study discussed information needs of three kinds:

1. Tested and/or researched software — The most desirable kind of software is also the most rare. Software products which have gone through rigorous field-testing and revision to ascertain quality before release is almost unheard of in the field. Most of what is available seems to be on the older systems such as Computer Curriculum Corporation and PLATO or has been translated from these systems for microcomputers. As Roblyer (1983) points out, "...our knowledge about what should work with given students is something less than scientific at this time. Without... evidence from tryouts with students, decisions on whether or not the instruction is effective will remain largely guesswork." A document which summarized available field-tested programs may be very short, but would be extremely useful to teachers selecting software.

2. Public domain software — Although free software is often worth as much, it represents a valuable source of materials for those with limited or nonexistent funds. Teachers need information on what is available and where they can obtain it.

3. Software with specific characteristics — As Goldberg (1985) documented, many teacher inquiries about software concern locating products which cover specific topics or addresses certain target groups of students. As the most recent EPIE (1985) survey found, about 25% of all CAI programs are on math areas. But even in math, most software seems to address primarily certain areas such as math facts and is aimed at a general student population. Nearly 70% of it runs only on the Apple family of microcomputers. Problems arise when teachers need software for specific populations such as gifted or special students, for specific areas such as problem-solving sequences or consumer skills, and for other-than-Apple equipment. Even though it has been developed in a number of cases, it also seems difficult to locate software which is able to be networked or licensed. A comprehensive, readily-available data base of specific information about software characteristics is clearly lacking.

Need Area #3: Software and Training Availability — Reviewing, Purchasing, and Using Software

As mentioned above, the lack of well-tested, proven effective courseware with built-in integration strategies presents real problems for practitioners because they cannot buy products without first previewing them for quality and addressing the issue of when and how to use it. Once teachers are able to locate software which at least has the appearance of meeting specific curricular needs, they are faced with the further problem of reviewing it, purchasing it, and determining how to use it optimally in their classrooms. The following represent the primary problems teachers face in this area.

Pre-screening Needs

Several organizations recognized the quality control problem early in the decade and developed courseware review and evaluation projects to meet this growing need. Roblyer (1983) documents the review criteria and procedures of five of these organizations. Others have since joined this group on a national and state level. For a time, it was hoped that teachers would be able to purchase software based on information from these sources. However, it now seems that these reviews can provide only some of the information required by teachers to make purchasing decisions. As NIE adviser Lawrence Grayson (1984) notes, "The concept of trying programs before they are purchased is an important one. Although the materials may have been evaluated and found to be effective, it may not be the most suitable for the particular application or class one has in mind." Although published reviews provide general screening information (titles, topic areas, evidence of minimum standards), teachers usually require more detailed, comprehensive information to determine if a given package really meets their specific needs.

Software review is a time-consuming task, becoming more so as the software market expands. Information on pre-screened software, while not adequate for making purchasing decisions, can greatly assist teachers by cutting down the amount of time they must spend on obtaining and reviewing software.

Obtaining Software for Review

Teachers are met with two kinds of problems in their attempts to preview software. First, they may have difficulty getting the software on a pre-purchase basis. For some educational organizations, this is becoming less of a problem as the software publishing industry moves toward a 30-day free trial policy. Still, many schools have purchase order arrangements which make it difficult, if not impossible, to return products once they are ordered. A second problem is the sheer amount of time it takes to review thoroughly a given software package, especially one of the more comprehensive ones. While it seems essential that someone closely involved with planning and carrying out classroom instruction should review the package, teachers are usually hard pressed to review all the possible products in order to select the most effective and least expensive ones for their purposes.

Funding for Software Purchases

A further issue in obtaining software has a familiar ring to educators. The perennial problem of finding funds for high-quality materials is especially difficult with instructional computing, since most money in this area is designated for the purchase of hardware. A relatively small amount is allocated for software. Although the average cost of software is from $30-$40 per disk, a comprehensive software series — most desirable from an integration standpoint — can run into the hundreds of dollars. For example, one popular math series is from $250 to $375, depending on whether disks contain the management system. If software is not networkable or not able to be licensed for multiple copying, teachers are required by copyright law to purchase one copy per machine. This places an even greater, often insurmountable, financial burden on school resources.

Guidance on Software Use

A final software-related problem is access to information about how to use products in an effective way. As Stecher (1984) notes, the Congressional Office of Technology has expressed concerns over the inadequate level of teacher skills in dealing effectively with technology in the classroom. Stecher (1984) and Pogrow (1985) report major projects aimed at providing expertise with software usage. Such information and training must be available to teachers on a widespread basis if software is to be used to optimal benefit in schools.

Strategies for Meeting Needs

As the previous discussion has indicated, software quality, access, and availability needs are immediate, widespread, and of critical importance to the success of future instructional computing activities. Although the problems are great, they can be overcome if certain conditions are met. First, there must be general consensus on the nature and magnitude of the problems. The AEL Needs Assessment Conferences have gone a long way toward achieving this essential step. Second, practical strategies must be carefully matched to each need to form a coherent plan. Finally, there must be substantial support on the part of participants for carrying out the planned strategies. These latter two steps will be the mission of the AEL and its members in the months to come.

The ideas expressed in this position paper can form the basis for the software portion of a regional instruction computing plan. However, the field of instructional computing is changing as rapidly as technology itself. Today's workable solutions may be unusable tomorrow because of altered conditions. The nature of the planning process in this evolving area requires that planners be flexible enough to modify strategies based on new information. Indeed, they should build this assumption of modification into any plan they develop.

Improving Software Quality and Usefulness

As former U. S. Commissioner of Education Bell (1984) admits, the educational software picture is currently disappointing. But he expresses hopes that it could improve measurably in the future. Some of the following strategies for improving quality have been known for some time, but have not been carried out in a coordinated way.

Teacher Input to Publishers and Developers

One way of increasing software responsiveness to teacher needs is to let teachers take a more active role during software development. Baker (1985) acknowledges that "...many classroom teachers are now in a position to tell instructional software implementers what is needed in the classroom. Such direction will have a profound effect upon the characteristics of software used in future computer-based learning systems."

Although many publishers employ teachers as advisors, this advice may or may not be representative of needs in the region, and it may or may not be heeded. The desires of teachers would have maximum impact if they were documented and collected in an organized way and channeled to developers through a formal mechanism such as a regional or State task force. The following benefits would accrue:

- Developers may respond more positively to teacher input if they knew they were creating a large potential market for their products.
- Developers and publishers would have a clearer message on what teachers really want in software products.
- Teachers could be more certain that software was directed toward their specific regional or State needs.

With a conduit for input such as this, teachers could make a strong case for requiring field tests of software among their own students and for correlations of software skills to State-mandated curricular objectives.

Development by Consortia

Software development has been and continues to be a labor-intensive, expensive activity, Arthur Melmed (1984) of the U. S. Department of Education says that a figure of $30,000 per hour of high-quality software is not unreasonable. While schools clearly must depend on publishers to shoulder most of the software development expense, it is occasionally beneficial for a State or region to develop a package to meet a high-priority need which is not otherwise being addressed. In this case, the cost of development can be amortized over several organizations if they are able to achieve consensus on desired software objectives and characteristics. Other states and districts (e.g., Minnesota Educational Computing Consortium; Houston Independent School District; Marion County, (Florida) School District) have already initiated such development efforts, and some have successfully covered their costs by marketing the software outside the region.

Roblyer (1981) has proposed a cost-effective instructional design model for large-scale efforts such as this which can greatly facilitate software development. Trained personnel and teacher-release time are a requirement for such activities, but the products resulting from this kind of systematic effort can be a major benefit to computer-using educators.

Research on Software Effectiveness

Although computers have been in schools for some twenty years, not enough is known about specific software design and use features which contribute to effectiveness (See Roblyer, 1985). Most research on these topics is carried out in universities. However, school districts are in a unique position to contribute to the data base of knowledge on this topic. Research efforts, like development activities, would be most useful if they were organized on a regional or State-level basis and directed toward identifying aspects of software which are specifically geared to their student populations. Studies which compare the relative effectiveness of microcomputer versus large-scale systems would be especially useful, since so few of these studies have been done and since they would help guide purchasing decisions for the region.

Improving Information Flow on Quality Software

Several strategies may be effectively employed to link up teachers with sources of information about software. Some of these require funds and specialized equipment, but others simply call for more coordinated efforts at collecting and disseminating available data.

Major Sources of Product Information

Holznagel (1983) describes three major sources of software product evaluation information. These include:

1. The RICE (Resources in Computer Education) Data Base — Available from the MicroSIFT Project at the Northwest Regional Educational Lab and accessible by anyone with a subscription to the BRS network, this data base contains information on available products, as well as the results of evaluations which have been performed by MicroSIFT and others.

2. EPIE (Educational Products Information Exchange) — This project involves the Consumer's Union (publisher of *Consumer Reports*) and several large school districts. Its purpose is to evaluate software and publish the reviews. School districts and states may subscribe to this service.

3. Magazines and journals — There are approximately 25 periodicals which contain software reviews of some kind.

Still another source of product information is the *Software Facts on File* published by Facts on File in New York. Educators may subscribe to this and receive a compendium of software reviews every two months.

Regional and State Clearinghouses

Although compilations of product information seem to be available, teachers still do not have the time or funds to access them. An agency which will act as "middle-person" is necessary to act as a conduit between them and the sources. This may be accomplished by establishing a regional or State-level clearinghouse which offers the following kinds of services:

1. Searches of data bases — The clearinghouse maintains subscriptions to electronic networks and other sources of information and does searches on request for software titles and reviews in given areas.

2. Publisher catalogs — The clearinghouse also serves as a central repository of publisher catalogs, so that teachers can obtain them without contacting a variety of publishers.

3 Hot-line for requests — In order to locate a specific product (e.g., a package to teach integers to remedial seventh graders), the agency could establish a resource hot-line through which teachers could place requests.

4. Newsletter with titles of pre-screened software — The clearinghouse would establish that the software met minimum quality criteria and periodically publish lists of titles and sources.

5. Newsletter of ideas on software use — Teacher could send in brief summaries of products and approaches which have worked for them. This information could be shared with others throughout the area.

These kinds of clearinghouses would seem most effective and cost-effective at existing organizations such as AEL. Considerable funding would, however, be necessary to carry out this idea. Although desirable from a coordination standpoint, no such clearinghouses currently exist, perhaps because of the costs involved. It may be beneficial for states to review the costs of doing such activities themselves and consider pooling their funding to establish a regional clearinghouse at AEL or a similar location.

Dissemination of Resources Lists

A final, less direct means of disseminating information is simply to provide teachers with brochures containing information such as the following:

1. Lists of publisher names and addresses
2. Magazines containing reviews and product announcements
3. Names and locations of user groups
4. Electronic networks with software product information
5. Local and regional workshops

Improving Methods of Software Selection and Use

Regardless of the quality and quantity of software reviews available, teachers still need access to products for hands-on review, and will need periodic assistance on implementing products after purchase. Both local and regional efforts are required to meet these needs.

Review Centers

The problem of obtaining software for review could be facilitated by creating local product review centers in existing media centers and libraries. Publishers would be more likely to respond to requests for review copies if requests came from an established review center rather than an individual or even a school. The centers would be legally responsible for protecting software from illegal copying, a major problem with review copies. Publishers would lend even more support to this review center concept if each reviewer completed a feedback form on the product, and the forms were sent periodically to the developer.

Workshops In Software Use

A continuing schedule of workshops, regionally planned, would also be desirable to address such topics as integration of software into existing curriculum and matching software to State-mandated basic skills. Many such workshops are held around the country by professional organizations and consultants. To assure that current training needs are being addressed and to get the most out of available inservice funds, workshops should be established for various locations and on various topics throughout the year. Some teacher workshops should also be designated for brainstorming and sharing ideas on software use, since this is often a most effective means of improving teaching strategies.

Summary and Conclusions: Some Common Themes

This paper has outlined software needs in the areas of quality, access to information, and availability of products and training. Recommendations for meeting these needs included:

- Implementing strategies for increasing the amount of teacher input during development
- Initiating consortia-based development of software in areas of key unmet needs
- Tapping several existing sources of software information
- Establishing a regional and/or State clearinghouse to disseminate product information and evaluations and to respond to specific requests for software assistance
- Dissemination of brochures containing lists of software and training resources
- Establishing local software review centers
- Holding a yearly series of workshops and teacher sharing sessions on software integration and use in classrooms

Some common factors tend to pervade each of the suggested strategies for making software a more effective resource to teachers. One is the need for planning and an adequate level of funding. Although some of the suggested activities would be expensive to implement, they would be approachable if several States were to pool their resources for a region-wide effort.

Another factor which could have a positive effect on improving the software picture is coordinated efforts on the part of educational organizations working as consortia to bring about desired software design and use. Such coordination is rare in education, since perceptions of needs and solutions usually vary considerable from school to school, let alone from state to state. Yet the AEL Needs Assessment Study has demonstrated that there can be substantial agreement among large educational entities on key computer-related issues, perhaps because teachers from each area had a key role in the discussions. Coordinated efforts at achieving solutions, as well as identifying needs, have powerful implications for cost-effective and beneficial changes to the nature of instructional computing. Many voices speaking as one have an economic and social force which cannot be ignored.

The AEL Needs Assessment Conferences have taken an essential first step in shaping the future of instructional computing in the region. It is imperative that a concerted effort be started now to build on this foundation.

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Hardware Issues in Using Microcomputers in Education by Charles R. Sanders

Introduction

Technological changes in this century have increased productivity in all aspects of the workplace. Achievements in such diverse areas as government, medicine, industry, agriculture, and the financial world have raised expectations that schools would be able to use computers to perform similar feats in teaching and learning. However, in the past 50 years, a number of pervasive technologies in society have also been perceived as having potential to improve education. The typewriter, radio, television, film projector, teaching machines - all received an outpouring of funds and attention in K-12 education, followed too often by disappointment and a failure to implement the newly-purchased equipment. Neither unique capabilities nor adequate numbers of devices seemed able to assure success.

Today, the newest technological wonder, the microcomputer, has been integrated only haphazardly into our schools. While the number of computers in the public school sector has increased from 30,000 in 1981 to 630,000 in 1984 (National Association of School Boards, 1985), policy for hardware and software acquisition and usage has not similarly developed. According to the National School Boards survey (1985), approximately 85% of all school districts nationwide had no policy for implementing computers.

The problems in bringing about a "planned revolution" are many. Although hardware-related problems and issues will be the primary focus of this paper, educational decision-makers must recognize that these problems must be dealt with in conjunction with software, training, and other issues in order to yield the desired results.

Obtaining Appropriate Numbers and Kinds of Computers

In the minds of many educators, the two greatest obstacles to using computers to maximum advantage are:

—The lack of an adequate number of computers to meet the demands of faculty and students, and

—Problems resulting from incompatability of unlike brands of equipment.

These are very real problems in light of the fact that many states are leaning toward or have already instituted computer literacy requirements. Such requirements often make it necessary for students to demonstrate computer skills before passing a given grade or getting a diploma. For these activities, and for other instructional purposes, having enough computers of one type is a prerequisite for success. However, having enough machines does little good if they are not sufficient for the specific needs of the school.

What kind(s) of computer systems should a given school purchase? There are no simple answers. The general guideline is that it depends on the types of applications desired, users (students, teachers, and administrators), and the environment in which equipment will be used. It may also depend on such mundane matters as how much money is on hand for equipment purchase. There are three general kinds of computer systems to consider, and each has distinct advantages and disadvantages.

Timesharing Systems

In spite of the "microcomputer revolution," some schools have opted to share time on a large mainframe computer located outside the school and accessed by school users from terminals. Timesharing is often available from universities and computer companies. These terminals usually do nothing by themselves; they must be tied into the large computer to receive software. An example of this kind of system is the Plato instructional system available from the Control Data Corporation.

The main advantage of time-sharing systems is their ability to handle large software programs and special features which take up considerably more memory than currently available on microcomputers. Downloading software from the mainframe also eases many of the logistics of handling large numbers of disks, and automatic student recordkeeping on many such systems can keep track of where students are in a given instructional sequence. Since the system is maintained completely by the host site, school personnel do not have to worry about repairs, cleaning, and other equipment necessities. Such systems also usually support non-CAI/CMI applications such as word processing and programming.

Disadvantages of such systems are primarily high cost and lack of autonomy for users. Since costs are usually figured on terminal rent plus CPU usage charges and phone line costs, the figure gets higher the more the system is used. A further disadvantage to school users is that they are dependent on the telephone company and the mainframe host. If either malfunctions, the system is "down" until repairs are made. Also, since the host may have contracted with many users to share time on a given mainframe, the on-screen response to users may be slow.

Instructional timesharing systems are usually selected primarily for one or more of the following instructional reasons:

1) Software and recordkeeping features are available which do not exist on other systems.

2) School personnel either do not have the expertise to structure their own computer-based curriculum or prefer to contract for this service instead of doing it themselves.

3) A school system has a need to deliver equivalent instruction to several remote locations.

4) Insufficient teachers are available to give instruction in a given content area, and the topic is an essential one.

Schools or school systems which elect this option must plan for the on-going costs of maintaining such service. Vendors of the systems usually point out that the cost per student decreases as greater number of students are added. As with other options, district or state-level policy and support are a prerequisite to assuring that the use of timesharing systems is the most efficient, cost-effective way of meeting the need.

Dedicated Minicomputer Systems

Another non-microcomputer option for delivering computer-based instruction is purchasing or leasing a small mainframe/minicomputer system with a set of instructional software. These machines are technically also timesharing systems since the students are using terminals connected to a computer, but the host is the school or district itself, and the system does only instructional functions. An example of a dedicated minicomputer system is the one available from the Computer Curriculum Corporation.

Advantages of dedicated systems are often the same as timesharing systems: availability of special-purpose software, pre-developed curriculum, and freedom from maintenance concerns. The users also have more autonomy, since they are responsible for running the system. Slowness of on-screen response is usually not a problem unless the system has too many terminals for the size machine. Disadvantages are also similar to timesharing: cost and dependence upon the software available from the company. Although maintenance may be less of a concern, a problem with the minicomputer means that the whole instructional system is "down" until it is fixed.

Dedicated minicomputer systems have achieved their greatest successes in situations where the student user population has a fairly homogeneous need, such as remedial basic math skills. Very often, these applications will be drill and practice for a short time every day, delivered in a laboratory separate from the classroom. A school system may elect this option as the most efficient way of doing something which teachers could do but either don't want to do or tend to do less effectively than the computer. Careful pre-planning and coordination of regular classroom activities with computer activities are required for this kind of option to be successful.

Microcomputer Systems

While standalone microcomputers are limited in memory and computing capability, they remain the most popular option in education today. Their most appealing advantage is complete autonomy on the part of the individual user. They also require comparatively low costs to initiate a computer-based program. Standalone units offer schools the flexibility to select the kind of configurations they want. Some examples:

1) Machines in classrooms or on moveable carts - Teachers often prefer to have autonomy to the extent that they have complete control over their computer. Or they may not be easily able to move their students from the classroom to a lab. In this case, a classroom-based machine may be their preference, although few schools can afford the luxury of a microcomputer in every classroom. Moveable carts are used to expand the on-site availability of equipment, but constant movement can lead to increased maintenance problems.

2) Microcomputer laboratories - To maximize the number of units they have, many schools have found it best to put all microcomputers in one central location, either in a special area set aside for them, or as part of the equipment in their media center. This configuration can create several kinds of management problems when students must leave their classrooms to use computers, but it also eliminates other logistical concerns such as maintaining and distributing software.

3) Networked microcomputers - This option can yield some of the benefits of dedicated minicomputer systems, while still maintaining teacher autonomy. When standalone units are connected via a networking system, teachers can download software lessons as desired and can monitor the progress of given users. This way, software disks never have to be distributed unless the teachers wants to do it that way. Since individual disk drives may not be needed, and since software wear-and-tear is decreased, costs may be reduced. However, a

networking device presents an additional cost. As with time-sharing kinds of systems, a malfunction in the networking device means that all networked computers are down for the duration of the problem. Finally, there are limitations on the kind of software available for networking.

Although there are many factors to consider in the development of a workable computer equipment plan, the central concern should always be what software is available to meet the users' needs. If this is used as the primary criterion, other decisions are often easier to make.

Procedures for Selecting Hardware

A rationale for the selection and use of computer equipment should be developed by an appropriate computer committee with input from the teachers, and should be approved by the principal, superintendent, or president of the educational entity. Hardware should be selected only after the committee and school leadership have carefully screened the available options for performance, compatibility with existing software and hardware, reliability and durability. Some useful guidelines for accomplishing this planning are as follows:

1. Match plan to stated goals - The plan should address both short and long-range goals relating to student achievement, as established by the State and the school administration. Each planning committee member should be required to have a thorough understanding of the school system's needs, computer equipment capabilities, and software uses.

2. Use pilot tests - The selection process should not take manufacturer's or seller's word for the equipment capabilities. Screening should include an actual pilot test of the desired features and software.

3. Get input from required personnel - If each school and school district has designated computer coordinators, the committee will find it beneficial to hear the perspectives of these personnel during the screening/selection process. Other personnel who should give input include: the Management Information Systems (MIS) coordinator, curriculum coordinators for elementary and secondary topics, the in-service training director, special education director, and vocational director, and a representative from the administrative and teaching organizations.

4. Use reliable companies - While fair practice requirements may mean that the committee has to hear presentations from all vendors, only reputable companies with a demonstrated commitment to education and which have third-party developers supplying their software should receive serious review.

After the committee completes its work, they should make provisions for an annual review of the status of their needs, how the equipment has met expectations, and what else has become available on the market since their selection.

Elements to Consider in Selecting Hardware

As tempting as it may be to spend less money, "low bid" must not be the primary criterion in selecting hardware. The following factors should all be considered:

1. Software Availability - An adequate amount and variety of proven-effective software should be on hand to meet specified instructional needs. Software should also be well-documented and readily-available (not "scheduled to be released at a future date").

2. Reliability - Hardware should have an established reliability record. Rapid breakthroughs in technology have flooded the computer market with an endless array of brand names. Determine reliability through trade magazine evaluations, advice from current school users, reliable vendors and pilot testing.

3. Expandability - Selection must be made not solely on the basis of present needs but should also consider future requirements. Computer should be able to expand not only memory but with items such as printers, modems, scanners, graphics tablets, joysticks, and plotters. The capability to expand should be inherent in the machine or available at minimal additional cost.

4. Durability - Hardware must be built to withstand use by students and faculty at varying levels of abuse and use. Such often-used parts as keyboards, disk drive doors, and power switches should be carefully scrutinized for durability.

5. Documentation - Operator/user manuals for the purchased equipment should be available and able to be understood by non-technical educators.

6. Compatibility - Selection should also be made in light of existing equipment and software. Also, it is easier to maintain a large number of one or two kinds of systems than it is to handle maintenance requirements for a smorgasbord of computer brands.

7. Service - Quick service (vs. shipping away units) is a primary requirement for educators, since the instruction may be dependent on the computers.

8. Training - Purchase of hardware should be made with the understanding (in writing) that the vendor will provide the necessary training in how to use and maintain the systems. The committee should review the company's personnel and training materials available for this purpose.

9. Printers and other peripherals - The computer is only one element in an array of equipment required to meet needs. Most of the factors discussed here should also apply to the evaluation of peripherals. CRT monitor features, such as color vs. black or green, should be considered. Printers are an especially important output device. Users should consider whether they need a letter quality or dot matrix printer, wide-carriage for different kinds of paper, color printout vs. black only, and special features such as underlining capability and various styles of print.

10. Other features - Some consideration should be given to such characteristics as upper-lower case capability, availability of languages, and computer memory available.

11. Maintenance requirements - The selection committee must consider carefully how the equipment will be maintained on a regular basis and how it will be repaired as needed. Many problems with computer equipment can be prevented with regular care and periodic check-ups with diagnostic programs. School systems may also opt for maintenance agreements with the manufacturer or local company after the warranty has expired.

12. Price - A final important consideration is the cost of investing in the "computer age." The TOTAL cost should be determined before a final decision is made, including costs of peripherals, software, training, and maintenance.

Conclusion

It cannot be emphasized enough that coordination among educational organizations is the key to success in hardware acquisition and use. District and State-level contracts and policies are essential, both to make obtaining computers economically feasible and to insure appropriate use after they are obtained. While the revolution in hardware capabilities continues, and computer achievements abound in other areas of society, education will begin to feel the positive effects of this capability only through careful planning and hard analysis of school, teacher, and student needs. The development of policies based on this planning and analysis is the key to assuring that education fulfills the promise of its technological future.

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Computer Training For Teachers
by John Cook

The Problem

1. Teachers need to have the knowledge and willingness to use computers as a tool for instruction in basic mathematics.
2. Administrators need to be aware of the value of instructional use of computers, and they need to know how to provide administrative support for this use.

Solution:

Appropriate instructions with effective incentives must be made available for teachers and administrators. Appropriate instruction must address both cognitive and affective domains.

Affective Instruction:

The first exposure must be carefully planned to be non-threatening. This can be done by beginning with short, easy lessons that provide success at every step. For example, the teachers could start by running some very easy-to-use software that is intended for elementary students.

Early lessons should focus on computer uses that will be of direct use to the teacher. These might include such things as word processing, grade-book programs, exam generation, and classroom management software.

Reluctant teachers may also be enticed by high-quality CAI software that helps students successfully learn a topic that is difficult to teach by traditional means.

The characteristics of the instructor are important for reducing computer anxiety. Teachers may feel more at ease learning about computers from a local classroom teacher than from an out-of-town "expert."

Another technique which helps to reduce computer anxiety for some teachers is to allow them to work with the computer independently. They need a chance to "play" with the computer and make their mistakes when no one else is watching.

Cognitive (and psychomotor) Instruction:

Teachers need to learn the nitty-gritty of how to use computer hardware for teaching. This instruction needs to be directed at the specific hardware that the teacher has available in the classroom. The ability to run the computer and to perform the first level of trouble-shooting when something goes wrong, while important in its own right, will also alleviate most computer anxiety.

Teachers should develop skill in using the computer keyboard. In some cases, this may just involve transferring typing skills to the computer keyboard. In other cases, teachers may need to learn touch-typing.

Teachers need to learn to use the computer as a general purpose tool. When using the computer as a tool for such mathematical applications as figuring grades, teachers are acting as role models for their students. They are demonstrating that computers are tools for basic mathematics.

Teachers need to learn various techniques and strategies for using computers as part of the delivery of instruction in mathematics. Administrators need to be aware of these strategies, and know how to provide the support that the teachers will need.

"Teachers... must be given training in the selection and use of appropriate software to enhance instruction in mathematics, and information should be given to them about sources of mathematics-related software." (Corbitt, 1985) Administrators need to be aware of the need for appropriate software for mathematics instruction.

Teachers must learn how to "...develop, deliver, and evaluate lessons and units that integrate existing software into mathematics instruction." (Corbitt, 1985)

As what is "basic" in mathematics instruction shifts away from paper and pencil computation, computers will increasingly become part of basic mathematics in the middle grades—not just as a tool for delivering instruction, but as a tool that students will use for problem solving and computation. As the curriculum evolves, teachers will need to learn both the new content and the appropriate teaching techniques for this content. Such topics are likely to include: iterative procedures for solving significant problems, computer applications for statistics, computer graphics for informal geometry, and computer programming.

Administrators need to be aware of changes occurring in the mathematics curriculum, and the implications of these changes for the need for computer hardware, software, and in-service education for teachers.

Delivery methods:

Most of the traditional methods of delivering in-service and pre-service education to teachers and administrators apply to the delivery of computer education. However, there are some unique features:

Computer education for teachers needs to involve a considerable amount of hands-on time with computer hardware and software. For some portions of the instruction, it may be appropriate for the participating teachers to work in pairs on the computers. At other times there will need to be one computer per participant.

The instructor of a computer course or workshop for teachers should have a computer available for whole-class demonstrations. It should be equipped with a visual display large enough for the whole class to see, using the kind of hardware likely to be available in the schools. It should be used to model the kind of whole-class instruction the teachers can do in their own classrooms, and to demonstrate things they are to do when working on the computers by themselves.

Many aspects of computer education for teachers lend themselves to independent learning. Teachers can learn from manuals, books, and computer software if they have the hands-on time with computers.

Teachers can also learn informally from fellow teachers or from a local or county level computer coordinator. When a teacher calls the computer coordinator with a specific question or problem, that teacher is motivated and ready to learn.

It is important to recognize that computer education for teachers and administrators will be a continuing need. With changes in hardware, software, and the mathematics curriculum, teachers and administrators will need to continually update their skills. This means that delivery systems should be locally available at convenient times. They should provide teacher education in frequent, small doses, rather than as one massive do-it-and-get-it-over-with course. This continuing education can be provided through support for independent learning, a locally available computer coordinator, short workshops, and conferences.

Teachers and administrators are individuals with individual learning styles and needs. It is important to have a variety of delivery systems available to accommodate these individual differences.

Incentives:

Professional associations, administrators, and other teachers can promote the idea that learning about computers is a professional duty. For many teachers, this is a sufficient incentive.

Many of the traditional incentives for in-service education are also applicable to computer education, e.g. stipends, free tuition, college credit (which may be applied toward advancement on the salary schedule), and conducting in-service during paid work hours.

Another traditional incentive is simply to make a certain type of in-service education required. While it is tempting to require computer education, this could be counterproductive. Teachers frequently resent added requirements. Any positive cognitive learning that might take place might be more than offset by negative attitudes. Another danger is that such a requirement (especially a state recertification requirement) would be met by a one-time college course. This kind of requirement would not encourage delivery systems that are appropriately varied and continuing in nature.

Requirements do make sense when considered as part of a program of pre-service education. Teachers or administrators are not being fully prepared for today's schools unless their preparation includes computer education. It should be part of both undergraduate and graduate programs leading to certification for teachers or administrators.

Teachers should be given access to a computer, time during the school day, and encouragement to use that time for learning how to use computers and software. The availability of a computer coordinator and other knowledgeable teachers could provide an incentive for informal computer education.

After-hours access to computer hardware and software plus encouragement from administrators would be an incentive for independent study. Teachers should be encouraged to take the school's equipment home for use during weekends and summer vacation. (Generally the equipment will be safer from theft or vandalism in the teacher's home than in the school building.) Teachers should also be encouraged to purchase a computer, like the one they use in school, for use in their own home. Arranging for a discounted price would be one way to encourage teachers to buy their own computer. They should also be able to borrow and use the school's software.

Teachers could be rewarded for computer knowledge gained through informal or independent study through a system of credit by examination.

In-service Education for Teachers

As a teacher, what can you do for yourself?

Acquiring the knowledge and skills to use computers as instructional tools is one of your professional responsibilities. You will find that the skills you learn and use will have a big payoff in your students' motivation and achievement. You will also learn how to be more productive and efficient in dealing with your own paperwork. And, you will learn that working with computers can be fun.

Here are some of the ways you can learn more about computers...

1. Take a college course. Many colleges and universities offer courses for teachers on the instructional use of computers. Before you sign up, ask some questions. Is the course intended for teachers? Is it relevant to your grade level and subject specialty? Will you learn how to use the kind of hardware and software that you have in your school?

2. Enroll in a workshop or short course. There are many workshops offered by teachers' organizations, and local, county, or state education agencies. Be sure to ask the same questions as above.

3. Read your professional journals. There are many magazines written for teachers on using computers in schools. (See the attached bibliography.) There are also many articles on computer use in the subject area journals, e.g. *The Arithmetic Teacher*.

4. Teach yourself. Get a computer and some manuals and dig in. When you get stuck, ask questions. There is bound to be someone you know who can help you—a local or county computer coordinator, a fellow teacher, or a student who's a computer whiz.

> Where can you get a computer? (1) Use a computer at school during your preparation time or before or after school. (2) Borrow one of the school's computers for the weekend or the summer. (When you ask for permission, remind your principal that the computer will probably be safer from theft or vandalism in your home than in the school building.) (3) Buy a computer of your own. Be sure to buy a computer like the computer you will be using at school. (If you have children of your own, you will find that it is an excellent investment in their future.)

Dramatic changes are occurring in school mathematics. As what is "basic" in mathematics instruction shifts away from paper and pencil computation, computers will increasingly become part of basic mathematics—not just as a tool for delivering instruction, but as a tool that students will use for problem solving and computation. (Corbitt, 1985) As the curriculum evolves, you will need to learn new content and new techniques for teaching the content. This means that learning about computers will be a continuing responsibility—not something you can do once and be done with it forever.

What kind of support should you expect?

As a teacher you should expect your efforts to be supported by your administration, by county and state departments of education, and by the taxpayers. But you will not get support unless you, individually and collectively, ask for it. Let them know what you need, and keep letting them know until you get it. Kids are too important to settle for less.

Administrators should...

> Take the time to learn about instruction uses of computer in order to know how to provide the support that teachers need.
>
> Let teachers know about college courses and workshops that they can attend, and encourage them to do so.
>
> Organize local in-service workshops that meet teachers' needs.

Provide incentives for teachers to attend courses and workshops on instruction use of computers. Such incentives could include paying expenses, releasing teachers to attend during paid school time, and building rewards for continuing education into the school's salary schedule.

Make sure teachers have someone they can go to when they have questions. This could mean hiring a local district computer coordinator.

Make sure teachers have access to a computer. This could involve buying more computers, adjusting the location and scheduling of the computers in the building, allowing teachers to take home the school's computers during weekends or over the summer, and allowing teachers to purchase their own personal computers at the school's discounted price.

Make sure that teachers have the software and instructional materials that they need. Buy what is needed, and assign someone the responsibility of keeping track of the materials so teachers can find what they need when they need it.

Consider in-service education needs when making hardware and software purchase decisions. It takes time to learn how to use new equipment or materials. Teachers should expect purchase policies that do not require them to learn how to use a new kind of computer every year.

Be award of changes occurring in the mathematics curriculum, and the implication of these changes for the need for computer hardware, software, and in-service education for teachers.

County or intermediate agencies should...

Provide computer education consulting services to teachers and local district administrators.

Work with local school districts to provide in-service workshops on instructional uses of computers.

Make sure that mathematics curriculum consultants are knowledgeable about the role of computers in teaching basic mathematics.

Provide a lending library of instructional materials for in-service education of teachers on computer education. These materials could be checked out for independent study by individual teachers or for local district in-service workshops.

State departments of education should...

Use certification requirements to make sure that all new teachers and school administrators are knowledgeable about instructional uses of computers.

Approach recertification requirements with caution. If computer education is added as a recertification requirement, it should be flexible enough to allow a wide variety of ways, including independent study, for teachers and administrators to learn about instructional uses of computers.

Consider the needs of teachers for in-service education when negotiating state-wide hardware or software purchases. Discounts available to schools should also be available to teachers who want to purchase similar equipment for their personal use.

Provide consulting help and leadership to make sure that colleges and universities, intermediate agencies, and local districts are providing a variety of opportunities and incentives for teachers to receive appropriate in-service education on instructional uses of computers. This may involve working with the legislature to obtain funding.

Colleges and universities should...

Make sure that instructional uses of computers are part of the preservice education curriculum for all teachers and administrators.

Work with state, intermediate, and local education agencies to design and offer in-service computer education courses for teachers and administrators. These courses should provide practical, hands-on experience with the kind of equipment that the teachers will be using in their schools.

Develop a system of support for independent study and credit by examination in the area of computer education.

Continue to study and do research on the use of computers in the teaching of basic mathematics. The clear, practical implications of that research should be communicated to teachers and administrators.

Taxpayers should...

Expect to pay for the cost of in-service education for teachers and administrators as part of the cost of keeping our public schools up to date.

Stop electing candidates who complain about the quality of education while promising no new taxes.

Plan now to learn more about computers, and to get the support you need. You will be glad you did, and so will your students.

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Computer Planning and Integration Issues by Jose Mestre

When computers first appeared on the educational scene about twenty-five years ago, many believed that a new era of computer-based instruction (CBI) was about to begin which would revolutionize education. These expectations were based on the belief that computers would be capable of both diagnosing learning difficulties and routing students to a program designed to meet the students' specific needs. Students would not only be able to proceed at their own pace, but also proceed along the most efficient path, a feature not possible within a conventional classroom setting. The benefits of CBI for the teacher were supposed to be equally impressive. Teachers would now be able to spend their time teaching higher-level material and leave the drudgery of drill to the computer. At the same time, computers could keep detailed records of student progress and leave teachers more time for planning their curricula. These dreams of twenty-five years ago have been only partially realized today.

Recent meta-analyses* of CBI reveals that the **effectiveness** of computers as an instructional medium is more modest than anticipated. A meta-analysis by Kulik, Kulik and Cohen (1980) reviewed 59 independent evaluations of computer-based college level teaching. This analysis showed that CBI made small improvements in achievements. For example, in the typical CBI program, student exam scores increased about three percentage points, or one-quarter of a standard deviation. This improvement translates to a score at the 60th percentile on an achievement examination covering course material for a typical student in a computer-based class, whereas a typical student in a conventional class would score at the 50th percentile. CBI also had a small positive effect on the attitudes of college students toward instruction and toward the subject matter. The most dramatic finding from this study was that the time requirements for CBI were significantly less than those for conventional methods; on the average, the computer accomplished its goals in two-thirds the time of conventional methods.

Computer-based instruction appears to be more effective at the elementary level than at either the secondary or college levels. For example, in a review of 10 independent studies, Vinsonhaler and Bass (1972) reported that elementary school children receiving computer-based drill-and-practice showed performance gains of 1 to 8 months over children receiving traditional instruction. Another study by Jamison, Suppes and Wells (1974) revealed that the achievement scores of disadvantaged elementary school students showed significant improvements when CBI was used as a supplement to conventional instruction. They also found that at the secondary and college levels CBI was at least as effective as conventional methods and that CBI often resulted in substantial savings in time. Hartley (1977) reported that when CBI was used at the elementary and secondary levels, the average effect was that student achievement improved from the 50th to the 66th percentile. She also found that elementary grade students showed more improvements under CBI than did secondary students. Burns and Bozeman (1981) found that both elementary and secondary grade students performed at the 67th percentile when receiving tutorial CBI and at the 63rd percentile when receiving drill-and-practice CBI. In a meta-analysis of 51 independent evaluations of CBI in grades 6 through 12, Kulik, Bangert and Williams (1983) reported that CBI improved scores on final

** The term "meta-analysis" means an analysis of analyses. It is a statistical procedure used to analyze a large collection of results from individual studies for the purpose of integrating findings.*

examinations from the 50th to the 63rd percentile. They also found that students who where taught with computers developed very positive attitudes towards the computer and gave favorable ratings to the computer-based courses they were taking. As in both the Kulik, Kulik and Cohen study and the Jamison, Suppes and Wells study, these researchers found that CBI resulted in substantial reductions in the amount of time students needed for learning.

In the domain of mathematics, the effectiveness of CBI also appears to decrease as the educational level increases. For example, Hartley (1977) found that CBI raised examination scores in mathematics to the 66th percentile at the elementary level, but only to the 62nd percentile level at the high school level. Kulik (1981) reported that at the college level, CBI raised examination scores in mathematics only to the 54th percentile level. Kulik suggested that at the upper levels of instruction a highly stimulative and interactive teaching medium may not only be unnecessary but may even interfere with learning, whereas at the lower levels of instruction, learners need the stimulation and interaction provided by CBI.

Two consistent findings emerge from the articles reviewed above. One is that CBI is effective mostly at the elementary level, and the other is that CBI saves instruction time. Given that these two findings are rather desirable and that CBI is gaining in popularity, an important question to consider is: What important issues should a school system, administrator or teacher consider when planning to establish a CBI program? This is neither an easy question to answer nor does it have only one correct answer. However, a brief look at the complexity of issues involved in CBI today show that the arguments for careful planning are compelling.

Even though computers have been in the educational scene for over two decades, it was the appearance of the low-cost microcomputer in the late 1970s that helped bring large numbers of computers into the classroom. Today there is quite a large selection of micro-, mini-, and midi-computers from which to choose. With several computer companies going out of business each year and with several new computer companies being established each year, deciding which brand or brands of computer to purchase can be a long, tedious process. Even more perplexing is deciding which programs (or "software" as computer programs are collectively called) to purchase. There are literally thousands of programs at all educational levels spanning a large number of topics, each one varying in quality and price. Another equally important task is deciding how to implement the CBI curriculum to assure effective use of both the computer's time and the computer's teaching power. Finally, there must be a way of assessing whether or not a CBI program is instructionally effective, and if an evaluation reveals that the program is not being effective, there must be enough flexibility to make quick modifications in order to maximize student learning.

The purpose of this paper is to discuss a number of issues which we believe to be crucial in planning a computer-based, or computer-assisted instructional curriculum. To avoid possible confusion, it would be wise to state what this paper will not attempt to do. We will not evaluate any specific hardware or software products, nor will we endorse any particular product or curriculum. Any mention of particular trademarks will be made for illustrative purposes only and should not be taken as endorsements. We will not deal with how one should go about evaluating CBI hardware or software, nor will we deal with how one should go about evaluating the effectiveness of an existing CBI curriculum. We will only state what issues should be considered when planning a CBI curriculum and argue why these issues are important. Our only purpose is that this article serve as a resource to anyone faced with the task of planning a computer-based instructional program. Finally, although our focus will be on planning a computer-based curriculum in mathematics, most of the issues discussed herein are relevant for planning a computer-based program in any subject area.

The Importance of A Well-Defined Curriculum

The most important part of any educational program is the curriculum. Without a well-defined curriculum, there will be little uniformity on what, when or if a particular topic is taught. A well-defined curriculum ensures uniformity and cohesion in the educational endeavor and allows periodic reviews of the students' progress within the curriculum. Too often CBI programs are implemented with little regard to the existing curriculum. As will be argued, establishing a CBI program independently from the existing curriculum can be dangerous.

To illustrate the possible risks endemic of a poorly designed CBI program, two hypothetical scenarios will be discussed. The first scenario is only partially hypothetical in that its frequency of occurrence is not uncommon. It certainly is unarguable that computers are becoming more and more fashionable in education. A school system today that does not have a CBI program is considered somewhat "behind the times" and is under pressure to initiate some form of instruction using computers. Let us suppose that at a particular school system, a new source of funds is identified part way into the fiscal year and it is quickly decided that the monies will be spent to start a computer instructional lab. However, since time is short and the funds must be spent within that fiscal year, there is no time to hire a "computer resource teacher" to help design a program which integrates smoothly into the existing curriculum. Instead the school system identifies a teacher at one of their schools who is "good with computers." This teacher is suddenly given the major responsibility of purchasing a substantial amount of hardware and software, of deciding what is going to be taught in the computer lab and to what specific age and ability group, and of designing a plan to cycle the students through the lab in an orderly fashion. In addition, this teacher may only be partially released from his or her normal teaching duties, and told to try to get all this done "in the next three or four months" so that the program is in place for September. One likely modification to this scenario which would worsen the already difficult situation is to replace the teacher above with a school administrator who is "not so good with computers."

The likelihood that a sound CBI program can be designed and implemented under these constraints is small. It is very probable that after the expenditure of large amounts of time and money, the resulting CBI program will work at cross purposes to the established school curriculum. An even bigger danger with this approach is that the computer might end up driving the curriculum instead of the curriculum dictating the function of the computer's role. This approach puts the computer in the role of a solution looking for a problem. The reason that computers have flourished in business and industry is that there was a clear problem that needed a solution. Computers in business and industry made manageable both long, complicated calculations which could not be done by hand, and large-scale storage and retrieval of information. In education, the "problem" which computers are supposed to solve is not as clear.

The second scenario that will be discussed is one which perhaps is too farsighted to be politically feasible. There have been a number of recent conferences designed to discuss the role of computers in the general curriculum (Computers in Education, 1983) as well as the role of computers in the mathematics curriculum (Fey, 1984; Conference Board of the Mathematical Sciences, 1983; Hansen, 1984; School Mathematics, 1983). The recommendations from one particular conference sponsored by the National Council of Teachers of Mathematics (The Impact of Computing, 1985) are somewhat innovative. A short passage from the conference report illustrates the point:

> "The major influence of technology on mathematics education is its potential to shift the focus of instruction from an emphasis on manipulative skills to an emphasis on developing concepts, relationships, structures, and problem-solving skills. Traditional precollege mathematics curricula have stressed the development of a variety of mechanical procedures, including the computational algorithms of arithmetic and the transformation of symbolic expressions in algebra, trigonometry, and analysis. The use of calculators and computers as standard tools in quantitative problem-solving situations, however has diminished the value of human proficiency in the execution of such procedures. Much of the instructional time currently devoted to acquiring proficiency with paper-and-pencil algorithms should be reallocated to support a range of new or previously neglected topics that have a valid place in the K-12 curriculum. Moreover, teacher education programs must be modified to reflect these changes in school mathematics content and to model the delivery of instruction through appropriate applications of technology." (p. 244)

In the second scenario, the mathematics curriculum committee at a particular school system decides to take these recommendations to heart and designs a curriculum which emphasizes problem-solving and higher-order skills and leave the drudgery of computations to calculators and computers which are readily available for students to use. Students would consequently spend considerably less time on basic skills and more time learning problem solving strategies. This CBI program would use the computer as a tool for teaching problem-solving and not as a teaching machine.

Whether or not this approach is successful, it would likely have difficulty gaining acceptance with the school board and with parents. Their attitude would likely be that the traditional approaches used to teach mathematics in the past have not been without success, and that before such a radical deviation is made from the traditional approach, there should be some proof that the new approach is in fact better than traditional approaches. This view is understandable since no one wants the responsibility of committing a child to 12 years of instruction without some guarantee the outcome of the second scenario until a commitment is made to try a curriculum for 12 years on a sample class.

The two examples above illustrate the importance of defining a curriculum and its objectives. The curriculum should be designed using whatever process the school system deems best, and this process should not depend upon whether or not computers will play an integral role. However, if it is the intent of the school system to have CBI in the curriculum, then the person(s) who will be (or are) responsible for the CBI component should definitely be part of the curriculum definition process. The end result of this process should be a document which establishes the following: 1) The curriculum to be followed for each subject and for each grade level, 2) The goals of the curriculum, and 3) A method for assessing whether or not the stated goals are being achieved. A well-defined curriculum will not only help to avoid a situation where the curriculum serves the need of the computer but also establish the groundwork necessary for the next step in planning a CBI program.

Selecting A CBI Program To Match The Needs of The Curriculum

The issues discussed in this section and the next major section on implementation of a CBI program are rather intertwined. This interrelationship means that, when planning a CBI program, there is no clear order in which to consider the different factors that will be discussed in these two section. It is fair to say that a decision concerning any one issue will affect the other issues either directly or indirectly.

Defining the Computer Instructional Curriculum

Assuming that a well-defined curriculum exists for all grade levels of the school system, there must now be an ordering of priorities of the content areas, audience, level, and type of CBI program that can be matched to the curriculum. One of the first decisions that must be made concerns the content areas that will be targeted for CBI. This decision will determine whether the CBI program will cover a wide range of subjects, such as math, reading and writing, or simply one subject, such as arithmetic skills. The extent of the CBI program must also be determined, that is, whether the program will cover grades K-12 on a system-wide basis, or whether it will only cover grades 1-5 at one particular elementary school. In addition, one has to decide whether the CBI program will serve all types of students or only specific types, such as learning-disabled students, gifted students, or language-minority students. The instructional style of the CBI program must also be selected, where the style can range from using the computer for drill-and-practice, to using it for improving conceptual understanding and problem solving skills, to using it as a tool to teach writing via word processing. Some issues related to logistics must be considered, such as whether students will receive computer instruction within their content-area classrooms, or whether students will be pulled out of their content-area classrooms to receive computer instruction. Finally, a decision must be reached concerning whether the CBI teaching staff will consist of "computer resource teachers" or of actual content-area teachers.

Decisions on these important issues are not easily reached. Three factors should help to constrain the possible choices into those feasible for the specific school system: the needs of the school system, the priorities of the school system and the fiscal resources available in the school system. Different school systems will have different needs. For example, students in the elementary grades of a school system may be lagging behind national norms in arithmetic skills, or perhaps the high school college-bound students show particular weaknesses in mathematical problem-solving skills or writing skills. Another need may consist of a large language-minority population within a school system coupled with a shortage of bilingual teachers. If chronic enough, any one such need could serve to focus the CBI program in one particular direction.

Priorities will also differ across school systems. One school system may decide that it wants to prioritize the college preparatory program and define as one of its goals to graduate seniors who are extremely well-prepared for college-level work. Another school system may decide that in today's world, what any citizen needs is to be computer-literate upon graduation from high school. Priorities like these will help define the type of CBI program selected.

The last factor, fiscal resources, will often determine whether the school system will adopt a very modest CBI program, a very ambitious program, or no program at all. A school system may have needs and priorities which clearly point to a particular type of CBI program, yet it may not have the resources available to implement the desired program. With teachers underpaid and school budgets increasingly lean, how to make the best use of available resources is not always obvious. When the price of a few computers and associated software rivals the hiring of a new teacher to alleviate a work overload, the choice could favor the increased teaching power brought by an additional teacher.

Hardware Considerations

Among the most important considerations are those related to hardware. Today, there is a wide range of computer brands and types, and an accompanying range of prices. For microcomputers (or "micros" as they are usually called) there are a number of manufacturers such as Apple, Commodore, Digital Equipment Corporation, IBM, Radio Shack and Zenith, to mention just a few. A significant number of manufacturers market "clones" of popular microcomputer models such as the IBM-PC. The prices of micros vary drastically, from a few hundred dollars to several thousand. What is likely to remain true is that as computer technology continues to make significant advances, the price of micros will continue to decline.

The machinations of the micro industry during the last decade are nothing short of amazing. Starting with the production of the first low-cost micro by Apple Computer Corporation in the mid 1970s, the micro industry has undergone radical changes. The original Apple II micro was quite powerful and advanced for its time. However, the Apple II+ and IIe micros that are so popular in schools across the country are primitive by today's standards. This places several limitations on the range of educational applications that can be run on these computers.

Typically, micros are used by a single user to run a single program; this program is loaded into the computer's memory from a magnetic storage device, such as a floppy diskette, and executed. One interesting application of micros is to interconnect them into what is called a "network." A network of micros is capable of various advanced features. For example, one of the micros in the network (usually the one controlled by the teacher) can be designated as the "master" or "host"; any program that is loaded on the host machine and executed is displayed on the other micros in the network. Another feature possible with networked micros is the ability of the master micro to "tap" into any one micro in the network and see what that user is doing; this allows a teacher to view the progress that any student is making at any time. Similarly, the teacher or a student can be working on an example on one micro while all the users in the network watch. The cautions that must be exercised with networking are that additional software and hardware are necessary to set up the network, and that many software packages will not run on a networked system of micros.

More powerful than micros are the minicomputers (or minis). Minis are used in educational settings usually consist of a central unit with a number of remote terminals linking to the central unit. Whereas micros, in their typical mode or operation, are single-user machines, minis are multi-user machines. In addition minis are capable of performing multiple tasks simultaneously (or multi-tasking), whereas micros are capable of performing a single task at a time, namely the program that is loaded into memory and executed. For example, a mini can be running a math tutorial for one student, a vocabulary skills builder program for another student, and at the same time be "listening" as a teacher inputs class grades. These minis are typically in the tens of thousands of dollars price range. Because of the rapidly advancing technology in the computer industry today, it is becoming increasingly difficult to distinguish between micros, minis and "midis." An illustration of this is the "PRO" series of micros manufactured by Digital Equipment Corporation. These rather powerful micros are capable of multi-tasking and for all practical purposes are equivalent or superior to many minis on the market, but for the fact that they are single-user machines. At the time this article was written, these micros retailed in the three- to 12-thousand-dollar range depending on options—a reasonable price considering the computational power.

A detailed discussion of hardware issues is beyond the scope of this article. We conclude this brief discussion of hardware with a word of warning. We strongly advise against basing the decision of what hardware to purchase solely on one single factor, such as price. Computer technology will continue to improve and in considering what hardware to purchase we must consider not only tangibles such as price, technical specifications and reliability, but also intangibles such as the likelihood that a particular computer company will still be in business two years from now.

Software Considerations

Certainly as important, and perhaps more important, than hardware considerations are issues related to software.

The type of software that will be used in the CBI program will likely determine the hardware which will run it. There are two distinct choices for the type of software that can be used in a CBI program. The first choice consists of purchasing a complete software package which usually covers several years of material in one or several topics. We will call this type of software an "extended software package." The second choice consists of selecting a number of individual software packages each covering a particular topic or series of topics. We will call this second type of software an "individual-topic software package." This second type of software comes packaged in some form of magnetic medium, such as a floppy diskette, and is designed to run either on individual micros or on networked micros. We will begin by discussing extended software packages.

An extended software package is designed to run on a minicomputer and all of the "lessons" are stored centrally in the mini's memory. Typically an extended software package works this way. The mini maintains class rosters with appropriate information on the topic or topics that each class (and therefore each student) will be covering. When a particular student in a particular class signs on the system, the appropriate topic is presented to the student at the appropriate level. An extended software package has a number of sophisticated features. Through an elaborate bookkeeping process, the computer keeps a record of each student's progress in every subject covered and tracks each student on a path designed to fit that student's specific needs. A student is tracked onto the next level or topic at mastery of the current level, with mastery typically defined as a 75% success rate on a series of assessment exercises and problems. With this system, a student who is having difficulties with a particular concept or topic keeps receiving tutorials or drill on the same topic until mastery is achieved. Due to the flexibility of this tracking system, any two students from the same class will very likely be at different places in the CBI curriculum. A particular student, for example, could be working at a level equivalent to third grade in arithmetic, and fourth grade in reading.

An extended software package is generally purchased with all the hardware necessary to run it as one complete hardware-software package. The cost is generally between $50,000 and $150,000, and the number of students who can be serviced simultaneously ranges from 30 to 120. One such package is marketed by Computer Curriculum Corporation of Palo Alto, California, and covers mathematics, reading, and language arts for grades levels 1-7 using a drill-and-practice format, as well as "advanced" subjects like algebra and computer programming for high school-level students. Another package covering the complete K-12 mathematics curriculum will soon be marketed by WICAT Systems of Provo, Utah; this package will go beyond drill-and-practice by attempting to improve students' conceptual understanding of mathematics as well as their problem-solving skills.

Extended software packages have both advantages and drawbacks. Purchasing a complete curriculum is one advantage. This translates to substantial time savings, since it no longer will be necessary to spend many hours deciding which individual-topic software packages to buy from the thousands available. Also, extended software packages usually come with explicit implementation instructions thereby alleviating the headaches associated with implementing a CBI curriculum consisting of many individual-topic software packages. The most important advantage of extended software packages it that there are usually several research evaluation studies available on the effectiveness of the package. As will be seen, the effectiveness of some of these packages is quite impressive.

The extended software package by Computer Curriculum Corporation (CCC) mentioned earlier has been evaluated by a number of independent sources (Ragosta, Holland and Jamison, 1982; Brust and Carver, 1984; Abram, 1980; Hotard and Cortez, 1983). Findings from these studies consistently indicate that students make substantial gains*, especially in the area of mathematics, while spending seemingly little time on CBI activities. In the CCC curriculum, students spend either 10 or 20 minutes per day on CBI, depending on the topic and level of material. Findings from the studies referenced above include:

- With only 10 minutes of CBI in mathematics each day, students made significant gains in computational skills compared to control students receiving no CBI.
- With 20 minutes of CBI in mathematics, students doubled gains in computational skills.

**The student gains were measured by standardized tests, such as the California Achievement Test and the Comprehensive Test of Basic Skills.*

- The mathematics gains of students receiving CBI increased as the number of years which they received CBI increased.
- The gains in these studies ranged between 1.2 and 2 years of achievement for each year of CBI instruction.
- Students who were 1.5 or more years behind in arithmetic skills in grades 5-8 averaged gains of 1.2 years under CBI.

Despite these impressive results, there are some drawbacks to extended software packages. One drawback is the rigidity of the package. There is no possible way to add instructional material to the package, or modify instructional material within the package. If a school wants to use word processing as part of an English composition CBI program, or include in the CBI program a new mathematics software package which has received excellent reviews as a tool for improving problem-solving skills, it will not be able to do so under a program based on an extended software package. Another problem is that these packages are very expensive, although considering that a package like the CCC curriculum can serve up to 128 students simultaneously, the price is not unreasonable on a per-student-hour basis. One definite drawback of a minicomputer-driven CBI program is that if the minicomputer breaks down, all computer-based instruction comes to a halt until the mini can be serviced. Finally, despite impressive gains in computational mathematics, there is no clear evidence that drill-and-practice packages, such as the CCC curriculum, are effective at improving problem-solving skills. Future evaluative studies of the forthcoming package by WICAT Systems will help to assess the ability of an extended software package to improve both conceptual understanding and problem-solving skills in mathematics.

If an extended software package is inappropriate, the other choice* is to purchase several individual-topic software packages spanning the range of topics that will be covered by the CBI program. Almost every major mathematics textbook publisher has a "complete" curriculum available. Individual-topic packages and extended software packages are different in several ways. On difference is that individual-topic packages generally have to be loaded into the microcomputer's memory before each use. Further, individual-topic packages to not have a tracking feature that evaluates student performance and places students on individual paths especially designed for them, although some have a simple "bookmark" feature which remembers where each student ended the lesson. The next time the students sign-on the computer, they will be restarted from their own bookmark positions.

As was the case with the extended software packages, both advantages and drawbacks are associated with individual-topic software packages. One advantage with individual-topic packages it that they are relatively inexpensive. Also, since they are designed to run on micros and micros are also relatively inexpensive, one can start with a very modest CBI program consisting of a few microcomputers and a small library of individual-topic packages and later upgrade the program as resources permit. Individual-topic packages also offer flexibility; topics can be added or deleted from the CBI curriculum depending on the school system's needs. In a subject like mathematics large numbers of packages on the same topic give one a large selection from which to choose; for example, if there is a need for a package to cover addition and subtraction of fractions, more individual-topic packages are available than any of us will likely

*There is a third choice, namely to commission the development of the software needed. Since this is very expensive and time consuming we do not consider it a viable option.

have time to preview. Finally, a CBI program using individual-topic software packages will degrade gracefully—that is, if one or two micros malfunction, the software can still be run on the remaining functioning machines so that the whole CBI program does not suffer.

A long list of drawbacks is associated with individual-topic software. That many packages are available covering the same topic can be a drawback as well as an advantage. Packages on the same topic vary drastically in quality and price. It would be too time-consuming to preview all the packages available on each topic before selecting one to purchase, so purchasing decisions are usually based on factors such as descriptions available in catalogues, word-of-mouth recommendations, reviews published by educational computing magazines, or reviews conducted by agencies such as EPIE. Since there are so many new individual-topic software products being produced, agencies like EPIE are not even able to keep up with them; in fact, it would be quite unmanageable to read all of the EPIE software reviews available in a subject like mathematics.

Another drawback centers around copyright restrictions. When an individual-topic package is purchased, the buyer agrees that it will only be used on one specific micro. To make multiple copies of the software and distribute it among all the micros in a CBI lab is illegal. Many software companies enforce the copyright laws by selling copy-protected diskettes which cannot be duplicated. To be forced to purchase multiple copies of the same software package for all of the micros in the CBI program can get very expensive. Even if multiple copies of a particular package were available, another drawback concerns the logistics of distributing 20 or 30 diskettes so that they can be loaded onto each micro in a CBI lab before any learning can take place. Distribution and collection of diskettes for seven or eight periods a day can create significant disruptions in a CBI lab.

Perhaps the most important drawback is individual-topic software packages is that virtually no information is available on the effectiveness of these packages. This is easy to understand. With so many individual-topic packages on the market it is literally impossible to conduct rigorous evaluations of an appreciable number of them. Some perceptive reader might ask why publishers of software do not commission evaluative studies of their products before marketing them. One reason is that to conduct a careful evaluation of the effectiveness of a product is both time-consuming and expensive. Another reason is that publishers do not want to risk a poor evaluation of one of their own products.

Avoiding False Economies

We would like to conclude this major section by offering a warning about two tactics which, in the short run, may result in saving money, but in the long run may result in wasted resources. One quandary will likely be the issue of choosing between the substantial initial investment associated with purchasing hardware/software for an extended software package or the more modest initial investment associated with purchasing hardware/software for a CBI program which uses individual-topic software packages. We point out that even though the initial investment for an extended software package and a minicomputer may appear to be high, the actual cost-per-student-hour may be lower than that for a library of individual-topic software packages and the equivalent number of microcomputers.

The second practice which we advise against is the "let's buy brand X to match what we have." Often a school will have a small number of a certain brand of microcomputer. The two Apple IIe or the three Radio Shack TRS-80 micros that may reside at two hypothetical schools may have been the result of equipment donations by local businesses, or perhaps the result of a small excess in the school's budget at the end of some year. A school or school system which has significant funds available to purchase hardware and software to initiate a CBI program should plan their CBI program by giving careful consideration to the issues discussed in this article. To center a new CBI program around a small number of micros and a small software library just so that these resources do not "go to waste" is very unwise.

Implementation of The CBI Program

Implementation of a CBI program also requires careful planning. Before the implementation phase can be appropriately planned, the following questions have to be answered: How many terminals (i.e. either microcomputers or terminals connecting to a minicomputer) will there be in the CBI program? Is there adequate housing available for these terminals? If a minicomputer in the CBI program requires air conditioning, has the appropriate location been identified? If there will be terminals in more than one school, is there adequate space to house them in all of the schools? Have there been safeguards installed to prevent sudden electrical power surges which can raise havoc with computers? If the CBI program requires networking several micros, has the appropriate wiring been installed? If the CBI program consists of an extended software package running off a central minicomputer, has the appropriate wiring been installed so that the terminals can communicate with the minicomputer? And in those cases where the terminals reside in a different building from the minicomputer, have the phone lines and modems been installed to allow communication with the minicomputer? If these questions are not considered with enough lead time, the entire CBI program could be delayed for months due to some uncontrollable event, such as delays by the phone company in installing the necessary phone lines needed to communicate with a minicomputer.

A mechanism must also be in place for servicing hardware. Considerable wear-and-tear is associated with hundreds of students working on the computers on a daily basis. Without the ability to service equipment quickly and efficiently equipment breakdown can cripple a CBI program. The need for efficient maintenance is more crucial with a minicomputer-based program; since the minicomputer is at the core of the entire system, any malfunctions will bring the entire CBI program to a halt. There are two common methods for dealing with maintenance. One is for the school system to hire a technician whose job consists of keeping the hardware in the CBI program running smoothly. The other is to purchase a maintenance agreement with the company or local store from which the computers were bought. In either case, maintenance is an expensive but necessary item in every CBI program and care should be taken to budget the funding for it.

Another important consideration is the logistics of cycling the students through the terminals in an orderly fashion. In pull-out program where students receive 10 minutes per day of computer instruction, there has to be careful scheduling maintained to ensure that the duty cycle of the terminals is high, and that students do not waste time traveling to and from the terminals. In the case of a program using individual-topic software packages, there should be a regimented and efficient procedure for the students to sign out and return the diskettes at the beginning and end of every CBI session; the lack of such a procedure will result in lost or damaged diskettes as well as inefficient use of the students' and the computers' time.

Before a CBI program can be implemented, the teaching staff that will be using it must be adequately trained. If, for example, the computer will be used for math instruction in a moderate size school, there will likely be between 5 and 10 teachers who will use CBI as part of their curriculum. It is very likely that all of these teachers will require training in the use of the CBI facility. This training may take a substantial amount of time. If the teachers do not have much spare time, this training may present some difficulties. The questions that have to be considered here are: How many teachers will require training? How will the training be coordinated so that all teachers participating in the CBI program are adequately prepared by the time the CBI program is implemented? Who will carry out the training? Will teachers be compensated for the time they spend in training either by academic credit or additional salary? Will the training be carried out locally or at some remote location such as a community college or university?

Training considerations largely depend on the type of CBI program chosen. With a pull-out program in which the CBI facility is managed by a computer resource teacher, the training required of the content-area teachers will likely consist of instruction concerning integration of the computer with the curriculum. A CBI program centered around individual-topic software packages will likely require that teachers receive substantial training. There are several reasons for this. Since programs based on individual-topic software are not as cohesive as programs based on extended software packages, the content-area teachers will need to be much more familiar with the actual content of each package in the software library. Further, if an individual-topic software CBI program is managed by the content-area teachers and not by a computer-resource teacher, these teachers will need to be familiar with all the idiosyncrasies of the different software packages so that the teacher will know exactly what to do when a computer "hangs up" on a particular student

Teacher training can be conducted in a number of different ways. One approach is to have the computer-resource teacher(s) or the school's computer-coordinator perform the actual training at the school where the CBI facility resides. The obvious advantage with this approach is that the teachers can get hands-on experience with the actual computers that they will be using. Another approach is to hire a computer training consultant to conduct the training program. There are two other choices worthy of consideration. One is to investigate the educational computing courses at the local colleges and universities. There may be an excellent selection of courses at a nearby university which can be supplemented with local training to suit the needs of the teachers. The second choice is to obtain the training by means of a teacher-outreach educational program. There are teacher computer-education outreach programs (one such program at Leslie College in Cambridge, Massachusetts has an excellent reputation) whereby an instructor travels to the local school system on a few weekends to provide intensive training on certain preselected topics.

Evaluation of The CBI Program

After the CBI program has been implemented, periodic evaluations must be conducted to assess the program's effectiveness. the evaluation component will serve several functions. First and foremost, it will determine whether or not computer instruction results in student gains which are significantly* higher than the gains achieved without CBI. If the gains achieved by using CBI are not significantly higher then the CBI program should be scrutinized to see where improvements can be made. Caution should be taken to assure that the scrutiny is complete. It may be that the program's lack of effectiveness is not due to the choice or quality of the subject matter covered by CBI but rather to the way the CBI program has been implemented; one possible cause of the lack of effectiveness could be that students need to spend more time on the computer than the time they are currently allotted. On the other hand, impressive gains achieved by the CBI will help to justify expanding the CBI program to include more students and more schools within the system.

The evaluation process itself must be designed carefully. If there is a flaw with the evaluation design, any findings, whether pro or against CBI, will be totally meaningless. We now mention the components that should minimally be included in evaluating a CBI program, and strongly advise that a school system seek the expertise of a statistical evaluation specialist when planning the evaluation component. In evaluating whether one method for doing anything is better than another method, there must be a "treatment group" and a "control group." For the case at hand, the treatment group consists of students receiving computer instruction. The control group consists of students who are not receiving computer instruction. In the event that all students in a school or in the school system are receiving computer instruction, then the control group can be comprised of students from previous years who were not part of any CBI program; if this is the case, however, the treatment group must be appropriately matched to avoid a design flaw. That is, one has to make sure that the students from the treatment group are not being compared to a control group comprised of students who received instruction at a school different from that in which the treatment group is enrolled.

The most typical form of evaluation is to select some standardized measure of achievement, such as the California Achievement Test, and administer it to both the treatment group and the control group. Differences in the performance levels of these two groups are then evaluated for statistical significance. The school system may choose to develop their own assessment test to use in the evaluation process. The locally developed assessment test may provide more flexibility in measuring areas which may be of specific interest, such as ability to solve mathematical word problems. We have a word of caution to offer in cases where a locally developed assessment test is used, namely that before this instrument is used in the evaluation, it must be validated for reliability, where we use "reliability" in the statistical sense.

We use "significantly higher" in the statistical sense. That is, do the gains achieved by the CBI students exceed the gains achieved by students not receiving computer instruction by a margin large enough that it could not have happened by accident.

Concluding Remarks

It should be evident from the previous sections that planning a computer-based instructional program is a major undertaking. To make well-informed decisions requires expertise covering topics in curriculum, hardware, software, implementation, and evaluation. We will now offer some suggestions on finding possible sources of information to help in the decision-making process, and on finding possible sources of financial support to help in the implementation phase.

The expertise provided by consultants can be a valuable source of information. Initially consultant fees may appear to be expensive but in the long run the investment can result in substantial savings of both time and money. A good consultant, if provided with the constraints that the school system wishes to impose on their CBI program, can provide advice on which CBI programs could prove effective, on hardware/software issues, and on financial sources which could be tapped to support the CBI program. What is more difficult to state is how one goes about finding a "good" consultant, or more appropriately, a consultant to meet the needs of the school system. There is no "best way" to search for a consultant—we can only suggest that the following organizations be asked to recommend possible candidates: 1) Universities with reputable "computers in education" programs, 2) School systems with successful CBI programs, and 3) Federally funded education labs and centers with "technology" programs, such as the Educational Technology Center at Harvard University or the Appalachia Educational Laboratory.

There are four other sources of information which we strongly recommend. The first consists of visiting schools which have successful CBI programs. Site visits are the best opportunity to assess whether a similar program is feasible at one's own school. Further, site visits are very useful for identifying not only what features make that particular CBI program effective but also what mistakes (if any) were made in designing and implementing the program so that these are not repeated. A second source of information is the articles and reviews that appear in the numerous educational computing magazines available today. A third source is various publications distributed by professional organizations such as the National Council of Teachers of Mathematics. Finally, the many conferences held each year under the general rubric of "computers in the classroom" can be quite informative.

We have a number of suggestions to help defray the costs of implementing and operating a CBI program. Collaborations between several school systems/districts can be financially advantageous. For example, since a minicomputer can service several remote sites, two or more school systems could share the costs of establishing a joint CBI program based on an extended software package. School systems could also form purchasing collaboratives and negotiate attractive purchasing agreements that would result in significant discounts on hardware/software. Another possible source of funding are Federal programs; although monies from many Federal programs cannot be used to purchase equipment, they can be used to defray the costs associated with personnel and operating expenses. Finally, we strongly urge that school systems seek support from the local private sector. Local business and industry are usually overlooked as a source of funding, however, they are often favorably disposed toward supporting worthwhile "causes" that serve to enhance their community image.

Up to now, no mention has been made of the important role that establishing the appropriate channels of communication plays in the success of a CBI program. The planning, implementation and operation stages can be greatly facilitated if the program gains acceptance and support from parents, teachers and the school system's administration. To achieve acceptance and support, we suggest the following: 1) A written summary of the plan should be disseminated which states the purpose for establishing a CBI program and the program's intended goals, 2) When the CBI program is implemented, an "open house" should be held to show parents the facility, and to explain to them both the type of CBI program that their children will be using and the expected benefits of the program, and 3) The findings from studies evaluating the program's effectiveness should also be disseminated. We should be aware that computer-based instruction can be intimidating, especially to a teacher who may fear that a computer may someday replace him/her. Keeping all interested parties well-informed will not only help ameliorate fears but also help the program gain acceptance.

We have covered quite an extensive list of issues that should be considered whey planning a CBI program. As formidable as the task may seem, farsighted educators must recognize that the use of computers in education will continue to grow at an ever increasing pace over the next few years. It is therefore imperative that care, vision and sensitivity be exercised in shaping the future of using new technologies in education.

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Appendix A

Needs Assessment Process Manual

Activity 1: An Overview of the Conference—Its Purposes and Processes.

Welcome to the State Conference on Educational Needs Assessment for teachers using microcomputers in the teaching of basic mathematics. This conference is sponsored by AEL, the Appalachia Educational Laboratory, and NIE, the National Institute of Education.

This conference is one of four being conducted in the states of Kentucky, Tennessee, Virginia, and West Virginia. It is a part of the Technology and Basic Skills (TABS) Program of AEL. The purpose of the program is to identify needs of teachers using microcomputers for instruction and to provide some assistance in coping with those needs.

Unlike many of the traditional teaching tools, the microcomputer presents new problems and issues that are outside the experience of many experts in education. Rather, expertise in the use of microcomputers for instruction lies with teachers such as you who have pioneered the use of this exciting new tool. Thus, you have an important perspective regarding the needs of teachers involved in instructional computing. We want to know how you perceive those needs, and so we have convened this conference for that express purpose—to learn what you consider to be the most important issues regarding the use of microcomputers for instruction—particularly in the basic mathematics classroom.

Before going any further, let's see who you are. You'll discover that you have some things in common. Each of you has used computers in the classroom. You are all teachers of mathematics. And, of course, you are all from the same state. On the other hand, there are some differences among you. You teach students at different grade levels. You teach at schools of varying size located in diverse kinds of communities. You use different kinds of computers and various software programs.

Let's now take a few minutes to meet each other and to find out where we're from and what some of those differences are. Let's begin our introductions with...

(A round of personal introductions)

Again, thank you for coming. In inviting you to this conference, we have tried to bring together experienced computer-using teachers and, at the same time, assemble a group representative of the diverse educational settings in the state.

As the "experts" in the field, we hope you can help us identify answers to the question that drives this conference:

> "What, as a group, do you consider to be the most important needs of teachers using microcomputers in teaching basic mathematics."

Now a word or two about the processes we'll be using to address our guiding question. Between now and mid-afternoon today when the conference adjourns, six important activities will take place. You will be intimately involved in all six of these activities, and taken together, they will result in a major product: a display of what you, as a total group, consider to be the most important needs of computer-using teachers of this state—particularly regarding basic mathematics instruction.

Here's a list of the six activities that will comprise the conference:

1. An overview of the conference—its purpose and processes
2. Generating initial need statements in four small groups
3. Searching for clarity and understanding within each group
4. Confirming clarity across the groups
5. Preparing each group's product—a set of refined need statements
6. And, then rating the importance of the needs described in the need statements.

The first five activities will comprise this morning's session. The sixth activity will be our major activity this afternoon.

During the lunch hour, we will introduce a somewhat different perspective. At that time, we will share with you some information about AEL as well as more details regarding the TABS program. We will explain how the needs you will identify today will become the basis for the development of practical solutions to help teachers, such as yourselves, to cope with those needs.

For several reasons, we think you'll appreciate the specific processes that we'll be using during the conference:

First, in about 6 hours, the processes will move us from a blank sheet of paper—in fact, many blank sheets of paper—to a list of educational needs and a clear indication of their relative importance.

Second, the processes are group processes, so they are designed to produce a final product that is more than a simple collection or aggregation of each person's individual input.

Third, the processes require you to structure your input in particular ways, so that the resulting information can be generated efficiently and presented most usefully to those who await it.

Fourth, in the interest of producing a product that is truly a group product, the processes require public display and review of much of your deliberations.

Fifth, and perhaps most important, the processes require you and the conference staff to view each other in very specific ways.

You are the "content experts" in this conference—or, to put it another way, we look to YOU for the substance of our conference.

In effect, then, YOU have the content, WE have the processes. Together, we can create an effective conference and a useful product for those concerned about improving education in this state through the use of computer assisted instruction.

Let us now proceed to Activity 2.

Activity 2: Generating initial need statements in four small groups

This is the first substantive activity of the conference, but before we begin it, you need a little more information:

- about what we mean by a "need statement," and
- about the particular procedures we'll be using to generate these need statements.

If someone were to ask you right now to identify your greatest need, you'd probably answer in a word or two. For instance, you might answer with the phrase, "more authority on the job." You might identify "a new car" as your greatest need, or you might simply respond, "a cup of coffee." Think about each of these answers to the question, for each of them probably identifies a prescription or solution to a need rather than to the need itself. For instance, you need "money" because that may be the best way to obtain something that you don't now have. And you need "a new car," not just to have a new car, but rather because you need to get from here to there.

The point is that when we're asked to identify needs—whether our own or someone else's—we typically identify prescriptions or solutions rather than explicit needs. Our answer to the question, "What do you need?" is usually not a need at all, but rather a specific way of satisfying some need that really remains unarticulated.

The danger in identifying prescriptions rather than needs is twofold:

First, the need itself remains implicit, unarticulated, and assumed, so we can never test to see if it really is a need.

Second, there are many different ways to meet the same need, and tunnel-vision on a particular prescription literally blinds us to considering those many alternatives.

Thus, throughout our work today, we want to avoid prescriptions as much as possible, and we want to focus instead on actual needs.

To help us do that, we're going to—quite arbitrarily—think of a "need statement" as consisting of three parts or components:

1. a **referent** or a broad topic about which we want to describe a particular need
2. a description of **what is** with respect to that particular referent or topic, and
3. a comparable description of **what is preferred** with respect to that same referent or topic.

Here, for example, are three illustrative **need statements**, any one of which might have been generated by several of us today:

Referent	**Description of what is**	**Description of what is preferred**
1. Current room temperature	It is now 75 in this room.	That is be only 68 in the room.
2. Interest rates in the U.S.	Interest rates are currently running at 11-13 percent.	That rates be no more than half their current rate.
3. My kids	They are many miles from here.	That we be together in the same place.

Note several characteristics about these three illustrative **need statements**:

First, note that the three parts of the need statements—that is, their **referent**, their descriptions of **what is**, and their descriptions of **what is preferred**—are interrelated to each other.

Second, note that assertions about **what is** lend themselves relatively easily to empirical evidence; assertions about **what is preferred** do so much less directly.

Third, as a consequence of the distinctions just drawn, you are likely to accept or not accept as factually correct assertions about **what is**, whereas you may agree or not agree with assertions about **what is preferred**.

Fourth, in each of the above illustrations, the combined assertions about **what is** and **what is preferred** describe a discrepancy or gap, and that is exactly how we want to think about "needs" during the next few hours. **A need (or need statement) describes a discrepancy between what is and what is preferred.** It does not describe a prescription, solution, or action to meet some unarticulated need.

Because this definition of a need is so important to the process we'll be using during the conference, it's probably worth repeating:

A NEED (OR NEED STATEMENT) DESCRIBES A DISCREPANCY BETWEEN **WHAT IS** AND **WHAT IS PREFERRED**.

Fifth, note that each assertion about **what is** can stimulate a variety of different assertions about **what is preferred**: similarly, the same assertion about **what is preferred** can be matched with assertions about **what is** that differ dramatically in degree, if not in kind. All of which underscores the importance of being careful as we can when we try to articulate what we perceive to be needs.

Last, note that historians heal with assertions about the past; futurologists with assertions about the future. For our purposes today, our assertions will be about present conditions—**what is** and **what is preferred**.

Let's practice for a few moments on this distinction between assertions of **what is** (A) or **what is preferred** (B):

Indicate in the blank before each statement whether the statement asserts **What is** (A) or **what is preferred** (B):

1._____Flights into Chicago-O'Hare are rarely on time.
2._____I wish the waitress would bring coffee without my having to ask for it.
3._____The world is a most unsettled place today.
4._____The service during last night's dinner was excellent.
5._____I'd like very much to return to the same restaurant tonight.
6._____State employees received a 6 percent salary increase last year and will probably receive another 6% this year.
7._____For my money, nothing's worse than a bed that's too soft.
8._____There are 32 persons in this room right now.
9._____There ought to be a law against things like that.
10._____There already is.

Now, let's go over your responses and see how you described each assertion.

(review response)

Now, you will generate a few assertions of your own. In the space below, write two statements that describe **what is, either with respect to the world out there—which includes others—or with respect to yourself.**

1.

2.

Let's take a moment to go over your responses.

(review responses)

And now, write two statements that describe **what is preferred**, again either with respect to the world out there or with respect to yourself. For the sake of consistency, begin with the word "that." You might want to relate the "that" statements to the "what is" statements you have just written.

1.

2.

Again, let's take a moment to go over your responses.

(review responses)

Finally, using the format presented on the next page, generate one need statement directly related to computer-assisted instruction. As you do, keep in mind the characteristics of need statements discussed earlier (pages 2.2 and 2.3).

Referent	Description of what is	Description of what is preferred

How did you do? Let's share some of these—not so much for the content, but rather for their format as need statements.

(review responses)

Now that we've developed a format for stating needs, we're ready to begin to tackle the big question:

"What, as a group, do you consider to be the most important needs of teachers using microcomputers in teaching basic mathematics?"

To get at this question, we're going to divide into four small groups, each of which will have 5-7 members and each of which will work simultaneously through the same set of procedures for the rest of the day. Within each of the four groups, which we've creatively labeled A, B, C, and D, we want as many perspectives presented as possible. To that end, we have preassigned each of you to one of the four groups. Your particular group assignment, along with the perspective you represent, is indicated on your name tag.

You should also notice that we have set up four "stations" in this room. Already formatted on a large piece of butcher paper at each station is the three-part structure of a need statement: a space for identify a **referent**, a space for writing a **what is** assertion about that **referent**, and a space for writing a comparable **what is preferred** assertion (beginning with "that") about the same referent. You'll also notice that each of the four stations has been designated A, B, C, or D so that you can find your particular group's station.

When you're given the signal to disperse, go to your station, meet the other members of your group, and, as soon as you can, designate someone within the group to serve as the group's initial "recorder."

- The job of a recorder is just that—to record or transcribe directly on the display chart before the group all of the statements of need that are contributed by the other members of the group.
- It is not the job of the recorder to edit any of the statements or to question their veracity or value. Rather, the recorder's responsibility is simply to record as faithfully as possible—verbatim, if necessary—the need statements offered by each group member. In fact, the recorder should check regularly to make certain that what has been recorded matches accurately what was intended by each contributor.
- Each need statement should be written legibly and large enough so that it can be easily read by all members of the group. Number each statement as it is added to the list. When you fill up a sheet of paper, rehang it off to the side, but still within sight of the group. Let us know if you need more paper.
- The job of the recorder should probably be rotated among group members, both to share the task equitably and to give the recorder ample opportunity to be a contributor to the list of need statements and not just a transcriber of them.
- Finally, the recorder should use the black marker to record these statements.

The name of the game here is group productivity—that is, generation within each of the four groups of a large number of statements of need. The task is essentially a brainstorming one, so the usual rules associated with brainstorming should be followed:

- No questioning of the meaning or clarity of statements offered. Either make mental notes or make notes on the sheets of paper provided in the packet. There will be ample time later to raise questions and seek clarification but to do so now will inhibit both the process and willingness of group members to contribute.
- Similarly, no evaluation—either verbally or non-verbally—of any statements contributed. Nothing will turn off group members faster then "put-downs" that make them wish they'd kept their mouths closed in the first place.
- No idle chatter that diverts the group from its production task.

Naturally, the pace of group contributions will depend largely upon the pace of the recorder and the ability of other group members to keep on task and fill every available moment with contributions. As a group member, be ready to contribute a new need statement as soon as the recorder has completed the current one.

Are there any questions?

If not, move to your stations, meet your colleagues, identify an initial recorder, and begin generating as many answers as you can to this question:

"What, as a group, do you consider to be the most important needs of teachers using microcomputers in teaching basic mathematics?"

Activity 3: Searching for clarity and understanding within each group

The goal of the prior activity was to generate in each of four groups as many need statements as possible in a relatively short period of time. Because the activity was essentially a production task, we ask you to avoid discussing the items as they were generated, even if you did not fully understand them or agree with them. This prohibition was designed, of course to increase group productivity—not just intimidate you or devalue your participation as a group member. Now, however, is the time to address the question of clarity and understanding.

For this third conference activity, we'd like you to remain with your original group, and, in a collaborative effort among all group members, we'd like you to revisit each of the need statements generated in your group. Discuss each statement, particularly with the person who generated it, and edit it to increase clarity, striving continually to develop a common, shared understanding of its meaning.

Whereas the prior activity called for minimal, overt group interaction, this next activity calls for maximum interaction among your group's members as together you work to increase the clarity of each need statement. Note though that the focus of group attention should be on the meaning of each statement, not on the truth or value of its assertions.

To carry out this search for clarity and understanding, we ask you to engage in the following sequence of activities in your group:

First, identify a member of the group who is willing to serve as a kind of "moderator" during this search for clarity and understanding. The moderator's primary responsibility will be one of keeping the group on task, guiding discussion of each item, soliciting reactions and comments—especially from those who originally contributed the items—and generally helping the group achieve consensus on the meaning of each need statement. This responsibility is certainly not awesome, but it is important to the group's effective functioning. OK, please identify a moderator. **Moderators, raise your hand.**

Second, identify another member of the group who is willing to serve as recorder during this clarifying task. As discussion of each need statement suggests the need to revise, add, or delete words or phrases in the original referent or in the original assertions of **what is** or **what is preferred**, it will be the recorder's responsibility to catch up these suggested changed directly on the display chart—striking out words, adding new ones, reorganizing phrases, or, if necessary, drafting entirely new statements. Make these modifications using the red marker, so that group members can distinguish easily between the original need statements and their revisions. OK, please identify a recorder. Recorders raise your hand.

Third, to get the process going, individually rate on a piece of paper, the clarity of each of your group's original need statements. Read each complete need statement carefully—that is, each referent and its comparable assertions about **what is** and **what is preferred**—and, on that reading, rate the clarity of each complete statement on a simple three-point scale:

3: This need statement is **quite clear**; I think I understand it.

2: This need statement is **moderately clear**, but I do have a question or two about its meaning.

1: This need statement is **pretty hazy**, and I have lots of questions about its meaning.

Fourth, process each of the original need statements, focusing on them one at a time. Share verbally your individual ratings of clarity as you review each need statement, for the numeric ratings will enable you quickly and easily to see which need statements are relatively clear to all and which require further discussion and revision. Analyze the ratings carefully. Raise questions. Suggest alternative phrasing. Invite the person who originally generated the item to explain points that are unclear. And, with the assistance and agreement of that individual, edit the statement as necessary to increase its clarity.

The goal is two-fold:

- to achieve reasonable consensus among group members on the clarity of each statement, and
- to make certain that the intended meaning of each statement will be reasonably clear to others **outside** the group who have not participated in its deliberations.

To increase the chances of achieving that goal:

- Add examples and illustrations to assertions that are general.
- Make certain that the **what is** and **what is preferred** assertions clearly address the same referent. If a need statement—or even part of it—seems to address two different referents, either split it out into two different need statements, or clarify the relationship between the assertions.
- If a need statement really presents prescriptions rather than assertions of **what is** or the desirability of **what is preferred**, work backwards to the needs that those prescriptions are designed to meet.

Throughout this search for clarity and understanding, avoid discussing the truth of **what is** or the desirability of **what is preferred.** The purpose here is to search for meaning, not for truth or value. By the same token, of course, if this search for clarity stimulates new need statements or alternatives to those already on the group's list, by all means add them to the list and process them for clarity in exactly the same way you have processed all of the other need statements.

A final suggestion before we begin. The rating activity with which you begin the search for clarity is an individual task. Rate the statements on first impressions of clarity using the rating scale. Don't take too much time on the rating process. Then begin consideration of each statement by quickly sharing the ratings, to determine if editing is needed. Pass over those with a predominance of 3 ratings.

Activity 4: Confirming clarity across the groups

At this point, we want to reorganize our four groups for a few moments and test briefly and clarity of the need statements generated and refined in each of the groups.

To do this, we ask that three members of each group—excluding those persons who served as moderator and recorder during the search for clarity—volunteer to scatter themselves among the other three groups. Then when the new groups are constituted and people have had a chance to meet each other, we ask the three visitors to each group to do the following:

- With the assistance of the moderator and recorder who can help you through the editings that have been made, read each of your new group's need statements. Essentially following the same procedure you used earlier in your own group, rate the clarity of each need statement on the same three-point scale.
- While you are rating the clarity of the various need statements, discourage the group's original members from adding verbal clarifications that are not stated explicitly in the written statements before you.
- When you've read and rated each statement, share your ratings with the group, and, even more important, share your reasons for those ratings. Work together through each item, and share with the group's original members your sense of what each statement communicates and how clearly it does so.

For those of you who are receiving these reactions to your group's edited need statements, take careful notes using the green marker on the display chart. You may not want to edit the statements permanently, preferring to await the return of your three absent group members, but do try to catch up somewhere the essence of the reactions and suggestions that your three visitors have to the clarity of your group's need statements.

The intent here is certainly not to find fault. Rather, it is to bring to each need statement the perspective of at least three individuals who have not been a party to your group's deliberations, but who, in their own groups, have worked just as hard as you have to maximize the clarity of a comparable set of need statements. By and large, this visit by three strangers ought to confirm the general success of your group's earlier search for clarity.

Let's see if it does. Identify the three group members who will scatter, send them on their way, welcome your three visitors, and take advantage of their willingness to test the clarity of your group's need statements. Remember, do not spend a lot of time on the rating activity! Go to it!

Activity 5: Preparing each group's product—a set of refined need statements.

Now that each group has taken full advantage of its three visitors and has received from them the reactions and suggestions they have to offer, let's reconstitute the original four groups and move into this fifth activity of the morning.

When your group is again together, take a final look at your need statements. Refine them as necessary or desirable in light of the reactions and suggestions offered by the three visitors who reviewed the statements. Focus particularly on those statements (or parts of statements) that appeared to have presented the greatest problems of understanding for the visitors and on those statements that have been edited as a result of the visitors' reactions.

Then, when you're satisfied with your group's product, please write each need statement on the forms using the black pens provided. Identify the need statement in the upper left-hand corner of each form with a combined letter and number (for instance, B-1, B-2, and B-3 for the first three need statements in Group B).

Please prepare these forms—which represent your group product—as neatly as possible, for copies of them will be used in this afternoon's activity. We suggest that the moderator assign 3-4 statements to each group member to divide the transcribing task. *Do not fill in the rating portion of each form, i.e., leave the right-hand column on the form blank.*

OK, take that final look at your need statements, review the revisions suggested by your three visitors, and then prepare your group's set of forms. At 12:30 we hope to be finished with this last activity of the morning. While we are having lunch, assistants will make each of you a copy of all four group's statements for use after lunch.

Activity 6: Assessing the importance of needs described in the revised need statements.

We're now ready to assess the importance of the needs described in each statement produced this morning.

We want you individually to draw your own conclusions and to rate the importance of the needs described in each need statement.

When you are rating the importance of the items, consider:

- The personal priority you place on that need, and
- the potential impact on the state if that need can be met.

Each of you has been given an envelope containing the full set of need statements produced by all four groups. Before you begin marking the scale on the right-hand side of each statement, we would like to mention a few points to keep in mind.

- The scale measures the level of importance you as an individual assign to the need expressed in the statement—from a high level of importance to a low level of importance.
- There are also question marks at the bottom of the scale. You should circle the question marks (a) when you feel the statement is unclear, or (b) when you feel that you don't understand the statements well enough to be rated.
- Please try to take full advantage of all five points on the scale. Avoid the tendency to rate the statements always at the extreme high or extreme low ends of the scale.
- Expect redundancy among the statements, since there will be repetition from group to group. Rate all items, even if you feel you have rated one previously that was the same or very similar.
- When you have completed rating all of the need statements, please put them back in their envelope.

Before you leave, we have one final request. Please fill out the conference evaluation form included in your envelope and return it along with the rated need statements. Thank you for all your effort today.

Appendix B

List of Need Statements from Conferences

KTA01 REFERENT: Software topics
WHAT IS: All tests alike in class because computer not used
PREFERRED: Tests be different through computer generation
RATING 2.68
STANDARD DEVIATION 1.04

KTA02 REFERENT: Software criteria
WHAT IS: Producers don't get input from teachers
PREFERRED: Producers get input from teachers
RATING 4.57
STANDARD DEVIATION 0.66

KTA03 REFERENT: Software topics
WHAT IS: Students weak in computational skills
PREFERRED: Software be available to improve computational ski
RATING 4.00
STANDARD DEVIATION 1.17

KTA04 REFERENT: Software topics
WHAT IS: Most software drill and practice
PREFERRED: More software for solving word problems
RATING 4.35
STANDARD DEVIATION 0.65

KTA05 REFERENT: Software topics
WHAT IS: Problem solving programs lack tutorials
PREFERRED: Tutorial software in problem solving be available
RATING 3.75
STANDARD DEVIATION 0.94

KTA06 REFERENT: Planning/direction
WHAT IS: Most teachers need help in using new programs
PREFERRED: Resource person be available to provide help
RATING 3.96
STANDARD DEVIATION 1.15

KTA07 REFERENT: Teacher incentives
WHAT IS: Teachers do not have time to preview software
PREFERRED: Teachers be given time to review available softwar
RATING 4.00
STANDARD DEVIATION 1.04

KTA08 REFERENT: Software preview
WHAT IS: Vendors do not allow software preview
PREFERRED: Vendors allow preview of software
RATING 4.57
STANDARD DEVIATION 0.73

KTA09 REFERENT: Planning/direction
WHAT IS: Administrators don't involve teachers in comp plan
PREFERRED: Administrators seek teacher input in planning
RATING 4.17
STANDARD DEVIATION 0.78

KTA10 REFERENT: Funding
WHAT IS: Each school district buys computers on their own
PREFERRED: Schools be provided funds for equality of purchase
RATING 3.83
STANDARD DEVIATION 1.06

KTA11 REFERENT: Training, specific prog
WHAT IS: Most teachers unaware of classroom management soft
PREFERRED: Teachers be made aware of and trained in Cl.Man.So
RATING 2.9[illegible]
STANDARD DEVIATION [illegible]

KTA12 REFERENT: [illegible] access, student
WHAT IS: Some [illegible] funded computers restricted in use
PREFERRED: Computers be used most efficiently
RATING 3.86
STANDARD DEVIATION 1.21

KTA13 REFERENT: Training, computer use
WHAT IS: Many teachers don't know how to use computers
PREFERRED: Training in use be provided to those who need it
RATING 4.50
STANDARD DEVIATION 0.67

KTA14 REFERENT: Software criteria
WHAT IS: Available software not relevant or challenging
PREFERRED: Software be more relevant to student needs
RATING 3.61
STANDARD DEVIATION 1.16

[illegible]5 REFERENT: Computer literacy
WHAT IS: Many seniors have not used computers
PREFERRED: Computer literacy course be available to all senio
RATING 4.06
STANDARD DEVIATION 1.11

KTA16 REFERENT: Software topics
WHAT IS: Students view computer use as fun and games
PREFERRED: Less game software be available
RATING 2.26
STANDARD DEVIATION 1.42

K[illegible]7 REFERENT: Software topics
WHAT IS: Much math software is garbage
PREFERRED: More quality math software be available
RATING 4.48
STANDARD DEVIATION 0.79

KTA18 REFERENT: Software topics
WHAT IS: Students have no skills in problem solving with co
PREFERRED: Students develop skills in computer problem solvin
RATING 3.64
STANDARD DEVIATION 1.09

KTA19 REFERENT: Hardware access, student
WHAT IS: Basic math students not allowed in programming cla
PREFERRED: Basic math students be allowed in programming cla
RATING 2.45
STANDARD DEVIATION 1.10

KTA20 REFERENT: Training, specific prog
WHAT IS: Many teachers do not understand LOGO in math curr
PREFERRED: Training be provided in use of LOGO in math curr
RATING 3.23
STANDARD DEVIATION 1.07

KTA21 REFERENT: Training, specific prog
WHAT IS: Many teachers do not understand pilot in math curr
PREFERRED: Teachers provided training in pilot in math curr
RATING 2.82
STANDARD DEVIATION 1.26

KTA22 REFERENT: Training, instruction use
WHAT IS: Most teachers frustrated in incorporating computer
PREFERRED: Teachers learn methods of incorporating computers
RATING 4.00
STANDARD DEVIATION 0.98

KTA23 REFERENT: Software access
WHAT IS: Much software available only for certain computers
PREFERRED: Software be prepared for most popular makes
RATING 4.30
STANDARD DEVIATION 0.93

KTA24 REFERENT: Software criteria
WHAT IS: Little student feedback given students
PREFERRED: Provide quick feedback through use of computers
RATING 2.81
STANDARD DEVIATION 1.36

KTA25 REFERENT: Software access
WHAT IS: Many teachers use pirated copies of software
PREFERRED: Teachers purchase software responsibly
RATING 3.48
STANDARD DEVIATION 1.12

KTA26 REFERENT: Software access
WHAT IS: Software is expensive
PREFERRED: Unprotected copies of software be provided schools
RATING 4.04
STANDARD DEVIATION 0.93

KTA27 REFERENT: Software criteria
WHAT IS: Software cartridges not durable
PREFERRED: Materials more durable than cartridges be availabl
RATING 3.05
STANDARD DEVIATION 1.28

KTA28 REFERENT: Hardware access, student
WHAT IS: Basic math student scheduled too little in lab
PREFERRED: Basic math student have more time in computer labs
RATING 3.74
STANDARD DEVIATION 0.96

KTA29 REFERENT: Software criteria
WHAT IS: Software does not allow teacher editing
PREFERRED: Software allow teacher editing
RATING 4.2[illegible]
STANDARD DEVIATION 1.06

KTA30 REFERENT: Software topics
WHAT IS: Too much drill and practice software used
PREFERRED: More software be used for higher levels of learnin
RATING 3.76
STANDARD DEVIATION 1.04

KYA31 REFERENT: Planning/direction
WHAT IS: Many administrators don't understand comp in math
PREFERRED: Administrators understand usefulness of comp in ma
RATING 4.43
STANDARD DEVIATION 0.79

KYB01 REFERENT: Software topics
WHAT IS: No software to support state skills list
PREFERRED: Software be available to support skills list
RATING 4.39
STANDARD DEVIATION 0.78

KYB02 REFERENT: Software access
WHAT IS: Not enough software of quality available in school
PREFERRED: More quality software be available in schools
RATING 4.48
STANDARD DEVIATION 0.67

KYB03 REFERENT: Hardware access, student
WHAT IS: Few computers available in schools
PREFERRED: Each classroom have adequate number of computers
RATING 4.64
STANDARD DEVIATION 0.58

KYB04 REFERENT: Teacher incentives
WHAT IS: Teachers have no time to study & prepare materials
PREFERRED: Study & prep time be provided teachers
RATING 3.91
STANDARD DEVIATION 1.34

KYB05 REFERENT: Training, computer use
WHAT IS: Teachers have anxiety about using computers
PREFERRED: Teachers be trained to use computers
RATING 4.09
STANDARD DEVIATION 0.85

KYB06 REFERENT: Integration
WHAT IS: Lack of correlation between software and texts
PREFERRED: Be correlation between software and texts
RATING 4.26
STANDARD DEVIATION 0.81

KYB07 REFERENT: Training, computer use
WHAT IS: Teachers spend little time learning to use compute
PREFERRED: Hands-on workshops be available for teachers
RATING 4.43
STANDARD DEVIATION 0.59

KYB08 REFERENT: Software topics
WHAT IS: Computer use often only drill and practice
PREFERRED: Higher level thinking skills be used with computer
RATING 4.17
STANDARD DEVIATION 0.85

KYB09 REFERENT: Software criteria
WHAT IS: Some software doesn't record student responses
PREFERRED: Software provide record of student responses
RATING 3.30
STANDARD DEVIATION 1.15

KYB10 REFERENT: Planning/direction
WHAT IS: Seldom seen using computers
PREFERRED: Administrators show support of computer use
RATING 4.13
STANDARD DEVIATION 1.01

KYB11 REFERENT: Software criteria
WHAT IS: Most software does not provide student control
PREFERRED: Software provide more student control over program
RATING 3.70
STANDARD DEVIATION 0.97

KYB12 REFERENT: Software criteria
WHAT IS: Software directions lengthy
PREFERRED: Software directions be precise
RATING 3.64
STANDARD DEVIATION 1.26

KYB13 REFERENT: Planning/direction
WHAT IS: State department doesn't provide direction for CAI
PREFERRED: State department provide direction & training
RATING 4.30
STANDARD DEVIATION 1.06

KYB14 REFERENT: Planning/direction
WHAT IS: Local boards do not provide direction for CAI
PREFERRED: Local boards provide more direction & training
RATING 4.48
STANDARD DEVIATION 0.73

KYB15 REFERENT: Planning/direction
WHAT IS: Adm lack vision of importance of computers for stu
PREFERRED: Adm become knowledgeable of advancing tech
RATING 4.26
STANDARD DEVIATION 0.86

KYB16 REFERENT: Parents
WHAT IS: Parents demonstrate anxiety with computers
PREFERRED: Parents be open to trends and advancing technology
RATING 3.04
STANDARD DEVIATION 0.98

KYB17 REFERENT: Training, computer use
WHAT IS: Teachers not willing to learn to use computers
PREFERRED: Teachers develop willingness to learn to use compu
RATING 4.26
STANDARD DEVIATION 0.97

KYB18 REFERENT: Software topics
WHAT IS: Little software dealing with problem solving
PREFERRED: More software dealing with problem solving
RATING 4.22
STANDARD DEVIATION 0.97

KYB19 REFERENT: Software criteria
WHAT IS: Software producers have little input from teachers
PREFERRED: Software producers get more input from teachers
RATING 4.48
STANDARD DEVIATION 0.85

KYB21 REFERENT: Training, computer use
WHAT IS: Teachers & adm not willing to deal with computers
PREFERRED: Staff demonstrate willingness to deal with compute
RATING 4.09
STANDARD DEVIATION 0.97

KYB22 REFERENT: Software criteria
WHAT IS: Software provide for limited skill levels
PREFERRED: Software provide multiple skill levels in program
RATING 3.78
STANDARD DEVIATION 1.20

KYB23 REFERENT: Training, computer use
WHAT IS: University courses lack applications & hands on
PREFERRED: Courses include applications & hands on
RATING 4.43
STANDARD DEVIATION 0.73

KYB24 REFERENT: Software criteria
WHAT IS: Software readability difficult
PREFERRED: Software readability be at level used
RATING 3.39
STANDARD DEVIATION 1.37

KYC01 REFERENT: Hardware access, student
WHAT IS: Many schools do not have computers
PREFERRED: Each school have adequate no. of computers
RATING 4.74
STANDARD DEVIATION 0.54

KYC02 REFERENT: Teacher incentives
WHAT IS: Teacher don't have time to preview software
PREFERRED: Teachers have paid time to preview software
RATING 3.96
STANDARD DEVIATION 1.15

KYC03 REFERENT: Training, instruction use
WHAT IS: Some teachers afraid of computers
PREFERRED: Teachers feel comfortable using computers for inst
RATING 4.35
STANDARD DEVIATION 0.88

KYC04 REFERENT: Integration
WHAT IS: There is abundance of software
PREFERRED: There be easy way to correlate st.needs with softw
RATING 3.74
STANDARD DEVIATION 1.05

KYC05 REFERENT: Computer literacy
WHAT IS: Not enough time in curriculum for computer lit
PREFERRED: Students have curriculum time for computer lit
RATING 3.48
STANDARD DEVIATION 1.12

KYC06 REFERENT: Training, instruction use
WHAT IS: Teachers do not perceive computer as math T. tool
PREFERRED: All teachers perceive computer as teaching tool
RATING 3.70
STANDARD DEVIATION 1.11

KYC07 REFERENT: Software criteria
WHAT IS: Some software to complicated in start-up
PREFERRED: Software be easy to start-up
RATING 3.48
STANDARD DEVIATION 0.99

KYC0[illegible] REFERENT: Computer literacy
WHAT IS: Little curriculum guidance for computer lit
PREFERRED: Be district scope and sequence for computer lit
RATING 4.00
STANDARD DEVIATION 1.13

KTC09 REFERENT: Hardware access, student
WHAT IS: Most classrooms have only one or no computers
PREFERRED: Classes have one per child or a lab
RATING 4.26
STANDARD DEVIATION 0.96

KTC10 REFERENT: Funding
WHAT IS: Not enough money for software purchase
PREFERRED: More funds for software purchase
RATING 4.26
STANDARD DEVIATION 0.62

KTC11 REFERENT: Planning/direction
WHAT IS: Some adm have little knowlege of comp as inst tool
PREFERRED: Adm have have adequate knowledge of comp as tool
RATING 4.39
STANDARD DEVIATION 0.99

KTC12 REFERENT: Training, instruction use
WHAT IS: Many teachers have little knowledge of comp uses
PREFERRED: Teachers have knowledge of computer use in class
RATING 4.37
STANDARD DEVIATION 0.66

KTC13 REFERENT: Software topics
WHAT IS: Most Programs are drill and practice
PREFERRED: More Programs requiring higher levels of thinking
RATING 4.17
STANDARD DEVIATION 0.83

KTC14 REFERENT: Software topics
WHAT IS: Little software on each basic math skill
PREFERRED: More software for each basic math skill
RATING 3.96
STANDARD DEVIATION 1.07

KTC15 REFERENT: Training, instruction use
WHAT IS: Educators don't share ideas about computer instruc
PREFERRED: Educators share ideas about computer instruction
RATING 3.96
STANDARD DEVIATION 0.98

KTC16 REFERENT: Integration
WHAT IS: Math text try to teach programming
PREFERRED: Math texts not teach programming
RATING 2.24
STANDARD DEVIATION 1.45

KTC17 REFERENT: Integration
WHAT IS: No texts with corresponding software
PREFERRED: There be texts with corresponding software
RATING 3.83
STANDARD DEVIATION 1.40

KTC19 REFERENT: Hardware access, student
WHAT IS: Not enough OC computer time for students & teacher
PREFERRED: There be OC time available for students & teachers
RATING 4.22
STANDARD DEVIATION 0.90

KTC20 REFERENT: Hardware access, student
WHAT IS: Many schools limit computer use to gifed
PREFERRED: Computer instruction be for all students
RATING 4.48
STANDARD DEVIATION 0.95

KTC21 REFERENT: Planning/direction
WHAT IS: No compatability among hardware & software company
PREFERRED: Be compatability among hardware & software company
RATING 3.52
STANDARD DEVIATION 1.29

KTC22 REFERENT: Planning/direction
WHAT IS: Lack of hardware & software purchase policies
PREFERRED: Be hardware & software purchase policies
RATING 3.39
STANDARD DEVIATION 1.41

KTC23 REFERENT: Training, specific prog
WHAT IS: Teachers lack knowledge of management programs
PREFERRED: Teachers have knowledge of management programs
RATING 3.74
STANDARD DEVIATION 1.21

KTDD1 REFERENT: Software criteria
WHAT IS: Most software dull drill and practice
PREFERRED: Software enhance student abilities & be interestin
RATING 4.14
STANDARD DEVIATION 1.06

KTDD2 REFERENT: Software access
WHAT IS: Limited amount and variety available in school
PREFERRED: More and variety of software be available in schoo
RATING 4.09
STANDARD DEVIATION 0.90

KTDD3 REFERENT: Software access
WHAT IS: Most software overpriced
PREFERRED: More software of moderate price
RATING 3.91
STANDARD DEVIATION 0.95

KTDD4 REFERENT: Software access
WHAT IS: Limited quantity of quality software available
PREFERRED: Unlimited copying be available
RATING 4.04
STANDARD DEVIATION 1.15

KTDD5 REFERENT: Integration
WHAT IS: Software not coordinated with curriculum
PREFERRED: Textbooks produced with coordinated software
RATING 4.43
STANDARD DEVIATION 0.95

KTDD6 REFERENT: Software criteria
WHAT IS: Much software documentation too vague
PREFERRED: Better software documentation for teacher
RATING 3.63
STANDARD DEVIATION 1.03

KTDD7 REFERENT: Training, computer use
WHAT IS: Many teachers uncomfortable using computers
PREFERRED: Teacher anxiety be reduced
RATING 3.87
STANDARD DEVIATION 1.10

KTDD8 REFERENT: Training, computer use
WHAT IS: Many teachers don't want to learn to use computers
PREFERRED: All teachers be willing to learn to use computers
RATING 3.73
STANDARD DEVIATION [illegible].20

KTDD9 REFERENT: Hardware access, student
WHAT IS: Not enough hardware in some schools
PREFERRED: There be sufficient hardware in all schools
RATING 4.70
STANDARD DEVIATION 0.56

KTD10 REFERENT: Software access
WHAT IS: Software packages not available for all computers
PREFERRED: Software packages be available for all major brand
RATING 3.61
STANDARD DEVIATION 1.31

KTD11 REFERENT: Training, computer use
WHAT IS: Computer use often presented in technical terms
PREFERRED: Computer use be presented in layman's terms
RATING 3.93
STANDARD DEVIATION 1.17

KTD12 REFERENT: Hardware access, teacher
WHAT IS: Many teachers have limited access to hardware
PREFERRED: Hardware be more accessible to all teachers
RATING 4.57
STANDARD DEVIATION 0.59

KTD13 REFERENT: Training, computer use
WHAT IS: Teachers unwilling to invest time to learn compute
PREFERRED: Teachers be willing to become computer literate
RATING 3.64
STANDARD DEVIATION 1.33

KTD14 REFERENT: Integration
WHAT IS: Computer use takes time from traditional classroom
PREFERRED: Find way of integrating computer into classroom
RATING 4.00
STANDARD DEVIATION 0.98

KTD15 REFERENT: Training, computer use
WHAT IS: Most teachers using computers lack training
PREFERRED: Teachers using computers have training to do so
RATING 4.26
STANDARD DEVIATION 0.86

KTD16 REFERENT: Teacher incentives
WHAT IS: Teachers have no time to preview materials
PREFERRED: Extra time be provided to preview and view resourc
RATING 4.40
STANDARD DEVIATION 0.82

KTD17 REFERENT: Training, instruction use
WHAT IS: Colleges offer only programming classes
PREFERRED: Colleges offer courses in classroom use of compute
RATING 4.26
STANDARD DEVIATION 1.05

KTD18 REFERENT: Planning/direction
WHAT IS: No state direction in use of computers in educatio
PREFERRED: Be state direction in use of computers in educatio
RATING 4.13
STANDARD DEVIATION 0.92

KTD19 REFERENT: ?
WHAT IS: Most materials, including cups ... re outdated
PREFERRED: More modern inexpensive ... available
RATING 2.38
STANDARD DEVIATION 1.32

KTD20 REFERENT: Integration
WHAT IS: Texts do not show computers as relevant
PREFERRED: Texts show computers as relevant
RATING 2.80
STANDARD DEVIATION 1.44

KTD21 REFERENT: Planning/direction
WHAT IS: Most computer programs initiated by 1-2 teachers
PREFERRED: Computer use be planned development program
RATING 4.00
STANDARD DEVIATION 0.90

KTD22 REFERENT: Software criteria
WHAT IS: Computer programs organized & directed by non-expe
PREFERRED: Programs have input/authority from comp-experience
RATING 4.67
STANDARD DEVIATION 0.48

KTD23 REFERENT: Planning/direction
WHAT IS: No state guidelines for certification exists
PREFERRED: There be certification guidelines/requirements
RATING 3.10
STANDARD DEVIATION 1.64

KTD24 REFERENT: Software topics
WHAT IS: Most software is drill and practice
PREFERRED: More tutorial software be developed
RATING 4.09
STANDARD DEVIATION 0.90

KTD25 REFERENT: Software criteria
WHAT IS: Low quality software exists
PREFERRED: All software be of high quality
RATING 4.39
STANDARD DEVIATION 0.72

THA01 REFERENT: Training, computer use
WHAT IS: Teachers not adequately trained in use of computer
PREFERRED: Teachers be trained in the use of computers
RATING 4.67
STANDARD DEVIATION 0.59

THA02 REFERENT: Integration
WHAT IS: Little coordination between text and software
PREFERRED: Be coordination between text and software
RATING 4.44
STANDARD DEVIATION 0.62

THA04 REFERENT: Hardware access, student
WHAT IS: Space for computer labs is limited
PREFERRED: Be more space for computer labs
RATING 3.33
STANDARD DEVIATION 1.28

THA05 REFERENT: Hardware access, student
WHAT IS: Ratio of hardware to students too small
PREFERRED: Ratio of hardware to students be increased
RATING 4.33
STANDARD DEVIATION 0.59

THA06 REFERENT: Software preview
WHAT IS: Little software can be previewed before purchase
PREFERRED: More software can be previewed before purchase
RATING 4.06
STANDARD DEVIATION 0.87

THA07 REFERENT: Integration
WHAT IS: Teachers do not have time to correlate softw & cur
PREFERRED: Means be provided to correlate software with curr
RATING 4.11
STANDARD DEVIATION 0.96

THA08 REFERENT: Hardware repair
WHAT IS: Maintenance is expensive and slow
PREFERRED: Maintenance be fast and cheap
RATING 3.00
STANDARD DEVIATION 1.22

THA09 REFERENT: Ethics
WHAT IS: Users are not ethical
PREFERRED: Users be encouraged to be ethical
RATING 2.93
STANDARD DEVIATION 1.27

THA10 REFERENT: Software reviews
WHAT IS: No organized indexing of software
PREFERRED: There be indexing of software
RATING 3.61
STANDARD DEVIATION 1.24

THA11 REFERENT: Training, computer use
WHAT IS: Few teachers are able to make routine minor repair
PREFERRED: Teachers gain knowledge to make routine, minor rep
RATING 3.06
STANDARD DEVIATION 1.11

THA12 REFERENT: Hardware security
WHAT IS: In lab, users feel little responsible for equipmen
PREFERRED: Users feel more responsible for equipment in labs
RATING 2.94
STANDARD DEVIATION 0.87

THA13 REFERENT: Software access
WHAT IS: Damaged software is hard to replace
PREFERRED: Damaged software be easier to replace
RATING 3.18
STANDARD DEVIATION 0.81

THA14 REFERENT: Software criteria
WHAT IS: Little software accepts alternate responses
PREFERRED: More software accept alternate responses
RATING 2.87
STANDARD DEVIATION 0.92

THA15 REFERENT: Software criteria
WHAT IS: Management portions of software not flexible
PREFERRED: Management portions of software be flexible
RATING 3.33
STANDARD DEVIATION 0.94

THA16 REFERENT: Software topics
WHAT IS: Quality software not available for math programs
PREFERRED: Be quality software for math programs
RATING 4.33
STANDARD DEVIATION 0.62

THA17 REFERENT: Software criteria
WHAT IS: Error analysis not common in math software
PREFERRED: Be more error analysis available in math software
RATING 3.71
STANDARD DEVIATION 1.14

THA18 REFERENT: Software access
WHAT IS: Teachers unaware of or unable to get pub. dom. sof
PREFERRED: Teacher be aware of and able to get public dom sof
RATING 4.30
STANDARD DEVIATION 0.71

THA20 REFERENT: Software criteria
WHAT IS: Too many programs are electronic workbooks
PREFERRED: Fewer programs be simple electronic workbooks
RATING 3.39
STANDARD DEVIATION 1.28

THA21 REFERENT: Planning/direction
WHAT IS: Little communication among educators re use of com
PREFERRED: Be more communications among ed. regarding uses
RATING 4.00
STANDARD DEVIATION 1.03

THA22 REFERENT: Software access
WHAT IS: Few companies offer multiple copy discounts
PREFERRED: More companies offer multiple copy discounts
RATING 3.78
STANDARD DEVIATION 1.26

THB01 REFERENT: Software reviews
WHAT IS: There is too much software to evaluate
PREFERRED: A way to evaluate software easily be available
RATING 3.78
STANDARD DEVIATION 1.11

THB02 REFERENT: Training, computer use
WHAT IS: Teachers cannot handle maintenance problems
PREFERRED: Teachers be able to handle maintenance problems
RATING 3.22
STANDARD DEVIATION 0.81

THB03 REFERENT: Hardware access, student
WHAT IS: Not enough hardware for classroom use
PREFERRED: Enough hardware for classroom use
RATING 4.22
STANDARD DEVIATION 0.65

THB04 REFERENT: Training, computer use
WHAT IS: Teachers have varying levels of "computer anxiety"
PREFERRED: Teachers feel comfortable using computers
RATING 4.61
STANDARD DEVIATION 0.61

THB05 REFERENT: Software access
WHAT IS: Software reps lack training
PREFERRED: Software reps have more training
RATING 3.00
STANDARD DEVIATION 1.46

TNB06 REFERENT: Software criteria
WHAT IS: Documentation is often unclear
PREFERRED: Documentation be more clear
RATING 4.17
STANDARD DEVIATION 0.86

TNB07 REFERENT: Software access
WHAT IS: Much software is too expensive for small schools
PREFERRED: More software be less expensive for small schools
RATING 3.72
STANDARD DEVIATION 1.45

TNB08 REFERENT: Integration
WHAT IS: Little software is correlated with adopted texts
PREFERRED: More software be correlated with adopted texts
RATING 4.22
STANDARD DEVIATION 0.65

TNB09 REFERENT: Software criteria
WHAT IS: Many BSF software requires 2 disk drives
PREFERRED: BSF software not require the use of 2 drives
RATING 2.61
STANDARD DEVIATION 1.42

TNB10 REFERENT: Integration
WHAT IS: Few software programs correlate with curriculum
PREFERRED: More software programs correlate with curriculum
RATING 4.00
STANDARD DEVIATION 0.84

TNB11 REFERENT: Software access
WHAT IS: Programs purchased cannot be copied
PREFERRED: Educators be allowed to copy programs for schools
RATING 4.17
STANDARD DEVIATION 0.92

TNB12 REFERENT: Hardware security
WHAT IS: Hardware cannot be secured in many classrooms
PREFERRED: Hardware be secured in all classrooms
RATING 3.67
STANDARD DEVIATION 1.41

TNB13 REFERENT: Training, computer use
WHAT IS: Inadequate teacher training in computers
PREFERRED: Adequate teacher training in computers
RATING 4.72
STANDARD DEVIATION 0.67

TNB14 REFERENT: Hardware access, student
WHAT IS: Whole class cannot see one monitor
PREFERRED: Hardware be available to allow entire class to see
RATING 3.75
STANDARD DEVIATION 1.13

TNB15 REFERENT: Software criteria
WHAT IS: Software differs in quality
PREFERRED: Rating scale be available to assess all software
RATING 3.76
STANDARD DEVIATION 1.15

TNB16 REFERENT: Hardware repair
WHAT IS: Too few technicians available for repair
PREFERRED: More technicians available for computer repair
RATING 2.94
STANDARD DEVIATION 1.26

TNC01 REFERENT: Software access
WHAT IS: Copyright law is too restrictive
PREFERRED: Copyright law be less restrictive
RATING 4.11
STANDARD DEVIATION 1.32

TNC02 REFERENT: Training, instruction use
WHAT IS: Few teachers aware of benefits of CAI
PREFERRED: More teachers be aware of benefits of CAI
RATING 4.35
STANDARD DEVIATION 0.79

TNC03 REFERENT: Training, computer use
WHAT IS: Many teachers view computers with anxiety
PREFERRED: Fewer teachers view computers with anxiety
RATING 4.56
STANDARD DEVIATION 0.62

TNC04 REFERENT: Software criteria
WHAT IS: Management systems not available for all basal pro
PREFERRED: Management systems be available for all basals
RATING 3.59
STANDARD DEVIATION 1.23

TNC05 REFERENT: Software access
WHAT IS: Little software for secondary students
PREFERRED: More software for secondary students
RATING 3.73
STANDARD DEVIATION 1.33

TNC08 REFERENT: Integration
WHAT IS: Software not focused on specific levels
PREFERRED: Software be focused on specific levels
RATING 4.13
STANDARD DEVIATION 1.02

TNC09 REFERENT: Software reviews
WHAT IS: Teachers unaware of many quality software programs
PREFERRED: Teachers be given info regarding quality software
RATING 4.39
STANDARD DEVIATION 1.37

TNC10 REFERENT: Integration
WHAT IS: Index of programs by skills no available
PREFERRED: Index of programs by skills be available
RATING 4.28
STANDARD DEVIATION 0.90

TNC11 REFERENT: Software reviews
WHAT IS: Evaluation of software is a lengthy process
PREFERRED: A better and faster way to evaluate software
RATING 3.61
STANDARD DEVIATION 0.92

TNC12 REFERENT: Software topics
WHAT IS: Too few true tutorial math programs
PREFERRED: More tutorial math programs
RATING 4.22
STANDARD DEVIATION 0.73

TNC13 REFERENT: Training, instruction use
WHAT IS: Teachers cannot justify time on computers
PREFERRED: Teachers can justify time on computers
RATING 3.40
STANDARD DEVIATION 1.12

TNC14 REFERENT: Training, computer use
WHAT IS: Teachers have limited familiarity with computers
PREFERRED: Teachers be more familiar with computers
RATING 4.47
STANDARD DEVIATION 0.72

TNC15 REFERENT: Software access
WHAT IS: Math software users group does not exist
PREFERRED: There be a math software users group
RATING 3.88
STANDARD DEVIATION 0.93

TNC16 REFERENT: Training, computer use
WHAT IS: Teachers do not have enough training in comp lit
PREFERRED: Teachers have more training in computer literacy
RATING 4.25
STANDARD DEVIATION 1.06

TNC17 REFERENT: Software access
WHAT IS: Little software can be legally networked
PREFERRED: More software that can be legally networked
RATING 3.72
STANDARD DEVIATION 1.02

TNC18 REFERENT: Planning/direction
WHAT IS: Computer coordinators have little authority
PREFERRED: Computer coordinators have more authority
RATING 3.33
STANDARD DEVIATION 1.18

TNC19 REFERENT: Integration
WHAT IS: Little software that correlates with BSF
PREFERRED: More software that correlates with BSF
RATING 4.39
STANDARD DEVIATION 0.61

TNC20 REFERENT: Integration
WHAT IS: Little software correlation with achievement tests
PREFERRED: More software correlated with achievement tests
RATING 3.61
STANDARD DEVIATION 1.32

TNC21 REFERENT: Hardware security
WHAT IS: Little hardware insurance and/or protection
PREFERRED: More hardware insurance and/or protection
RATING 3.06
STANDARD DEVIATION 1.43

TNC22 REFERENT: Training, instruction use
WHAT IS: Few staff development in use of CAI
PREFERRED: More staff development in use of CAI
RATING 4.17
STANDARD DEVIATION 0.79

VAA01 REFERENT: Hardware access, student
WHAT IS: General math students have no access to computers
PREFERRED: General math students have access to computers
RATING 4.25
STANDARD DEVIATION 0.85

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VAA02         REFERENT: Teacher incentives
      WHAT IS: Teachers don't have planning time to revelw softwa
   PREFERRED: Teachers be given time to review software
RATING                      3.73
STANDARD DEVIATION          1.19

VAA03         REFERENT: Hardware access, student
      WHAT IS: Ratio of computers to students is poor
   PREFERRED: Better ratio of computers to students
RATING                      4.29
STANDARD DEVIATION          0.91

VAA04         REFERENT: Software access
      WHAT IS: Software not readily available for teacher use
   PREFERRED: Software be more available to teachers
RATING                      3.70
STANDARD DEVIATION          1.15

VAA05         REFERENT: Software reviews
      WHAT IS: Lack of catalogs of software content and level
   PREFERRED: Be software catalogs with content and level given
RATING                      3.63
STANDARD DEVIATION          1.09

VAA06         REFERENT: Training, computer use
      WHAT IS: Few teachers understand computer capabilities
   PREFERRED: More teachers understand computer capabilities
RATING                      3.92
STANDARD DEVIATION          1.32

VAA07         REFERENT: Training, instruction use
      WHAT IS: Computer courses not relevant to classroom use
   PREFERRED: Teacher courses be more relevant to classroom use
RATING                      3.83
STANDARD DEVIATION          1.01

VAA08         REFERENT: Software access
      WHAT IS: Programs not transportable to different makes
   PREFERRED: Programs be written for transfer to different make
RATING                      3.17
STANDARD DEVIATION          1.27

VAA09         REFERENT: Planning/direction
      WHAT IS: No continuous computer curriculum for K-12
   PREFERRED: There be a continuous curriculum for K-12
RATING                      3.74
STANDARD DEVIATION          1.21

VAA10         REFERENT: Planning/direction
      WHAT IS: There is no full-time computer coordinator
   PREFERRED: There be a full-time computer coordinator
RATING                      3.21
STANDARD DEVIATION          1.22

VAA11         REFERENT: Software access
      WHAT IS: Not enough software for basic level students
   PREFERRED: More software for basic level students
RATING                      3.65
STANDARD DEVIATION          0.98

VAA12         REFERENT: Teacher incentives
      WHAT IS: Little time for teachers to create software
   PREFERRED: Time provided for teachers to create software
RATING                      3.04
STANDARD DEVIATION          1.36

VAA13         REFERENT: Software criteria
      WHAT IS: Software seldom can be adjusted to teaching situat
   PREFERRED: More software that can be adjusted to situation
RATING                      3.73
STANDARD DEVIATION          1.28

VAA14         REFERENT: Integration
      WHAT IS: Math curriculum does not integrate computers
   PREFERRED: Math curriculum that integrates computers
RATING                      3.75
STANDARD DEVIATION          1.24

VAA15         REFERENT: Planning/direction
      WHAT IS: Computer curriculum not for all levels of students
   PREFERRED: Computer curriculum be for all levels of students
RATING                      3.26
STANDARD DEVIATION          1.21

VAA16         REFERENT: Training, specific prog
      WHAT IS: Teacher courses too general and too much
   PREFERRED: Computer courses for teachers be focus on areas
RATING                      2.91
STANDARD DEVIATION          1.31

VAA17         REFERENT: Planning/direction
      WHAT IS: Different makes of hardware often in same school
   PREFERRED: Hardware in school should be standardized
RATING                      2.67
STANDARD DEVIATION          1.51

VAA18         REFERENT: Computer texts
      WHAT IS:
   PREFERRED:
RATING                      3.33
STANDARD DEVIATION          1.15

VAA19         REFERENT: Integration
      WHAT IS: Texts are not machine-specific
   PREFERRED: Texts be more machine-specific
RATING                      2.54
STANDARD DEVIATION          1.32

VAA20         REFERENT: Integration
      WHAT IS: Curriculum segmented into programming, lit, math
   PREFERRED: Curriculum integrated based on problem solving
RATING                      3.43
STANDARD DEVIATION          1.44

VAA21         REFERENT: Hardware access, teacher
      WHAT IS: Little hardware for teacher use
   PREFERRED: Hardware for teacher use
RATING                      3.58
STANDARD DEVIATION          0.94

VAA22         REFERENT: Hardware repair
      WHAT IS: Lab instructors cannot repair minor problems
   PREFERRED: Lab instructors be able to repair minor problems
RATING                      3.29
STANDARD DEVIATION          1.39

VAA23         REFERENT: Training, specific prog
      WHAT IS: Teachers & students not aware of value of LOGO/COB
   PREFERRED: Teacher devel awareness of value of LOGO/COBOL
RATING                      2.64
STANDARD DEVIATION          1.29

VAA24         REFERENT: Funding
      WHAT IS: No funds to purchase software
   PREFERRED: More funds to purchase software
RATING                      3.82
STANDARD DEVIATION          1.03

VAA25         REFERENT: Integration
      WHAT IS: Computer programs not included in texts
   PREFERRED: Computer programs be included in texts
RATING                      3.42
STANDARD DEVIATION          1.23

VAA26         REFERENT: Software criteria
      WHAT IS: Content teachers not involved in software develop
   PREFERRED: More content teachers involved in software develop
RATING                      3.88
STANDARD DEVIATION          1.32

VAA27         REFERENT: Software criteria
      WHAT IS: Basic math students uninterested in using computer
   PREFERRED: Interest of basic math students be stimulated
RATING                      2.87
STANDARD DEVIATION          1.32

VAA28         REFERENT: Software criteria
      WHAT IS: Software is locked and cannot be modified by teach
   PREFERRED: Software be unlocked and be modified by teachers
RATING                      3.50
STANDARD DEVIATION          1.44

VAB01         REFERENT: Hardware access, student
      WHAT IS: Limited hardware available in classrooms
   PREFERRED: Be more hardware available in classrooms
RATING                      4.48
STANDARD DEVIATION          0.90

VAB02         REFERENT: Software access
      WHAT IS: Limited access to software in classrooms
   PREFERRED: More software available in classrooms
RATING                      4.13
STANDARD DEVIATION          0.73

VAB03         REFERENT: Software criteria
      WHAT IS: Little teacher input in software development
   PREFERRED: Be more teacher input in software development
RATING                      4.17
STANDARD DEVIATION          0.85

VABC4         REFERENT: Funding
      WHAT IS: Inadequate funding available for purchases
   PREFERRED: Adequate funding available for purchases
RATING                      4.23
STANDARD DEVIATION          0.97

VAB05         REFERENT: Hardware access, student
      WHAT IS: Not enough hardware for number of students
   PREFERRED: Enough hardware for number of students
RATING                      4.33
STANDARD DEVIATION          1.13
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VAR06 REFERENT: Software reviews
WHAT IS: Most softare available is inappropriate
PREFERRED: Be way for communicating software uses
RATING 4.04
STANDARD DEVIATION 0.93

VAR07 REFERENT: Software criteria
WHAT IS: Tutorial programs usually poorly written
PREFERRED: [illegible] written tutorial software
RATING 3.91
STANDARD DEVIATION 1.16

VAR08 REFERENT: Software reviews
WHAT IS: Too many evaluation models
PREFERRED: Standardization of evaluation models
RATING 3.17
STANDARD DEVIATION 1.20

VAR09 REFERENT: Training, specific prog
WHAT IS: Little training that meets teacher needs
PREFERRED: Appropriate training for teacher needs
RATING 4.22
STANDARD DEVIATION 0.74

VAR10 REFERENT: Training, instruction use
WHAT IS: Not enough teacher interest in CAI
PREFERRED: Teacher interest in CAI be generated
RATING 3.50
STANDARD DEVIATION 1.41

VAR11 REFERENT: Software criteria
WHAT IS: Software management systems cannot be bypassed
PREFERRED: Software allow management systems to be bypassed
RATING 3.19
STANDARD DEVIATION 1.33

VAR12 REFERENT: Software access
WHAT IS: Limited licensing agreements for multi-use
PREFERRED: More liberal licensing agreements for multi-use
RATING 3.64
STANDARD DEVIATION 1.43

VAR13 REFERENT: Software criteria
WHAT IS: Software not adaptable to recieve new problems
PREFERRED: Software allow insertion of new problems
RATING 3.74
STANDARD DEVIATION 1.18

VAR14 REFERENT: Integration
WHAT IS:
PREFERRED:
RATING 3.38
STANDARD DEVIATION 1.26

VAR15 REFERENT: Teacher incentives
WHAT IS: Little time for teacher to develop software
PREFERRED: More time for teacher to develop software
RATING 3.83
STANDARD DEVIATION 1.40

VAR16 REFERENT: Software criteria
WHAT IS: Software often of one ability level
PREFERRED: Software provide for multiple ability levels
RATING 3.67
STANDARD DEVIATION 1.05

VAR17 REFERENT: Software preview
WHAT IS: Limited access to local teachers for preview
PREFERRED: More access to local teachers to preview software
RATING 3.88
STANDARD DEVIATION 0.95

VAR18 REFERENT: Software topics
WHAT IS: Few application programs for basic math skills
PREFERRED: More application software for basic math skills
RATING 4.63
STANDARD DEVIATION 0.58

VAR19 REFERENT: Planning/direction
WHAT IS: Flexible scheduling not available in computer lab
PREFERRED: Flexible scheduling be developed for computer lab
RATING 3.58
STANDARD DEVIATION 1.25

VAR20 REFERENT: Planning/direction
WHAT IS: Supervisors don't have adequate training
PREFERRED: Supervisors have adequate training
RATING 3.17
STANDARD DEVIATION 1.55

VAC01 REFERENT: Hardware access, student
WHAT IS: Students do not have enough time on computers
PREFERRED: Adequate time be allocted students on compters
RATING 4.17
STANDARD DEVIATION 0.79

VAC02 REFERENT: Training, computer use
WHAT IS: Teachers do not have proper training in use of com
PREFERRED: Teacher have proper training in cmputer use
RATING 4.29
STANDARD DEVIATION 0.91

VAC03 REFERENT: Integration
WHAT IS: Software not coordinated with objectives
PREFERRED: Software be coordinated to curriculum issues
RATING 4.29
STANDARD DEVIATION 1.00

VAC04 REFERENT: Integration
WHAT IS: Little software is appropriate to curriculum
PREFERRED: More software appropriate to curriculum
RATING 4.25
STANDARD DEVIATION 0.94

VAC05 REFERENT: Software reviews
WHAT IS: Software for particular use difficult to find
PREFERRED: Software for specific use be easier to find
RATING 4.04
STANDARD DEVIATION 0.93

VAC06 REFERENT: Training, specific prog
WHAT IS: Teacher have difficulty tracking student progress
PREFERRED: Teacher have help in tracking student progress
RATING 3.17
STANDARD DEVIATION 1.21

VAC07 REFERENT: Teacher incentives
WHAT IS: Inadequate time for faculty to review software
PREFERRED: Time be provided for faculty to review software
RATING 3.67
STANDARD DEVIATION 1.17

VAC08 REFERENT: Hardware access, student
WHAT IS: Too little hardware for each class
PREFERRED: Enough hardware in each class for students
RATING 4.09
STANDARD DEVIATION 1.12

VAC09 REFERENT: Training, computer use
WHAT IS: Teachers are not computer literate
PREFERRED: Teachers become computer literate
RATING 3.92
STANDARD DEVIATION 0.88

VAC10 REFERENT: Software criteria
WHAT IS: Teachers not involved in development of most softw
PREFERRED: Teachers be involved in development of more softwa
RATING 4.00
STANDARD DEVIATION 1.14

VAC11 REFERENT: Hardware repair
WHAT IS: Hardware repair time extensive
PREFERRED: Hardware repair time be reduced
RATING 3.38
STANDARD DEVIATION 1.35

VAC12 REFERENT: Software preview
WHAT IS: Teacher depend on software reviews of others
PREFERRED: Teachers receive software for preview
RATING 3.04
STANDARD DEVIATION 1.12

VAC13 REFERENT: Hardware access, teacher
WHAT IS: Teacher access to hardware is limited
PREFERRED: Teacher have better access to hardware
RATING 4.00
STANDARD DEVIATION 0.95

VAC14 REFERENT: Software reviews
WHAT IS: Teachers not aware of software avialiable
PREFERRED: Teachers be made aware of software available
RATING 3.50
STANDARD DEVIATION 1.06

VAC15 REFERENT: Planning/direction
WHAT IS: Scheduling does not provide enough hands-on
PREFERRED: Scheduling provide more hands-on experience
RATING 4.08
STANDARD DEVIATION 0.88

VAC16 REFERENT: Software criteria
WHAT IS: Software and documentation not user friendly
PREFERRED: Software and documentation be more user friendly
RATING 3.78
STANDARD DEVIATION 1.20

VAC17 REFERENT: Planning/direction
WHAT IS: Scheduling does not provide for main streamed stud
PREFERRED: Scheduling provide for main streamed student
RATING 3.00
STANDARD DEVIATION 1.31

VAC18 REFERENT: Integration
WHAT IS: Texts don't meet needs of students with varied exp
PREFERRED: Other materials be developed for varied experience
RATING 3.50
STANDARD DEVIATION 1.01

VAC19 REFERENT: Planning/direction
WHAT IS: No system-wide coordination of computer ed
PREFERRED: Be system-wide coordination of computer ed
RATING 1.57
STANDARD DEVIATION 1.16

VAC20 REFERENT: Hardware repair
WHAT IS: Little communications between user and repairer
PREFERRED: More communications between user and repairer
RATING 2.79
STANDARD DEVIATION 1.23

VAC21 REFERENT: Teacher incentives
WHAT IS: Little time for inter-staff communications
PREFERRED: Time be provided for inter-staff communications
RATING 3.57
STANDARD DEVIATION 1.12

VAC22 REFERENT: Software access
WHAT IS: Teachers unaware of software available locally
PREFERRED: Teachers need to be aware of what is available lot
RATING 3.92
STANDARD DEVIATION 1.12

VAD01 REFERENT: Funding
WHAT IS: Funding restricts use of what is purchased
PREFERRED: Funding not restrict use of what is purchased
RATING 3.55
STANDARD DEVIATION 1.10

VAD02 REFERENT: Software topics
WHAT IS: No variety software available for basic math drill
PREFERRED: Be more varied software for basic math drill
RATING 3.63
STANDARD DEVIATION 1.18

VAD03 REFERENT: Training, computer use
WHAT IS: Teachers fear computers
PREFERRED: Teachers not fear computers
RATING 4.17
STANDARD DEVIATION 0.89

VAD04 REFERENT: Software topics
WHAT IS: Students weak in vocabulary and abstract figures
PREFERRED: Software for vocabulary and dealing with abs fig.
RATING 2.91
STANDARD DEVIATION 1.15

VAD05 REFERENT: Hardware access, student
WHAT IS: Lack of hardware available for teachers and studen
PREFERRED: More hardware available for teachers and students
RATING 4.33
STANDARD DEVIATION 0.82

VAD06 REFERENT: Training, instruction use
WHAT IS: Few math teachers know how to teach with computer
PREFERRED: All math teachers know how to teach with computer
RATING 4.50
STANDARD DEVIATION 0.58

VAD07 REFERENT: Software topics
WHAT IS: Little software regarding problem solving
PREFERRED: Software to teach problem solving
RATING 4.17
STANDARD DEVIATION 0.93

VAD08 REFERENT: Software topics
WHAT IS: Too much drill and practice software
PREFERRED: More software to develop concepts
RATING 3.42
STANDARD DEVIATION 1.30

VAD09 REFERENT: Hardware access, teacher
WHAT IS: No hardware for classroom demonstrations
PREFERRED: Be hardware designed for classroom demonstrations
RATING 3.96
STANDARD DEVIATION 1.26

VAD10 REFERENT: Hardware access, teacher
WHAT IS: Computers not available for teacher use
PREFERRED: Computers be made available for teacher use
RATING 3.92
STANDARD DEVIATION 0.93

VAD11 REFERENT: Teacher incentives
WHAT IS: Teachers do not have time to try new ideas
PREFERRED: Teachers have time to try new ideas
RATING 3.96
STANDARD DEVIATION 1.15

VAD12 REFERENT: Software reviews
WHAT IS: Not enough software have been reviewed
PREFERRED: More groups be trained to review software
RATING 3.33
STANDARD DEVIATION 1.15

VAD13 REFERENT: Training, instruction use
WHAT IS: Teachers don't know what others doing in system
PREFERRED: Ideas and activities of teachers be shared
RATING 3.79
STANDARD DEVIATION 1.72

VAD14 REFERENT: Software criteria
WHAT IS: Software is not modular or transportable
PREFERRED: Software be modular and transportable
RATING 3.13
STANDARD DEVIATION 0.97

VAD15 REFERENT: Software criteria
WHAT IS: Software cannot be modified by classroom teacher
PREFERRED: Software be open to modification by teacher
RATING 3.61
STANDARD DEVIATION 1.70

VAD16 REFERENT: Curriculum
WHAT IS:
PREFERRED:
RATING 2.19
STANDARD DEVIATION 1.36

VAD17 REFERENT: Planning/direction
WHAT IS: Computer is often misused
PREFERRED: Computer use be clarified
RATING 3.23
STANDARD DEVIATION 1.34

VAD18 REFERENT: Software criteria
WHAT IS: Learning new software is too difficult
PREFERRED: Ways of learning new software be improved
RATING 3.26
STANDARD DEVIATION 1.32

VAD19 REFERENT: Planning/direction
WHAT IS: Skills needed by students not identified
PREFERRED: Skills needed by students be identified
RATING 3.93
STANDARD DEVIATION 1.27

VAD20 REFERENT: Hardware access, student
WHAT IS: There is no equity of use of computer lab
PREFERRED: Be equity of student use of computer lab
RATING 3.71
STANDARD DEVIATION 1.12

VAD21 REFERENT: Planning/direction
WHAT IS: Unclear goals among computer lit, basic math, prog
PREFERRED: Clarified goals among literacy, basic math, prog
RATING 3.58
STANDARD DEVIATION 1.25

VAD22 REFERENT: Software topics
WHAT IS: Few good simulation software programs
PREFERRED: More good simulation software programs
RATING 3.92
STANDARD DEVIATION 0.93

VAD23 REFERENT: Software topics
WHAT IS: Few good tutorial software programs
PREFERRED: Be more good tutorial software programs
RATING 3.96
STANDARD DEVIATION 0.96

VAD24 REFERENT: Software access
WHAT IS: Much software protected and related laws unclear
PREFERRED: Software be more accessible and laws more lenient
RATING 3.17
STANDARD DEVIATION 1.47

VAD25 REFERENT: Software topics
WHAT IS: Little diagnostic and prescriptive software
PREFERRED: More diagnostic and prescriptive software
RATING 3.60
STANDARD DEVIATION 1.19

VVA01 REFERENT: Hardware access, student
WHAT IS: Few computers available for elementary classrooms
PREFERRED: More computers for elementary classroom
RATING 4.48
STANDARD DEVIATION 0.73

VVA02 REFERENT: Hardware access, teacher
WHAT IS: Teachers have no access during planning periods
PREFERRED: Computers be available for teachers in planning
RATING 4.17
STANDARD DEVIATION 0.65

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WVA03        REFERENT: Training, specific prog
       WHAT IS: Teachers have few skills in using management progs
    PREFERRED: Teachers be trained in using management programs
 RATING                    3.36
 STANDARD DEVIATION        1.26

WVA04        REFERENT: Integration
       WHAT IS: Software not correlated with topics/texts
    PREFERRED: Software be correlated with topics/texts
 RATING                    4.30
 STANDARD DEVIATION        0.76

WVA05        REFERENT: Software preview
       WHAT IS: Producers don't allow preview before purchase
    PREFERRED: Producers allow preview before purchase
 RATING                    4.39
 STANDARD DEVIATION        0.89

WVA06        REFERENT: Software reviews
       WHAT IS: Software catalogs do not describe program well
    PREFERRED: Catalogs provide better descriptions of software
 RATING                    3.48
 STANDARD DEVIATION        1.20

WVA07        REFERENT: Software topics
       WHAT IS: Little software for basic skills in gen math
    PREFERRED: More software for basic skills in general math
 RATING                    3.91
 STANDARD DEVIATION        1.15

WVA08        REFERENT: Training, computer use
       WHAT IS: Little training in use of computers available
    PREFERRED: Training be provided in use of available computers
 RATING                    4.43
 STANDARD DEVIATION        0.90

WVA09        REFERENT: Hardware access, teacher
       WHAT IS: Most teachers do not have personal computer
    PREFERRED: More teachers have their own computers at home
 RATING                    2.35
 STANDARD DEVIATION        1.19

WVA10        REFERENT: Training, instruction use
       WHAT IS: Teachers lack knowledge for using computers in cla
    PREFERRED: More training and sharing of ways to use computers
 RATING                    4.32
 STANDARD DEVIATION        0.75

WVA11        REFERENT: Software access
       WHAT IS: Producers restrict copying of software for all cla
    PREFERRED: Producers allow teachers to copy for all in class
 RATING                    3.70
 STANDARD DEVIATION        1.40

WVA12        REFERENT: Hardware access, student
       WHAT IS: Not enough computers for classroom of students
    PREFERRED: That entire class be accommodated by computers
 RATING                    4.26
 STANDARD DEVIATION        1.10

WVA13        REFERENT: Integration
       WHAT IS: Not time to use computers in regular class
    PREFERRED: Time be scheduled for remediation & reinforcement
 RATING                    3.68
 STANDARD DEVIATION        1.15

WVA14        REFERENT: Funding
       WHAT IS: Low funding for hardware/software purchase
    PREFERRED: More funds for hardware/software purchase
 RATING                    4.48
 STANDARD DEVIATION        0.79

WVA15        REFERENT: Integration
       WHAT IS: Computers are not integrated into the curriculum
    PREFERRED: Computers be integrated into daily classroom activ
 RATING                    3.45
 STANDARD DEVIATION        1.18

WVA16        REFERENT: Software criteria
       WHAT IS: Software does not utilize capabilities of computer
    PREFERRED: Software make better use of color, animation, etc.
 RATING                    2.64
 STANDARD DEVIATION        1.33

WA17         REFERENT: Integration
       WHAT IS: No problem solving by computer in texts
    PREFERRED: Computer problem solving be included in texts
 RATING                    3.73
 STANDARD DEVIATION        1.02

WA18         REFERENT: Teacher incentives
       WHAT IS: Computer classes not required of education student
    PREFERRED: Computer classes be degree requirement
 RATING                    3.57
 STANDARD DEVIATION        1.27

WVA19        REFERENT: Hardware access, teacher
       WHAT IS: Teachers cannot afford to buy a computer for home
    PREFERRED: That state help teachers buy home computers
 RATING                    7.68
 STANDARD DEVIATION        1.46

WVA20        REFERENT: Hardware access, student
       WHAT IS: Computers not available to students outside class
    PREFERRED: Students have access to computers for homework,etc
 RATING                    3.48
 STANDARD DEVIATION        0.99

WVA21        REFERENT: Hardware access, teacher
       WHAT IS: Few teachrs have access to a computer
    PREFERRED: More teachers have access to develop materials
 RATING                    3.59
 STANDARD DEVIATION        1.14

WVA22        REFERENT: Software criteria
       WHAT IS: Much software not at student level
    PREFERRED: Software be appropriate for intended student
 RATING                    3.82
 STANDARD DEVIATION        1.33

WVA23        REFERENT: Training, instruction use
       WHAT IS: Computer courses not education-oriented
    PREFERRED: College courses be classroom relevant
 RATING                    4.09
 STANDARD DEVIATION        0.92

WVA24        REFERENT: Training, computer use
       WHAT IS: Many teachers are afraid of computers
    PREFERRED: Training be provided to help teacher overcome fear
 RATING                    3.52
 STANDARD DEVIATION        1.04

WVA25        REFERENT: Software criteria
       WHAT IS: Software not always user friendly
    PREFERRED: Software allow students to work independently
 RATING                    3.93
 STANDARD DEVIATION        1.29

WVB01        REFERENT: Hardware access, student
       WHAT IS: Insufficient number of computers
    PREFERRED: A lab with sufficient number of computers
 RATING                    4.00
 STANDARD DEVIATION        1.38

WVB02        REFERENT: Hardware access, teacher
       WHAT IS: Few teacher have computers for instructional use
    PREFERRED: More teachers have computers available for instruc
 RATING                    4.68
 STANDARD DEVIATION        0.48

WVB03        REFERENT: Hardware access, student
       WHAT IS: Students have no access beyond regular class
    PREFERRED: Supervised lab available for extra work by student
 RATING                    4.36
 STANDARD DEVIATION        0.73

WVB04        REFERENT: Software reviews
       WHAT IS: No way of examining software by subject
    PREFERRED: Master generic catalog of software by subject
 RATING                    3.57
 STANDARD DEVIATION        1.31

WVB05        REFERENT: Planning/direction
       WHAT IS: No computer resource personnel available
    PREFERRED: That computer resource person be available
 RATING                    4.26
 STANDARD DEVIATION        0.81

WVB06        REFERENT: Training, specific prog
       WHAT IS: Lack knowledge of little beyond D & P software
    PREFERRED: Training to learn about types of software
 RATING                    3.91
 STANDARD DEVIATION        1.16

WVB07        REFERENT: Integration
       WHAT IS: No texts relating computer use to basic skills
    PREFERRED: Textbooks relating computer usage and basic skills
 RATING                    3.82
 STANDARD DEVIATION        1.22

WVB08        REFERENT: Training, instruction use
       WHAT IS: Few teachers training in classroom use of computer
    PREFERRED: All teachers be trained in classroom use of comput
 RATING                    4.13
 STANDARD DEVIATION        1.14

WVB09        REFERENT: Training, instruction use
       WHAT IS: Colleges provide little in instructional use
    PREFERRED: Colleges provide more courses in instructional use
 RATING                    4.13
 STANDARD DEVIATION        0.97
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WVB10 REFERENT: Software preview
WHAT IS: Software often purchased without prior evaluation
PREFERRED: Software be evaluated before purchase to find uses
RATING 4.65
STANDARD DEVIATION 0.78

WVB11 REFERENT: Hardware access, student
WHAT IS: Not enough computers
PREFERRED: We have more computers
RATING 4.47
STANDARD DEVIATION 0.77

WVB12 REFERENT: Hardware access, student
WHAT IS: Some computers not scheduled fully
PREFERRED: That available computers be scheduled fully
RATING 4.05
STANDARD DEVIATION 1.00

WVB13 REFERENT: Training, specific prog
WHAT IS: Teachers not prepared to teach problem solving
PREFERRED: Teachers be trained to teacher problem solving
RATING 3.91
STANDARD DEVIATION 1.11

WVB14 REFERENT: Training, specific prog
WHAT IS: Teachers not using computer to teacher problem sol
PREFERRED: Teachers be trained to use computers in prob/solv
RATING 4.32
STANDARD DEVIATION 0.78

WVB15 REFERENT: Planning/direction
WHAT IS: Some teachers capable of teaching others
PREFERRED: Knowledgeable teachers teach other teachers
RATING 4.05
STANDARD DEVIATION 1.09

WVB16 REFERENT: Teacher incentives
WHAT IS: No incentives to produce software
PREFERRED: Money incentives to produce software
RATING 3.23
STANDARD DEVIATION 1.45

WVB17 REFERENT: Teacher incentives
WHAT IS: No incentive for production of instructional mater
PREFERRED: Teachers be compensated for producing inst. materi
RATING 3.19
STANDARD DEVIATION 1.40

WVB18 REFERENT: Teacher incentives
WHAT IS: No training incentives
PREFERRED: Compensation for training be provided
RATING 4.14
STANDARD DEVIATION 1.13

WVB19 REFERENT: Integration
WHAT IS: Computer not integrated into texts
PREFERRED: Computers be integrated into texts
RATING 3.96
STANDARD DEVIATION 1.31

WVB20 REFERENT: Software topics
WHAT IS: Little available in general math applications
PREFERRED: Applications software for general math area
RATING 4.13
STANDARD DEVIATION 0.92

WVB21 REFERENT: Hardware access, student
WHAT IS: Computers often confined in small areas
PREFERRED: Lab with adequate space be set aside for computers
RATING 3.90
STANDARD DEVIATION 1.26

WVB22 REFERENT: Training, instruction use
WHAT IS: Teachers lack experience in grouping with computer
PREFERRED: Teachers be trained in grouping with computers
RATING 4.05
STANDARD DEVIATION 0.92

WVC01 REFERENT: Teacher incentives
WHAT IS: Teachers lack time for planning computer managemen
PREFERRED: Teachers be given time for planning comp managemen
RATING 4.00
STANDARD DEVIATION 0.98

WVC02 REFERENT: Teacher incentives
WHAT IS: Teachers receive little paid time for training
PREFERRED: Teachers receive more paid time for training
RATING 4.05
STANDARD DEVIATION 0.94

WVC03 REFERENT: Teacher incentives
WHAT IS: Teachers have no time in day to use computers
PREFERRED: Teachers be given time to use computers in day
RATING 3.83
STANDARD DEVIATION 0.92

WVC04 REFERENT: Hardware access, student
WHAT IS: Most schools do not have enough hardware
PREFERRED: Each school have enough hardware for population
RATING 4.65
STANDARD DEVIATION 0.57

WVC05 REFERENT: Planning/direction
WHAT IS: Various hardware brands available in school
PREFERRED: Computer lab with single brand be available
RATING 3.96
STANDARD DEVIATION 1.41

WVC06 REFERENT: Hardware access, student
WHAT IS: Not all students have equal access to computer ed
PREFERRED: All students have access to computer ed
RATING 4.48
STANDARD DEVIATION 0.85

WVC07 REFERENT: Hardware evaluation
WHAT IS: Variety of makes and models of hardware availble
PREFERRED: Reviews of hardware be available
RATING 3.35
STANDARD DEVIATION 1.53

WVC08 REFERENT: Hardware access, student
WHAT IS: Not enough hardware available for student needs
PREFERRED: Enough hardware be available to meet student needs
RATING 4.50
STANDARD DEVIATION 0.74

WVC09 REFERENT: Planning/direction
WHAT IS: Students need instruction in use of computers
PREFERRED: Trained resource person be employed for students
RATING 3.62
STANDARD DEVIATION 1.20

WVC10 REFERENT: Software reviews
WHAT IS: Much software purchased without complete reviews
PREFERRED: Complete reviews of software be available
RATING 4.14
STANDARD DEVIATION 0.99

WVC11 REFERENT: Training, instruction use
WHAT IS: Teachers don't know how to use software in subject
PREFERRED: Training be given about using software in subject
RATING 4.45
STANDARD DEVIATION 0.74

WVC12 REFERENT: Hardware access, teacher
WHAT IS: Little hardware available for teacher use
PREFERRED: More hardware be available for teacher use
RATING 3.13
STANDARD DEVIATION 1.55

WVC13 REFERENT: Teacher incentives
WHAT IS: No computer time for teachers during day
PREFERRED: Teacher be provided time on computer during day
RATING 2.95
STANDARD DEVIATION 1.62

WVC14 REFERENT: Integration
WHAT IS: Computer use not integrated into class activities
PREFERRED: Computer use be integrated into class activities
RATING 4.18
STANDARD DEVIATION 1.14

WVC15 REFERENT: Software criteria
WHAT IS: Most software purchased is drill and practice
PREFERRED: Software be purchased to allow students to explore
RATING 4.09
STANDARD DEVIATION 0.79

WVC16 REFERENT: Hardware repair
WHAT IS: Hardware repair service for computers is slow
PREFERRED: Hardware repair be speeded and available in school
RATING 3.96
STANDARD DEVIATION 1.19

WVC17 REFERENT: Software reviews
WHAT IS: Little critical software evaluation available
PREFERRED: More critical software evaluation be available
RATING 4.09
STANDARD DEVIATION 0.97

WVC18 REFERENT: Software reviews
WHAT IS: No county-wide method of selecting software
PREFERRED: County-wide software review/evaluation board be e
RATING 4.04
STANDARD DEVIATION 1.07

WVC19 REFERENT: Software criteria
WHAT IS: Software does not meet state learning outcomes
PREFERRED: Software meet state learning outcomes
RATING 3.55
STANDARD DEVIATION 1.47

WVC20 REFERENT: Training, computer use
WHAT IS: Many teachers afraid to use computers
PREFERRED: Teachers be trained to overcome computer fears
RATING 3.83
STANDARD DEVIATION 1.03

WVC21 REFERENT: Software criteria
WHAT IS: Most software drill and practice
PREFERRED: More software allowing students to explore & learn
RATING 4.04
STANDARD DEVIATION 0.88

WVD01 REFERENT: Teacher incentives
WHAT IS: Computer training is teacher choice
PREFERRED: Computer training be required of all teachers
RATING 3.91
STANDARD DEVIATION 1.20

WVD02 REFERENT: Teacher incentives
WHAT IS: Computer training is teacher choice
PREFERRED: Money be incentive for teacher computer training
RATING 3.68
STANDARD DEVIATION 1.17

WVD03 REFERENT: Teacher incentives
WHAT IS: Computer training is teacher choice
PREFERRED: Training be paid by state, county, or others
RATING 4.17
STANDARD DEVIATION 0.97

WVD04 REFERENT: Teacher incentives
WHAT IS: Computer training is teacher choice
PREFERRED: Inservice/continuing ed credit be given for comp t
RATING 4.18
STANDARD DEVIATION 1.10

WVD05 REFERENT: Training, computer use
WHAT IS: Training not always on computers available to teac
PREFERRED: Training be provided on hardware available
RATING 4.00
STANDARD DEVIATION 1.24

WVD06 REFERENT: Hardware access, teacher
WHAT IS: All teachers do not have access to computers
PREFERRED: All teachers have access to computers for practice
RATING 4.04
STANDARD DEVIATION 0.72

WVD07 REFERENT: Hardware access, student
WHAT IS: Not enough computers in classroom
PREFERRED: More computers be provided in classroom
RATING 4.57
STANDARD DEVIATION 0.66

WVD08 REFERENT: Hardware access, student
WHAT IS: Not enough coordinated hardware purchase
PREFERRED: More coordinated hardware purchase for schools
RATING 4.50
STANDARD DEVIATION 0.80

WVD09 REFERENT: Software access
WHAT IS: Limited amount of relevant software available in a
PREFERRED: More relevant software be available in school
RATING 4.52
STANDARD DEVIATION 0.90

WVD10 REFERENT: Integration
WHAT IS: Software not correlated with subject matter
PREFERRED: Software be correlated with subject matter
RATING 4.23
STANDARD DEVIATION 0.97

WVD11 REFERENT: Software reviews
WHAT IS: Software not cataloged by teaching concept
PREFERRED: Software be cataloged by teaching concept
RATING 3.95
STANDARD DEVIATION 1.08

WVD12 REFERENT: Software reviews
WHAT IS: Software reviews not generally available
PREFERRED: Experienced user publish and distribute reviews
RATING 3.93
STANDARD DEVIATION 1.21

WVD13 REFERENT: Software preview
WHAT IS: Software producers do not allow teachers to previe
PREFERRED: Software producer allow teachers to preview
RATING 4.32
STANDARD DEVIATION 0.93

WVD14 REFERENT: Software reviews
WHAT IS: No county procedure for selection of software
PREFERRED: County software evaluation committee be formed
RATING 3.74
STANDARD DEVIATION 0.98

WVD15 REFERENT: Software access
WHAT IS: Producers do not allow multiple use of software
PREFERRED: Producers allow multiple use of software in county
RATING 3.91
STANDARD DEVIATION 1.18

WVD16 REFERENT: Software access
WHAT IS: Software producers limit software copies
PREFERRED: Software producers provide classroom packages
RATING 3.96
STANDARD DEVIATION 1.15

WVD17 REFERENT: Planning/direction
WHAT IS: State does not have computer math curriculum
PREFERRED: State have a standard computer math curriculum
RATING 3.80
STANDARD DEVIATION 1.06

WVD18 REFERENT: Planning/direction
WHAT IS: There is no one coordinating computer buy/use
PREFERRED: Computer coordinators to coord. buy/use of compute
RATING 3.57
STANDARD DEVIATION 1.24

WVD19 REFERENT: Planning/direction
WHAT IS: Computer use left to teachers
PREFERRED: Teachers have guidelines for computer use
RATING 3.09
STANDARD DEVIATION 1.22

WVD20 REFERENT: Training, instruction use
WHAT IS: Computer use left to teachers
PREFERRED: Conference/workshop to exchange computer use ideas
RATING 4.04
STANDARD DEVIATION 1.11

WVD21 REFERENT: Software topics
WHAT IS: Little software in area of ratio/proportion
PREFERRED: More software in area of ratio/proportion
RATING 3.48
STANDARD DEVIATION 1.27

WVD22 REFERENT: Software topics
WHAT IS: Little software for teacher management systems
PREFERRED: More software for teacher management systems
RATING 3.60
STANDARD DEVIATION 1.27

WVD23 REFERENT: Teacher incentives
WHAT IS: Teachers have no time to use management systems
PREFERRED: Teachers be given time to work with management sys
RATING 3.62
STANDARD DEVIATION 1.20

Appendix C

Description of Brochures Addressing Priority Needs

By classroom teachers, for classroom teachers—that's what makes the **Microcomputers for Teachers** Series unique. Resulting from a project that originally set out to provide help to secondary teachers of mathematics, the set of ten brochures proved to be applicable to all teachers using microcomputers for instruction.

The project began with a set of needs assessment conferences in the four states of AEL's region. A group of teachers in each state worked with AEL staff to generate lists of need statements, which they then ranked according to the felt personal intensity of the need and the potential impact on education if the need were met. Although the order varied from state to state, all four state groups considered "most important" needs to be 1) hardware access for students, 2) competency training for teachers, 3) integrating computers into curriculum, and 4) considerations about software.

Some 90 conferees attended the needs assessment meeting. They came from very small to quite large high schools, junior highs, and elementary schools. More than three-quarters came from suburban or rural communities, and slightly more women than men participated. Almost all were classroom teachers who had used microcomputers—some only in a laboratory setting, some in classrooms only, and some in a combination. Nearly half had used them to teach mathematics and a fourth to teach only programming and/or computer literacy.

A representative panel of eight teachers form that original group came together for a second conference where four computer consultants presented their interpretations of the assessment findings. They then served as facilitators of small groups that developed guidelines for position papers in the four need areas, using group discussion and problem solving techniques.

Following that conference the consultants wrote papers, and the eight teachers came together one final time to react to the papers and to identify the brochures to be written and disseminated to teachers and other educators. Recalling their own problems and looking both pragmatically and idealistically at schools, they decided what kinds of guides and cautions teachers might need in the exciting but hazardous world of microcomputers.

Mike and Mini Computer Mice serve as insightful if somewhat insouciant guides to the series of ten brochures, the titles, topics and purposes of the brochures follow.

1. **A POCKET GLOSSARY FOR COMPUTER-EASE** is offered as the first step to computer literacy. BPS, CPS, RAM, DOS—you could drown in the alphabet soup. Unfamiliarity with the jargon is a large part of technophobia; not understanding the language puts you in alien territory. Dozens of books about computers include glossaries, but they are not readily portable. The POCKET GLOSSARY terms were carefully selected to give the uninitiated both an introduction and a handy future reference to this newest of technologies for the classroom.

2. **TECHNOTALK: SORTING OUT CAI, CBI, AND CMI** poses at least some of the major questions that should be resolved before you and your school or district decide what hardware to purchase. Computer Assisted Instruction (CAI),

Computer Based Instruction (CBI) and Computer Managed Instruction (CMI) are simply and clearly defined. A glimpse of future directions and some sources of additional information complete the brochure.

3. **COMPUTER CURRICULUM: WHAT WILL OURS LOOK LIKE?** helps you design computer curricula to suit your school. What are your priorities? Literacy? Remediation? Both? Neither? This brochure takes a teacher perspective on how to avoid the all-too-common situation of a curriculum serving the needs of the computer, instead of the other way around.

4. **HICCUPS, BURPS AND GROANS: MAYBE YOU CAN FIX IT YOURSELF** deals with basic maintenance of your hardware. Most of the problems with today's microcomputers can be dealt with by checking for loose plugs, swapping circuit boards, or performing a simple housekeeping chore like cleaning a sticky key. A Q-tip and a little pure alcohol can be as good as a $60 service call—and a lot faster. Waiting for days while a machine is in for minor repairs contributes to the bad reputation computers have in some circles; this brochure can help you avoid such aggravation.

5. **SOFTWARE: CHOOSING AND USING.** Deciding whether to use software as part of your instructional plan comes first. Then you must decide what software to use. Whether you are part of a review and selection committee for the total school or district, or are choosing from software available in your school's media center, this brochure can help. It sets out some criteria for review, alerts you to some of the pitfalls in relying on professional reviewers, and provides a number of software resources.

6. **DON'T SALT YOUR FRENCH FRIES WHILE YOU'RE USING THE COMPUTER** can save you untold grief. If you didn't already know that running the vacuum close to your operating computer can wipe out a diskette, this brochure is for you. How you should store diskettes, when you should make back-ups, why you shouldn't place your monitor screen in direct sunlight—all this and more is part of *Don't Salt...*"

7. **PIRACY OFF THE HIGH SEAS.** Few issues are more hotly debated than that of what constitutes theft of computer software. Teacher as exemplar, multiple-licensing agreements, software copyright law, and unauthorized intrusion into data bases are among issues dealt with in this brochure that looks at legal and ethical issues in computer education.

8. **TEACHING TEACHERS ABOUT COMPUTERS.** Teacher attitudes toward computers vary from virtual technophobia to "I can't wait to get my hands on one." Planning and developing in-service for such diverse audiences is not easy; this brochure includes topics that should be on the training agenda, alternative delivery methods, and enticements for the teacher who suffers from keyboard anxiety. The importance of using the technology to teach the technology is basic to the brochure.

9. **EXPECTATIONS IN COMPUTER IN-SERVICE** delineates who is responsible for what to assure high quality continuing teacher education in the use of the newest technology. What teachers can do for themselves, what support they should expect from their administrators, and how to go about getting the support needed from the extended school family are all part of this treatment of the important subject of expectations.

10. COMPUTER EQUITY MAY BE ELUSIVE. The microcomputer may be a tool for equal access to quality education the like of which we have never imagined. But there is evidence that use of the present supply of micros is at best uneven, and possibly outright biased against females, minorities, economically disadvantaged and certain ability groups. This brochure looks at practices that lead to unfair allocation of computer resources in our schools.