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AUTHOR	Ellis, James D.; Kuerbis, Paul J.
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ABSTRACT

This document represents the final report of a project which was designed to improve the quality and quantity of microcomputer use in science teaching. The five major goals of the project were met, and 22 essential competencies for computer literacy among science teachers were identified. The model and materials developed tended to be successful in improving the skills, knowledge, and attitudes of science teachers. Results of the project were disseminated by workshops, papers at professional meetings, publicity releases, and published articles. The materials developed and summarized in this document include: (1) a teacher enhancement model that applies to implementing any educational innovation; (2) a definition of what it means to be a computer-literate science teacher; (3) strategies for implementing educational computing; (4) materials and approaches that continue in use without outside support; and (5) a determination of the appropriate use of microcomputers in teaching science. Appendixes, which make up two-thirds of the document, include lists of contributors to ENLIST Micros, evaluation instruments, materials pertaining to the dissemination activities, and responses to the use survey conducted as part of the study. (TW)

Encourage Literacy of Science Teachers in the Use of Microcomputers (ENLIST Micros)

FINAL REPORT
NSF Grant No. MDR-8470061

Project Co-Directors:

James D. Ellis
Paul J. Kuerbis

Submitted to:

Materials Development for Precollege Science and Mathematics
The Science Education Directorate
The National Science Foundation

Biological Sciences Curriculum Study
1115 North Cascade Avenue
Colorado Springs, Colorado 80903

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Summary of Completed Project

On 1 February 1985, the BSCS began the *ENLIST Micros* project to develop materials to prepare science teachers to use educational computing. The following goals were set:

1. Identify and validate computer literacy objectives for science teachers.
2. Develop and evaluate a model for training science teachers in educational computing.
3. Develop and evaluate materials for training science teachers in educational computing.
4. Improve knowledge, skills, and attitudes of science teachers in educational computing.
5. Disseminate information to science educators on how to train science teachers to use educational computing.

All goals were met. We determined 22 essential competencies for computer literacy among science teachers. The model and materials were successful in improving the knowledge, skills, and attitudes of science teachers. We disseminated the results of the project by workshops, papers at professional meetings, publicity releases, and published articles.

We developed a teacher enhancement model that applies to implementing any educational innovation; defined what it means to be a computer-literate science teacher; determined strategies for implementing educational computing; developed materials and approaches that continue in use without outside support; and, determined appropriate use of microcomputers in science education.

FINAL REPORT OF ENLIST MICROS

On 1 February 1985, the Biological Sciences Curriculum Study (BSCS), with support from the National Science Foundation (NSF), began the *ENLIST Micros* project to *En*courage the *Li*teracy of *S*cience *T*eachers in using *Micro*computers. During the subsequent 23 months, BSCS staff and consultants who worked on *ENLIST Micros* developed models and materials for training science teachers to use microcomputers in the classroom.

To guide the development of the *ENLIST Micros* curriculum, we (the project directors) set the following goals:

1. Identify and validate computer literacy objectives for science teachers.
2. Develop and evaluate a model for training science teachers in educational computing.
3. Develop and evaluate materials for training science teachers in educational computing.
4. Improve knowledge, skills, and attitudes of science teachers in educational computing.
5. Disseminate information to science educators about how to train science teachers in educational computing.

RATIONALE

The purpose of *ENLIST Micros* is to improve the quality and quantity of microcomputer use in science teaching, because American society wants the new information technologies included in science education (Ellis, 1984; NSF,1979; Hurd, 1982; NSB, 1983). Prior to *ENLIST Micros,* however, science educators were slow to respond.

Computer technology is having a major effect on our economy and is revolutionizing the way we live and learn:

> Information is essentially the major national resource of all countries. Every country has the potential to participate in the global economy providing it knows how to manage information. The computer is a sophisticated memory bank with great facility at organizing and retrieving information. Rapid advances in computer technology are the driving force behind the information revolution. That technology, for the first time, makes it cost effective for anyone to access great volumes of

> detailed information. It is the application of the information, that is knowledge utilization, that solves the problems confronting society (Ellis, 1984 p. 200).

These technological and social changes have educational implications. In recent years, computer literacy has become a basic skill required for full participation in society. The National Science Foundation points out that "as the computer becomes a part of the home, school, and business landscape, people will need to know how to make intelligent, productive, and creative use of it" (NSF, 1979, p. 23). The noted science educator Paul DeHart Hurd states that "quite likely, the 'disadvantaged' learners of the near future will be those who lack the skills to exploit the microelectronic information resource and synthesize the findings" (Hurd, 1982, p. 11). Public education must ensure that future citizens have the skills required to function in an electronic society. Therefore, it is imperative that students at all levels learn to use the microcomputer to obtain and manipulate information and to extend knowledge.

Microcomputers should enhance science education. In a recent report, the National Science Board (NSB) made the following recommendations that support the use of microcomputers in science teaching:

- An important role is seen for technology in enriching the educational experiences of all children.
- The most critical need is to train teachers, administrators, and parents in the uses of technology in the education of children.
- The nation must find ways to provide equality of access to advantages of technology to all children.
- The federal government has a crucial role in establishing educational technology. This includes investing venture capital in development, coordination among the states, and establishing long-term evaluation programs.
- Business and the military benefit from the products of our educational system, but must invest in overcoming its deficiencies when they exist. Ways must be found to bring these two groups into the development program along with the federal and state governments, and the educational system (NSB, 1983 p. 93).

In summary, the NSB Commission on Precollege Education in Mathematics, Science, and Technology recommended a massive federal responsibility ($1.5 billion for the first year) in upgrading mathematics, science, and technology education, in which educational technologies play a central role.

Research studies prior to and since the beginning of *ENLIST Micros*, however, have found that science teachers use educational computing only occasionally. Lehman (1985) found that in 41 percent of 193 high schools not one science faculty member used microcomputers for instruction. In rural areas the situation was worse: 52 percent. Overall, of the 1,470 science teachers sampled in his study, Lehman found that 77 percent *did not* use microcomputers in their classes. Only six percent used microcomputers at least one hour per week per class and 17 percent used them occasionally. Because 75 percent of the teachers using microcomputers had completed formal training in educational computing, Lehman explained, the lack of inservice or preservice courses on educational computing for science education might be a significant barrier to increased implementation.

A study conducted by Kherlopian and Dickey (1985) in South Carolina (where small, rural school districts predominate) corroborates Lehman's findings. Kherlopian and Dickey found that only 40 percent of the of the K-12 science teachers were using microcomputers—primarily for drill and practice. Furthermore, more than 80 percent of the teachers using computers had completed formal course work in educational computing. They found that very few teachers started using computers on their own. In a more recent study, Becker (1986) found computers being used in K-12 science about 15-20 percent of the time, even though he found that at that time the ratio of computers to students in those schools was one computer to 40.

In light of the disappointing implementation up to then, we developed models and training materials for *ENLIST Micros* so that science teachers would improve both the quantitative and qualitative use of educational computing. Even though lack of teacher training is not the only barrier to implementing educational computing in science education, the BSCS position was that the greatest need was to train science teachers to use microcomputers effectively. In an attempt to alleviate the software barrier, the BSCS—when proposing new projects—now recommends including computer courseware as an integral part of the curriculum.

PROCEDURES

Curriculum development is a well-established discipline within the educational enterprise. The process of curriculum development includes, but is not limited to, the specification of program goals; development of program objectives; research and application of relevant literature; design and establishment of learning environments; creative preparation of learning materials and instructional activities that are both appealing and substantive; physical preparation of materials (typesetting, book design, paste-up, illustration, photography, films, slides, equipment, and sound tapes); development, validation, and use of test instruments; creation and application of teaching techniques and strategies; pilot testing and field trials; formative and summative evaluations of educational materials; process evaluations of program management; expert critical review; assessment; teacher training; and, replicable, empirical research on selected phases of the instructional process.

It is a misconception that educational materials are the product of one author working with pencil and paper. The truth of the matter is that curriculum development is a complex specialty field that requires a level of precision, efficiency, and productivity comparable to the best models found in business and industry.

We developed *ENLIST Micros* through an evolving and interactive process of curriculum development. The setting of objectives, and selection of writers, advisory committee members, field-test teachers, and sites for field testing were part of the process. We accomplished those tasks through interaction and collaboration with the advisory committee and other experts. Appendix 1 lists the individuals who were involved in the project and the roles they played.

A full discussion of the processes used in the design and development of curricula is beyond the scope of this report. There is, nevertheless, a large volume of theory and research to support the approach typically taken by the BSCS (Mayer, 1976). Figure 1 displays a flow chart of the tasks

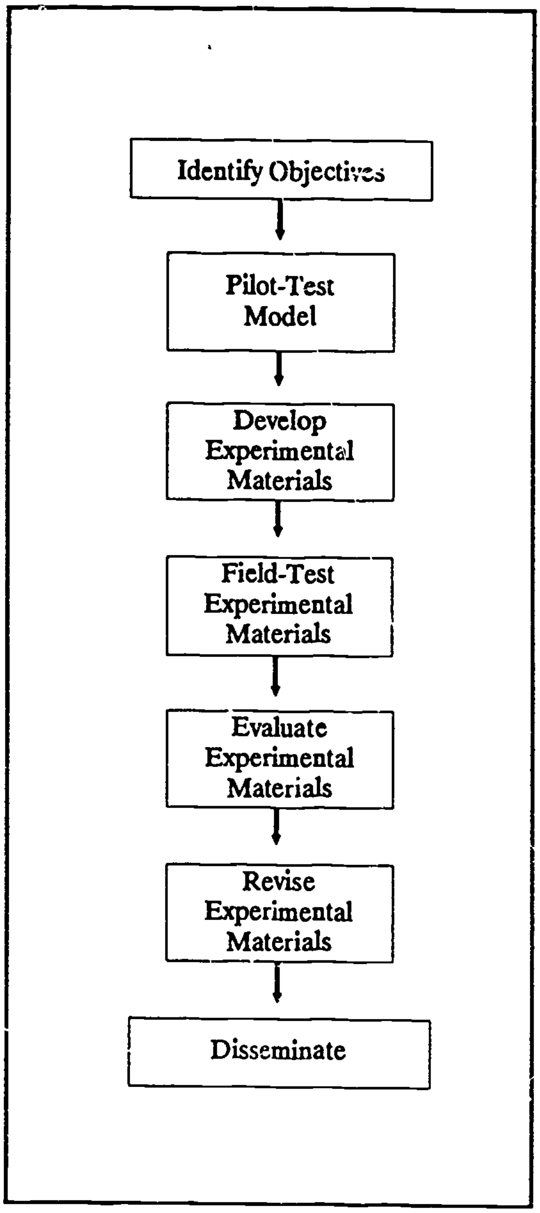

Figure 1: Flow Chart of Project Tasks

identifying the procedure we used to develop the curriculum.

Identify and Validate Objectives

In 1984, there was little consensus among educators about the definition of computer literacy. Questions under consideration included: Is computer literacy different for students, computer professionals, and educators? Is computer literacy the same for a science teacher as it is for other teachers? Is it the same for students, teachers, and general citizens?

We believed that certain skills of operating a computer were mandatory for computer literacy and that other knowledge and skills were specific to a particular occupation. Therefore, in the proposal, we defined a science teacher who was computer literate as *one who is able to use a microcomputer effectively for the purpose of improving the quality and efficiency of learning science.*

In preparing the *ENLIST Micros* proposal, we conducted a preliminary review of the literature and found a wide range of objectives for computer literacy among science teachers. The objectives suggested knowledge in the following major areas: components and functions of computers, history of computers, mathematical functioning of computers, computer operation, programming language, computer applications, computer courseware, and evaluation methodologies for courseware.

The preliminary search for computer literacy objectives uncovered more than we deemed appropriate for inclusion in a curriculum for training science teachers. In collaboration with the advisory committee, we judged the time available for inservice and preservice instruction of science teachers in educational computing to be no more than 15 hours (one semester credit). Fifteen hours is not enough time to achieve all of the objectives recommended in the literature. Therefore, the first task for *ENLIST Micros* was to determine which objectives of computer literacy for science teachers were the most important.

A paper by Ellis and Kuerbis (1985) describes the development of the essential competencies. The first step involved reviewing the literature to identify a pool of possible objectives. In the second step, we consolidated the tentative objectives; a group of science educators and computer educators evaluated our process and the results of the consolidation. In the third step, we sent the objectives to a sample of professors in science education and computer education, school administrators, and science teachers to rank the objectives by level of priority for science teachers. The fourth step involved selecting those objectives ranked as important by 75 percent of the reviewers as the focus for developing the training materials. In the fifth step, we used factor analysis to determine major constructs of the essential competencies for computer literacy for science teachers.

Pilot Test Model and Materials

The project staff developed pilot materials based on the objectives from the needs-assessment study. We pilot tested the materials in several preservice and inservice settings and used evaluations of the pilot tests to develop the experimental training materials.

Develop Experimental Materials

The experimental curricular materials were developed immediately following the completion of the pilot testing. An advisory committee of ten members (Appendix 1) met and reviewed the essential competencies and the constructs derived by the needs assessment, and they evaluated the training model used in the pilot test. The constructs determined by the factor analysis defined the chapters for the curriculum. During the meeting, the advisory committee recommended methods and activities to achieve the curriculum's objectives.

Development of the curriculum began in the summer of 1985, when we convened a six-member writing team. We also retained computer programmers, media consultants, an artist, an editor, and a secretary to develop the curriculum. The writing team consisted of science teachers, scientists, computer educators, and science educators. The project staff, and later the advisory committee, reviewed and edited the activities developed by the writing team. A copy editor and secretary produced the final draft of the print materials; media consultants and computer programmers completed the nonprint materials.

The experimental curriculum included a text, a leader's guide, slides, video, and computer software. The materials were designed to be used with a group or individually, and by all science teachers in all grade levels.

Field Test

Field test coordinators implemented the experimental curriculum in preservice and inservice teacher education settings across the country. We sought a minimum of five preservice and five inservice settings–ranging in size from small, private, liberal arts colleges to major science education centers–to test and evaluate the materials. We identified and selected the field test sites through a process of recommending and screening by the advisory committee and project staff. We sought participants with experience ranging from preservice teachers with no experience to inservice teachers with more than 20 years of experience, with assignments ranging from elementary to secondary. We sought out a diversity of sites for field testing so as to ensure that the final curriculum would be appropriate to meet the diverse needs of a wide range of science teachers.

Evaluation and Revision

A thorough evaluation accompanied the field testing of the experimental materials. We used both formative and summative evaluation procedures. Formative evaluation procedures included questionnaires and interviews with instructors, questionnaires and outcome measures for participants, and expert review. We used outcome measures to assess knowledge, skills, and attitudes about educational computing of the science teachers participating in the project.

William E. Baird, a writer and field test coordinator, conducted a follow-up survey at Auburn University to measure the implementation of computers in science teaching by participants of his inservice workshops. Baird, Ellis, and Kuerbis (1987) presented a paper reporting the results of this study to the 1987 meeting of the National Association of Research in Science Teaching.

Late in 1985, we realized that the participating science teachers would need follow-up implementation support, after the initial 15-hour training workshop, to increase their use of educational computing. The BSCS submitted a proposal to the NSF for funding *ENLIST Micros II (EM2)*, which the NSF subsequently approved. *EM2* is a three-year project for the design and development of a model for enhancing use of computers in science classrooms. We gathered additional formative evaluation data during the first year of *EM2* (1986-1987) and used those data to evaluate the training process and experimental materials.

The advisory committee and project staff reviewed the evaluation results and experimental materials and recommended improvements. During 1986-87, the project directors, a media consultant, a computer programmer, and education consultants revised the curriculum materials and the project staff prepared the final copy of the materials for dissemination.

The revised curriculum will be used with the participants in year two of *EM2*. We will use summative outcome measures to determine the participant's knowledge, skills, and attitudes about educational computing and the implementation of microcomputers. The results of the summative evaluation will be an early indication of the success of the training model and curriculum developed by *ENLIST Micros* and *EM2*.

Dissemination

In the *ENLIST Micros* proposal, we agreed that 50 sets of the final curriculum would be distributed to institutions that train science teachers. We decided to use articles in science education journals and presentations at professional meetings of science educators to disseminate information about the project. The BSCS agreed to offer the final materials for commercial publication; if no commercial publisher was found, however, the materials were to be submitted to the National Diffusion Network for distribution.

RESULTS

The Essential Competencies

From the 160 objectives for computer literacy in the literature, we identified 63 separate objectives appropriate for science teachers. In the needs assessment study, 46 professors of science education and computer education, 65 school administrators, and 146 science teachers identified 22 objectives as essential competencies for science teachers. Next, we performed a factor analysis to uncover the underlying constructs for those essential competencies.

Table 1 lists the 22 competencies and the six factors to which they correspond. For more complete discussions of the process followed to determine the essential competencies, see papers by Ellis and Kuerbis (1985 and 1986a).

The Experimental Curriculum

The advisory committee recommended the basic design of the experimental curriculum and its process of development. Project staff, writers, and media consultants developed the materials during the summer of 1985. The experimental materials consisted of a text and an annotated guide for workshop leaders. We also included videotape programs of interviews with teachers and scenes depicting students using computers in science to introduce computer literacy competencies for science teachers and to illustrate how to integrate microcomputers into instruction. Some of the experimental materials were computer software programs, which we wrote specifically for *ENLIST Micros*. These programs tutored participants in applications of educational computing for science education. We provided many

TABLE 1

Essential Competencies and Factors

Awareness of Computers

Upon completion of *ENLIST Micros* the participant will be able to:

- Demonstrate an awareness of the major types of applications of the computer--such as information storage and retrieval, simulation and modeling, process control and decision making, computation, and data processing.
- Communicate effectively about computers by understanding and using appropriate terminology.
- Recognize that one aspect of problem solving involves a series of logical steps, and that programming is translating those steps into instructions for the computer.
- Understand thoroughly that a computer only does what the program instructs it to do.
- Demonstrate an awareness of computer usage and assistance in fields such as:

health	business and industry
science	transportation
engineering	communications
education	military

- Respond appropriately to common error messages when using software.
- Load and run a variety of computer software packages.

Applications of Microcomputers in Science Teaching

Upon completion of *ENLIST Micros* the participant will be able to:

- Describe the ways the computer can be used to learn about computers, to learn through computers, and to learn with computers.
- Describe appropriate uses for computers in teaching science, such as:
  —computer-assisted instruction (simulation, tutorial, drill and practice)
  —computer-managed instruction
  —microcomputer-based laboratory
  —problem solving
  —word processing
  —equipment management
  —record keeping
- Apply and evaluate the general capabilities of the computer as a tool for instruction.
- Use the computer to individualize instruction and increase student learning.
- Demonstrate appropriate uses of computer technology for basic skills instruction.

(Continued)

TABLE 1 *(Continued)*

Implementation of Microcomputers in Science Teaching

Upon completion of *ENLIST Micros* the participant will be able to:

- Demonstrate ways to integrate the use of computer-related materials with non-computer materials, including textbooks.
- Plan appropriate scheduling of student computer activities.
- Respond appropriately to changes in curriculum and teaching methodology caused by new technological developments.
- Plan for effective pre- and post-computer interaction activities for students (for example, debriefing after a science simulation).

Identification, Evaluation, and Adoption of Software

Upon completion of *ENLIST Micros* the participant will be able to:

- Locate commercial and public domain software for a specific topic and application.
- Locate and use at least one evaluative process to appraise and determine the instructional worth of a variety of computer software.

Resources for Educational Computing in the Sciences

Upon completion of *ENLIST Micros* the participant will be able to:

- Identify, evaluate, and use a variety of sources of current information regarding computer uses in education.

Attitudes About Using Computers in Science Education

Upon completion of *ENLIST Micros* the participant will be able to:

- Voluntarily choose to use the computer for educational purpose.
- Display satisfaction and confidence in computer usage.
- Value the benefits of computerization in education and society for contributions such as:
  - —efficient and effective information processing,
  - —automation of routine tasks,
  - —increasing communication and availability of information,
  - —improving student attitude and productivity, and
  - —improving instructional opportunities.

programs of commercial computer software; this software served as examples of the appropriate use of computers in science teaching. Finally, the experimental materials included catalogs of commercial computer software to simplify locating and analyzing software for particular topics, objectives, and grade levels.

The text included a preface introducing *ENLIST Micros* and the following five chapters and six appendices:

Chapter 1: Awareness
Chapter 2: Applications
Chapter 3: Implementation
Chapter 4: Evaluation
Chapter 5: Resources
Appendix A: Getting Started
Appendix B: History and Impact of the Computer
Appendix C: NSTA Microcomputer Software Evaluation Instrument
Appendix D: Resources in Educational Computing in the Sciences
Appendix E: Answers to Discussion Questions
Appendix F: Glossary of Terms

Each chapter in the text included an introduction with a chapter overview; objectives to be mastered; prerequisite knowledge and skills; and a vocabulary of new terms to be used in the chapter. The chapters also included activities for the learner, optional application activities for reinforcement, and supplemental resources.

The First Field Test

The experimental materials were field tested with 18 groups at 15 sites around the nation and were reviewed by a panel of experts. See Appendix 1 for a list of the field test coordinators and reviewers. During the field test, we gathered descriptive data on the group leaders and asked them to complete a questionnaire to evaluate the curriculum. We also used the following methods to obtain information from the participants: a questionnaire on personal characteristics, pre- and post-test of computer literacy, pre- and post-test of attitudes toward computers, and a questionnaire to evaluate the *ENLIST Micros* curriculum. See Appendix 2 for the instruments used in the field test to gather data.

Descriptive information for group leader. We gathered information on 13 variables that described the background and experiences of the group leaders—such as the number of years teaching experience, degrees earned, college credits in science, computer science, and computer education. Table 2 lists the variables and descriptive statistics for the leaders who returned the descriptive information form.

In general, the leaders had a great deal of teaching experience. On the average, they had earned more than 120 college semester credits in science and had an average of two courses in computer science and two in educational computing. Sixty percent had PhD degrees and 40 percent had Master's degrees; seventy percent majored in science education or in science; one hundred percent indicated they had used microcomputers; and all of them believed they were either a typical user or expert user and were not novices. In summary, the instructors were very knowledgeable in science education and were developing expertise in educational computing. The workshop leaders had the level of knowledge and skills for which we designed the experimental materials.

Critique by group leaders. The critique of the curriculum by the workshop leaders included information describing the course, a general critique of the curriculum, and critiques of each chapter and activity. Table 3 lists the items and descriptive statistics for each item. The workshops averaged 25 participants, 11 hours of contact time, four meetings, and six hours of homework. At least 80 percent of the workshop leaders conducted each activity.

In conclusion, the curriculum was implemented as intended, with the exception of the number of hours of contact time, which was less than we requested. The 11 hours of contact time, however, substantiates our belief that 15 hours of contact time is the maximum available for training science teachers in educational computing.

More than 85 percent of the workshop leaders felt the curriculum met its goals and objectives; few thought the materials were too easy or too difficult; 82 percent said they would use the materials again. The workshop leaders rated all of the chapters as somewhat effective to very effective; none was rated not effective. Respondents rated chapter 5: "Resources" as the least effective. Even in this case two-thirds of the workshop leaders rated it as very effective or effective; one-hundred percent of the ratings for chapter 4: "Evaluation" were either very effective or effective. Workshop leaders agreed that the individual activities were effective, with many of them rated effective or very effective by 100 percent of the leaders. Every activity was rated as effective or very effective by the majority of the leaders.

In conclusion, workshop leaders responded that the curriculum materials and activities were well selected and constructed. Nevertheless, we found the comments

TABLE 2

Descriptive Information for Group Leaders

N = 15

Variable and value	Percentage
Highest degree earned	
Bachelors	0.0
Masters	60.0
Doctorate	40.0
Major	
Education	30.0
Science	10.0
Science education	60.0
Have you ever used a microcomputer?	
Yes	100.0
No	0.0
If you have used a microcomputer, are you a:	
Novice	0.0
Typical user	80.0
Expert	20.0

Variable	Mean	Standard Deviation
Number of years		
teaching experience	12.26	4.20
administrative experience	4.29	8.09
experience as a trainer of science teachers	9.83	9.26
experience teaching computer courses	1.86	1.20
experience training teachers to use computers	1.76	0.96
Number of college credits (semester hours) in		
Science	123.85	38.34
Education	69.40	26.00
Computer science	6.34	8.29
Educational computing	4.44	3.42

TABLE 3

Descriptive Statistics for Group Leader Critique

N = 15

Variable and value	Percentage
ENLIST Micros was very effective in meeting its goals and objectives.	
Strongly agree	25.0
Agree	62.5
Disagree	12.5
Strongly disagree	0.0
ENLIST Micros met the stated objectives.	
Strongly agree	18.2
Agree	72.7
Disagree	9.1
Strongly disagree	0.0
ENLIST Micros was at too low a level.	
Strongly agree	9.1
Agree	18.2
Disagree	54.5
Strongly disagree	18.2
ENLIST Micros was too advanced.	
Strongly agree	0.0
Agree	0.0
Disagree	54.5
Strongly disagree	45.5
I would use *ENLIST Micros* again to teach similar participants to use the microcomputer in science teaching.	
Strongly agree	45.5
Agree	36.4
Disagree	9.1
Strongly disagree	9.1

(Continued)

TABLE 3

Descriptive Statistics for Group Leader Critique

(Continued)

Variable and value	Percentage
Rate the overall effectiveness of each chapter in meeting its particular goals and objectives for most participants.	
Chapter 1: Awareness	
Very effective	36.4
Effective	36.4
Somewhat effective	27.3
Not effective	0.0
Chapter 2: Applications	
Very effective	70.0
Effective	10.0
Somewhat effective	20.0
Not effective	0.0
Chapter 3: Implementation	
Very effective	9.1
Effective	63.6
Somewhat effective	27.3
Not effective	0.0
Chapter 4: Evaluation	
Very effective	20.0
Effective	80.0
Somewhat effective	0.0
Not effective	0.0
Chapter 5: Resources	
Very effective	11.1
Effective	55.6
Somewhat effective	33.3
Not effective	0.0

(Continued)

TABLE 3

Descriptive Statistics for Group Leader Critique

(Continued)

Variable	Mean	Standard Deviation
Number of participants in this *ENLIST Micros* course.	24.67	5.87
Number of hours you met with participants as a group.	11.77	4.14
Number of times your group met.	4.07	2.49
Estimated number of hours participants worked outside of class.	5.73	2.00

and evaluation responses from the leaders useful in determining revisions for the curriculum.

Participant descriptive information. In addition to the critiques we also gathered descriptive information on 18 variables from 322 participants (Table 4). The items included information on teaching assignment; teaching experience; college degrees; college credits in science, education, and computer science; college credits and inservice credits in educational computing; past experience with microcomputers; availability of microcomputers for teaching; and, plans to use computers in science teaching during the next year.

In general, the participants ranged from those with no teaching experience to one with 32 years experience teaching in secondary schools. Approximately one-third were preservice teachers, one-third were inservice elementary school teachers, and one-third were secondary school teachers. The average number of credits in science and education was 36, but we found large standard deviations of 29 and 33, indicating that some had few credits and others had many.

The participants had little experience in educational computing or computer science. The average number of inservice credits in educational computing was 2.2. Forty-eight percent indicated they were novice users of microcomputers; 80 percent indicated they had not used the microcomputer previously in teaching; but, 72 percent planned to use microcomputers in science teaching next year. Sixty-seven percent indicated they had microcomputers available for science teaching, and that an average of 4.2 microcomputers were available for science teaching.

We concluded that this group of participants was well suited to our field test needs. They had a varied background in science and science education; they had minimal prior experience with computers; and, many of them indicated that microcomputers were available for science teaching, even though they weren't currently using them for that purpose.

Participant critique. We asked the participants to use a questionnaire developed for the project to critique the *ENLIST Micros* experimental materials. The participant critique was an abbreviated version of the leader critique. The participants evaluated the materials in general and each chapter of the text, and they identified the most effective and least effective activities (Table 5).

Generally the participants gave the curriculum materials a high rating. More than 85 percent of the participants agreed or strongly agreed that the curriculum was effective at meeting its goals and objectives. More than 70 percent felt that the

TABLE 4

Descriptive Information for Participants

N = 322

Variable and value	Percentage
Teaching level	
K - 6	35.3
7 - 9	12.9
10 - 12	15.4
K - 8	1.8
K - 12	0.7
Preservice	32.7
College	0.4
Teaching subject(s)	
General elementary	31.0
Elementary science	8.7
General science	8.7
Life science/biology	10.3
Earth/physical science	3.8
Physics	1.6
Chemistry	1.6
Other	0.5
Biology and earth/physical science	2.2
Biology and chemistry	2.2
Biology and other	6.0
Earth/physical science and physics	0.5
Earth/physical science and chemistry	0.5
Earth/physical science and other	2.2
Physics and chemistry	1.6
Biology and earth science and physics	0.5
Biology and earth science and chemistry	0.5
Biology and physics and chemistry	1.1
Supervisor	4.3
Science and other	10.3
Math	1.1
Earth science and physics and chemistry	0.5

(Continued)

TABLE 4

Descriptive Information for Participants

(Continued)

Variable and value	Percentage
Highest degree earned	
Bachelors	57.6
Masters	35.4
Doctorate	1.7
Major	
Education	34.5
Science	15.8
Science education	6.5
Have you ever used a microcomputer?	
Yes	74.7
No	25.0
If you have used a microcomputer, are you a:	
Novice	48.2
Typical user	26.4
Expert	0.7
Have you used a computer in science teaching?	
Yes	19.8
No	80.2
Do you have computer(s) available for your science teaching?	
Yes	66.5
No	33.5
Do you plan to use a computer in science teaching during the next year?	
Yes	71.7
No	28.3

(Continued)

TABLE 4

Descriptive Information for Participants

(Continued)

Variable	Mean	Standard Deviation
Number of years		
teaching experience K-6	3.20	5.86
teaching experience 7-12	3.66	6.80
Number of college credits (semester hours) in		
Science	36.18	32.86
Education	36.89	28.78
Computer science	1.46	3.18
Educational computing	0.68	2.11
Number of inservice hours in educational computing.	2.19	6.35
Frequency of microcomputer use in science teaching.	1.49	1.00
Number of microcomputers available for science teaching.	4.[illegible]	7.03

TABLE 5

Descriptive Statistics for Participant Critique

N = 322

Variable and value	Percentage
ENLIST Micros was very effective in meeting its goals and objectives.	
Strongly agree	23.3
Agree	65.8
Disagree	10.9
Strongly disagree	0.0
ENLIST Micros met the stated objectives.	
Strongly agree	19.1
Agree	75.8
Disagree	5.1
Strongly disagree	0.0
ENLIST Micros was at too low a level.	
Strongly agree	8.1
Agree	20.9
Disagree	57.9
Strongly disagree	13.2
ENLIST Micros was too advanced.	
Strongly agree	0.8
Agree	2.1
Disagree	61.4
Strongly disagree	35.6
I would recommend *ENLIST Micros* to other science teachers who have no experience with computers.	
Strongly agree	38.8
Agree	51.1
Disagree	8.9
Strongly disagree	1.3

(Continued)

TABLE 5

Descriptive Statistics for Participant Critique

(Continued)

Variable and value	Percentage
Rate the overall effectiveness of each chapter in meeting its particular goals and objectives.	
Chapter 1: Awareness	
Very effective	30.0
Effective	55.8
Somewhat effective	13.8
Not effective	0.4
Chapter 2: Applications	
Very effective	31.3
Effective	49.6
Somewhat effective	18.7
Not effective	0.4
Chapter 3: Implementation	
Very effective	19.2
Effective	49.8
Somewhat effective	26.5
Not effective	4.5
Chapter 4: Evaluation	
Very effective	19.8
Effective	55.0
Somewhat effective	22.3
Not effective	2.9
Chapter 5: Resources	
Very effective	24.3
Effective	54.0
Somewhat effective	19.2
Not effective	2.5

materials were neither too easy nor too advanced. Ninety percent agreed or strongly agreed that they would recommend the workshop to other science teachers. Each chapter was rated as effective or very effective by more than two-thirds of the participants. Chapter 3: "Implementation," was rated least effective; only five percent, however, rated it as not effective. We used the results of the ratings for individual activities to revise the total curriculum.

Participant outcomes. We developed and administered (pre- and post-) a Test of Computer Literacy for Science Teachers (TCLST) and administered the Computer Opinion Survey version AZ (COS), developed at Iowa State University (Maurer and Simonson, 1984), as a pre- and post-test of anxiety for computer use. Kuerbis and Ellis (1986b) described the process of developing the TCLST in "The Development of a Test of Computer Literacy for Science Teachers in Grades K-12."

We used the *t*-test to compare the pre- and post-test data for the TCLST and COS. The workshop group was the unit of analysis. Tables 6 and 7 present the results of the analyses. For both the TCLST and the COS we found a significant difference (.001 level) between the pre-test and post-test means for the groups. Therefore, we conclude that the materials were very effective at improving the participants' knowledge and attitudes about educational computing.

The Implementation Study

William E. Baird conducted an implementation study at the Auburn University site, using the participants in two workshops, to determine how the participants were using microcomputers during the year following the training. A configuration-of-use instrument was developed to measure implementation at the Auburn site (Appendix 2). Baird, Ellis, and Kuerbis (1987) presented the findings in "ENLIST Micros: Training Science Teachers to Use Microcomputers."

The outcome measures for the 33 participants in the Auburn workshops indicated that the teachers mastered the knowledge and attitudes for computer literacy. The majority of the participants indicated that the workshop was the best they attended that year. Eighty-eight percent indicated that they had microcomputers available to them for teaching purposes; sixty-four percent had software and supplies available; only 12 percent, however, were currently using microcomputers for teaching science. Because more than two-thirds of the sample were elementary teachers, specifying science as a focus for computer use may have biased the 12 percent figure, as indicated by the fact that an additional 21 percent used computers in teaching other subjects. Thus 67 percent of the participants in *ENLIST Micros were not* using computers one year after the workshops. Despite this, 76 percent felt

Table 6

Results of *t*-test Pre- and Post-comparison for Test of Computer Literacy for Science Teachers

N = 15

Test	Mean	Standard Deviation	Degrees of Freedom	*T* Value
Pre-test	13.51	1.46	14	- 4.25 *
Post-test	14.62	1.17		

* Significant at .001 for two-tail probability

Table 7

Results of *t*-test Pre- and Post-comparison for Computer Opinion Survey

N = 15

Test	Mean	Standard Deviation	Degrees of Freedom	*T* Value
Pre-test	59.02 *	10.51	11	7.67 **
Post-test	52.24	8.77		

* A lower mean indicates more positive attitudes
** Significant at .001 for two-tail probability

that the training had positively affected their use of computers and 42 percent said they had used skills from the workshop to help train other teachers in computer skills.

That was a disappointing degree of implementation. We had anticipated, however, that changing teacher behaviors would require more than a 15-hour workshop and already had initiated *EM2* to develop implementation strategies.

To determine barriers to educational computing in science teaching, the Auburn participants were asked to rank barriers to greater implementation of computers in their classroom. The lowest-ranked barriers were personal and student interest in the use of computers; highest barriers were lack of money, lack of time to prepare, and lack of available equipment and supplies. We asked teachers if they would use computers "more," "less," or "about the same" if these barriers did not exist. Eighty-eight percent indicated they would use the computer more frequently if the barriers were removed. Support from peers and technical support did not seem to be major barriers.

Baird , Ellis, and Kuerbis (1987, p. 8) concluded:

> It seems clear that teachers who participated in the *ENLIST Micros* workshops acquired needed skills and knowledge for better application of computers in teaching. What emerges from the follow-up interviews is the powerful influence of local environment on teachers' use of the computer. Lack of money for software and hardware sufficient to create a "critical mass" of computer resources within each school may, along with the lack of follow-up to the initial training, limit the implementation of educational computing in science. While a disappointing number of teachers are using computers regularly one year after a 16-hour, hands-on training workshop, there is evidence that teachers remember and value that training and feel that local factors inhibit their application of the new skills and knowledge.

ENLIST Micros Part Two

The results from the Auburn study were expected. We were aware that promoting change of teacher behaviors is a complicated process, involving much more than knowledge, skills, and attitudes. Therefore, we used the results of the field test, the results from the implementation study, and information gleaned from the literature and other teacher-training projects to design a model for teacher enhancement in educational computing in the sciences *(EM2)*.

With *ENLIST Micros Part II (EM2),* we are developing strategies to increase the implementation of microcomputers in science education. The project goals are to:

1. Train 260 science teachers and administrators in the 22 districts in the Pikes Peak region to use the computer to enhance science learning and teaching.
2. Establish a network in the Pikes Peak region to implement educational computing in the sciences.
3. Develop and test a model for teacher enhancement for educational computing in the sciences.
4. Disseminate a model of teacher enhancement for educational computing in the sciences.

The preliminary results from the first year of *FM2* indicate that the model is working well. More than 60 teachers and administrators participated in leadership training for educational computing in the sciences for their districts. They used microcomputers regularly and in a variety of ways. The results of *EM2* will be reported in the project report to NSF for the first year of the project.

The Dissemination

We have distributed the results of the *ENLIST Micros* project through presentations at the National Association for Research in Science Teaching, at workshops at state, regional, and national meetings of the Association for the Education of Teachers of Science, the National Association of Biology Teachers, the Association of Teacher Educators, the Association of Educators of Teachers of Science, the National Council of States on Inservice Education, and the National Science Teachers Association; at a presentation in Hanasaari, Epsoo, Finland to the Commission for Biology Education of the International Union of Biological Sciences; through articles in the BSCS newsletter; and through published articles. Appendix 3 lists the papers presented or published, workshops or courses conducted, and articles published in the BSCS newsletter. Dissemination activities have continued with *EM2,* and additional publications, workshops, and advertisements will follow.

To determine how much the materials have been used beyond the initial field test, we conducted a survey of 151 trainers of science teachers, including the field-test coordinators, who had requested and received copies of the experimental curriculum. We did not include in the survey the more than 500 science teachers who had been trained with the materials during the field test or at workshops held by the project directors. We asked four questions to determine the teacher trainers' past use, current use, and planned use of the materials; one about their job title;

one to obtain names of other people who have used the materials; and one to obtain comments about the materials (Appendix 2).

Thirty-one responded to the survey. They included science teachers, professors in education and science education, science supervisors, and school administrators. They had used the materials for self-study, for informal sharing with other science teachers, to instruct preservice courses on educational computing and science methods, and for inservice courses on educational computing for science teachers. Appendix 4 presents the responses to the survey.

Under the guidance of the 31 who responded to the survey, more than 800 additional science teachers were exposed to the *ENLIST Micros* curriculum. This figure is likely a very low estimate of the total number of science teachers exposed to the materials, because the response rate to the use survey was only 20 percent. Many of the respondents indicated they used the materials, but did not indicate how many teachers were involved. The materials were implemented in a variety of ways. Some instructors just showed the video tape, others put the materials in a learning center and sent students there to study them, and others included the entire program in preservice methods courses and training workshops for inservice science teachers.

From previous experiences the BSCS has had with developing curricula, we expected the use of the experimental materials outside of the field test sites. These uses, however, were not planned. The high level of use with no support from the BSCS or from the NSF indicates that this program has had an impact much greater than we had predicted. We can expect this impact to continue.

If we find a commercial publisher or another means of marketing and distributing the revised materials, these materials may reach a large number of science teachers and might do much to improve the use of educational computing in science education. Nevertheless, the BSCS will distribute 50 sets of the materials to training sites in the nation and continue to provide them to participants involved in *EM2* and at workshops at the regional and national meetings of the National Association of Biology Teachers and the National Science Teachers Association.

DISCUSSION

In the proposal, we set five goals for *ENLIST Micros*. We have accomplished them all. With *EM2*, we continue to refine the model and materials developed by

ENLIST Micros and to disseminate the results of our work. In the following sections, we discuss the achievement of the project's goals.

Establish Essential Competencies

Our first goal was to identify and validate computer literacy objectives for science teachers. We completed that task by determining 22 essential competencies in educational computing for science teaching. During our work with training teachers and from our continued study since identifying those competencies, however, we have enriched our understanding of what it takes for a science teacher to be a successful user of educational computing.

Our original conception was that the purpose of *ENLIST Micros* was to assist non-users of educational computing to become novices. The competencies we identified, if mastered, will achieve that goal. We have learned, however, that there is a great diversity of abilities and interests in educational computing among science teachers. Also, we believe that there is a need for leaders in educational computing in science education to serve as facilitators of the change process within each district and school building. Therefore, we are expanding our curriculum to include broader and deeper coverage of the essential competencies and adding more information appropriate for leaders of educational computing.

We are expanding the curriculum into three levels. The first level covers how to operate the microcomputer, the second level introduces information that science teachers need to begin using the microcomputer in their classrooms. For instance, novice users need to have a broad understanding of all applications, but they are primarily interested in applications that have immediate, positive effects on making their job easier or more effective. An experienced user wants to know: "How can I use the computer to improve students' learning of science?" and, "How do I change the way I teach and the way I organize my class and instruction?" Novice users are interested in evaluating courseware only to make decisions about purchases they may use, while experienced users want to standardize the process and be involved in decisions affecting their building or district. Experienced users who want to become leaders need to learn more about the process of change in school settings and how to facilitate that process for their peers. Therefore, we are adding to the revised curriculum a third level that goes into more depth on issues of interest to potential leaders who wish to learn more about educational computing in science education.

Develop the Teacher Training Model

We have developed and extensively tested a model for training science teachers in educational computing. The *ENLIST Micros* curriculum is based on that model, and guidelines for following the model are included in the guide for the workshop leader.

We continue to expand and refine the model during the *EM2* project. In the *EM2* proposal, we added implementation strategies for long-term, follow-up support for beginning users.

We are building, from the ground-up, a support system for educational computing in science education within each district involved in the project. Experienced teachers are being trained as team leaders to facilitate implementation of educational computing in their building. District-wide committees are being established to coordinate educational computing activities; representatives of those committees work together to establish policies and share resources for the Pikes Peak region.

We have established the position of master teacher on special assignment for educational computing in science education for the Pikes Peak region. The master teacher serves as a change facilitator who visits novice users—providing assistance, encouragement, and technical support. This position has received 50 percent support from the districts in the region and 50 percent from NSF; however, if the districts value the position, they will support it 100 percent when NSF support is removed.

When the next two years of *EM2* are completed, we hope to have a proven model for implementing educational computing in science instruction. We will disseminate that model widely via workshops and publications.

Develop the Curriculum and Improve Knowledge, Skills, and Attitudes

We were successful at developing curriculum materials that improve the knowledge, skills, and attitudes in educational computing of science teachers. We successfully achieved the third and fourth goals of *ENLIST Micros*. All measures used to evaluate the curriculum were positive, except for an increase in implementation (not one of our primary goals for *ENLIST Micros*).

With *EM2*, however, we have tentatively found that the revised and expanded model does increase implementation. We are incorporating the experience gained from *EM2* in the revised *ENLIST Micros* curriculum and look forward to using those materials and strategies during the second year of EM2 with more than 100 science teachers.

Disseminate Information

We have disseminated the results of the project widely. We have used a variety of dissemination approaches—including workshops, short articles in newsletters, paper presentations, and published articles. However, as *EM2* progresses we will continue to disseminate information and will seek a commercial publisher for the curriculum.

IMPLICATIONS

There are several implications for *ENLIST Micros*. The impact of *ENLIST Micros* on science education extends well beyond the project in that we have:

- developed and validated a model for science teacher enhancement that can be used to train science teachers and to implement innovative educational materials and approaches, beyond educational computing;
- defined more clearly what it means to be a science teacher competent in educational computing;
- determined strategies for implementing computing in science teaching;
- developed materials to prepare science teachers to implement educational computing that can be used without continued support from BSCS or NSF; and,
- determined appropriate uses of educational computing in science education.

RECOMMENDATIONS FOR RESEARCH AND DEVELOPMENT

We recognize that much additional work is needed to achieve the potential that educational computing has for science education. Much is not known; much needs to be accomplished. We recommend that the following activities be considered as means to further our understandings in this area:

- Determine effective uses of educational computing to enhance the productivity of science teachers.
- Determine effective uses of educational computing to help students develop deeper understandings of concepts in science that have been resistant to traditional instructional approaches.
- Determine effective uses of educational computing to help students do science.
- Determine conditions of the school environment that reinforce innovation in science education.
- Develop support systems for life-long improvement of science teaching.
- Develop computing courseware for science teaching that is an integral part of the curriculum.
- Establish procedures to disseminate information about science education so that research is translated into practice more quickly.
- Provide science teachers sufficient hardware and software to use educational computing.
- Ensure that the support for teacher training, curriculum development, implementation, research, and equipment and supplies is established as a perpetual component of educational activities at the national, state, and local levels.
- Establish science education centers for research, development, dissemination, and implementation.

CONCLUSION

We feel that ENLIST Micros has been a complete success and that our work will have longlasting effects on science education. The *ENLIST Micros* curriculum is effective at improving the knowledge and attitudes of educational computing of science teachers. By using these materials as one part of an implementation effort, we believe that more teachers will begin using microcomputers effectively in science education.

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Appendix 1

Contributors to ENLIST Micros

CONTRIBUTORS TO ENLIST MICROS

Project staff and consultants

James D. Ellis BSCS Colorado Springs, Colorado	Project Director
Martha A. Geisler BSCS Colorado Springs, Colorado	Computer Consultant
Joan M. Hillrich BSCS Colorado Springs, Colorado	Project Secretary Desktop Publishing
Steven Janke The Colorado College Colorado Springs, Colorado	Computer Consultant
Bert Kempers Media Design Associates, Inc. Boulder, Colorado	Media Consultant
Don Kinney Rocky Mountain Reflections Denver, Colorado	Video Consultant
Paul J. Kuerbis The Colorado College Colorado Springs, Colorado	Project Director
Ellen G. Rosenthal The Colorado College Colorado Springs, Colorado	Copy Editor
Norris Ross Media Design Associates, Inc. Boulder, Colorado	Media Consultant
Robert F. Wilson Tincup Graphics Boulder, Colorado	Artist

Advisory committee

Alan Brightman Apple Education Foundation Cupertino, California	Educational Computing Consultant
Theodore J. Crovello California State University Los Angeles, California	Biologist Computer Educator
Edward C. Hall, Jr. Wayland High School Wayland, Massachusetts	Science Teacher
Adeline Naiman HRM Software, Inc. Cambridge, Massachusetts	Director of Software Publishing
John D. Putnam Irving Junior High School Colorado Springs, Colorado	Computing Teacher
James P. Rodman Pike Elementary School Colorado Springs, Colorado	Elementary Teacher
James D. Spain Clemson University Clemson, South Carolina	Chemist Computer Educator
R. Ralph Sparks Carolina Biology Supply, Inc. Burlington, North Carolina	Director of Software Publishing
Richard R. Tolman Brigham Young University Provo, Utah	Biologist Science Educator
Barry L. Welsh Hewlett-Packard Inc. Colorado Springs, Colorado	Engineer

Writers

William E. Baird Auburn University Auburn, Alabama	Science Educator Computer Educator
Stephen F. Cowdrey King Elementary School Colorado Springs, Colorado	Elementary Teacher Computer Educator
David W. Dalton Indiana University Bloomington, Indiana	Computer Educator
James D. Ellis BSCS Colorado Springs, Colorado	Science Educator Computer Educator
Edward C. Hall Wayland Public Schools Wayland, Massachusetts	Science Teacher
Paul J. Kuerbis The Colorado College Colorado Springs, Colorado	Science Educator Computer Educator
James D. Spain Clemson University Clemson, South Carolina	Chemist Computer Educator
Robert F. Tinker Technical Education Research Centers Cambridge, Massachusetts	Physicist Computer Educator

Field test coordinators

William E. Baird Auburn University Auburn, Alabama	Science Educator
Nancy Bredemeier Kent State University Kent, Ohio	Science Educator
Joan Bruening Northmont Senior High Englewood, Ohio	Science Teacher
James D. Ellis BSCS Colorado Springs, Colorado	Science Educator
Larry Enochs Kansas State University Manhattan, Kansas	Science Educator
Anne Gymer Madera County Department of Education Madera, California	Science Supervisor
Eugene Gennaro University of Minnesota Minneapolis, Minnesota	Science Educator
Garland Johnson Fresno Unified School District Fresno, California	Science Supervisor
Jane Kahle and Cheryl Mason Purdue University West Lafeyette, Indiana	Science Educators
Ivo Linduer University of Northern Colorado Greeley, Colorado	Biology Educator

Frederick Staley and Patricia Fedock Arizona State University Tempe, Arizona	Science Educators
Philip Mattingly Northmont School District Englewood, Colorado	Science Supervisor
Paul Peknik Hunter College Stamford, Connecticut	Science Educator
James Shymansky and Joseph Krajcik University of Iowa Iowa City, Iowa	Science Educators
Melinda Wilder Eastern Kentucky University Richmond, Virginia	Science Educator

Reviewers

Advisory committee members, writers, and field test coordinators completed written reviews of the experimental materials. In addition the following experts reviewed the curriculum:

Lane Adams Broadmoor Elementary Colorado Springs, Colorado	Elementary Teacher Computing Teacher
Hal Fe Condui University o. Iowa Iowa City, Iowa	Computer Educator
Carl Berger University of Michigan Ann Arbor, Michigan	Science Educator Computer Educator
Robert Sherwood Peabody College Nashville, Tennessee	Science Educator Computer Educator
Michael Padilla University of Georgia Athens, Georgia	Science Educator

Appendix 2

Evaluation Instruments

DESCRIPTIVE INFORMATION -- GROUP LEADER
ENLIST MICROS

NAME________________ INSTITUTION____________________

______ Number of years teaching experience (K-12).

______ Number of years administrative experience (K-12).

______ Number of years experience as a trainer of science teachers.

______ Number of years experience teaching computer courses.

______ Number of years experience training teachers to use computers.

______ Highest degree earned. ______________________ major

______ Number of college credits (semester hours) in science.

______ Number of college credits (semester hours) in education.

______ Number of college credits (semester hours) in computer science.

______ Number of college credits (semester hours) in educational computing.

______ Number of inservice hours in educational computing.

______ Have you ever used a microcomputer?

______ If you have ever used a microcomputer, are you a (1) novice, (2) typical user, (3) expert?

______ Have you ever used a microcomputer in science teaching?

If yes, indicate frequency of use: ______________________

______ Do you have computer(s) available for your science teaching?

______ How many?

______ Do you plan to use a computer in science teaching during the next year?

Explain your experience with and past use of computers for teaching science.

GROUP LEADER CRITIQUE OF ENLIST MICROS

NAME____________________ INSTITUTION_________________________

I. COURSE LOGISTICS

_____ Number of participants in the *ENLIST Micros* course.

_____ Number of hours you met with participants as a group.

_____ Number of times your group met.

_____ Estimated number of hours participants worked outside of class.

II. GENERAL DESCRIPTION OF COURSE

A. Describe below any topics and objectives you elected not to teach and explain why you omitted them.

B. Describe below any topics and objectives you added to the *ENLIST Micros* course and explain why you added them.

III. GENERAL CRITIQUE

A. *ENLIST Micros* was very effective in meeting its goals and objectives for most of the participants.

CIRCLE = = > ONE

SA = Strongly agree
A = Agree
DA = Disagree
SDA = Strongly disagree

B. *ENLIST Micros* met the stated objectives.

SA A DA SDA

C. *ENLIST Micros* was at too low a level for most participants.

SA A DA SDA

D. *ENLIST Micros* was too advanced for most participants.

SA A DA SDA

E. I would use *ENLIST Micros* again to teach similar participants to use microcomputers in science teaching.

SA A DA SDA

F. I recommend the following changes in *ENLIST Micros:*

G. Other comments about *ENLIST Micros.*

H. Critique of chapters in *ENLIST Micros*

Rate the overall effectiveness of each chapter in meeting particular goals and objectives for most participants. (circle answer)

1. Chapter 1: Awareness

    a. very effective
    b. effective
    c. somewhat effective
    d. not effective

2. Chapter 2: Applications

    a. very effective
    b. effective
    c. somewhat effective
    d. not effective

3. Chapter 3: Implementation

    a. very effective
    b. effective
    c. somewhat effective
    d. not effective

4. Chapter 4: Evaluation

    a. very effective
    b. effective
    c. somewhat effective
    d. not effective

5. Chapter 5: Resources

    a. very effective
    b. effective
    c. somewhat effective
    d. not effective

IV. CRITIQUE OF SPECIFIC ACTIVITIES IN *ENLIST MICROS*

A. Introduction (Videotape: "Using the Computer in Science Teaching")

1. I (did / did not) use this activity with my group.
2. _____ percent of the participants completed this activity
3. This activity was done (during class / as homework).
4. _____ minutes was the average time participants spent on this activity.
5. This activity was very effective.
   SA A DA SDA
6. This activity met the stated objectives.
   SA A DA SDA
7. This activity was at too low a level.
   SA A DA SDA
8. This activity was too advanced.
   SA A DA SDA
9. I would use this activity again to teach similar participants.
   SA A DA SDA
10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

B. Chapter 1: Activity 1 (slide-tape: "Computer Awareness")

1. I (did / did not) use this activity with my group.

2. _____ percent of the participants completed this activity

3. This activity was done (during class / as homework).

4. _____ minutes was the average time participants spent on this activity.

5. This activity was very effective.
SA A DA SDA

6. This activity met the stated objectives.
SA A DA SDA

7. This activity was at too low a level.
SA A DA SDA

8. This activity was too advanced.
SA A DA SDA

9. I would use this activity again to teach similar participants.
SA A DA SDA

10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

C. Chapter 1: Activity 2 (computer program: "Maze")

1. I (did / did not) use this activity with my group.

2. ______ percent of the participants completed this activity

3. This activity was done (during class / as homework).

4. ______ minutes was the average time participants spent on this activity.

5. This activity was very effective.
SA A DA SDA

6. This activity met the stated objectives.
SA A DA SDA

7. This activity was at too low a level.
SA A DA SDA

8. This activity was too advanced.
SA A DA SDA

9. I would use this activity again to teach similar participants.
SA A DA SDA

10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

D. Chapter 2: Activity 1 (computer programs: "Applications")

1. I (did / did not) use this activity with my group.

2. _____ percent of the participants completed this activity

3. This activity was done (during class / as homework).

4. _____ minutes was the average time participants spent on this activity.

5. This activity was very effective.
SA A DA SDA

6. This activity met the stated objectives.
SA A DA SDA

7. This activity was at too low a level.
SA A DA SDA

8. This activity was too advanced.
SA A DA SDA

9. I would use this activity again to teach similar participants.
SA A DA SDA

10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

E. Chapter 3: Activity 1 (slide-tape: "Implementation: Problems and Solutions")

1. I (did / did not) use this activity with my group.
2. _____ percent of the participants completed this activity
3. This activity was done (during class / as homework).
4. _____ minutes was the average time participants spent on this activity.
5. This activity was very effective.
   SA A DA SDA
6. This activity met the stated objectives.
   SA A DA SDA
7. This activity was at too low a level.
   SA A DA SDA
8. This activity was too advanced.
   SA A DA SDA
9. I would use this activity again to teach similar participants.
   SA A DA SDA
10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

F. Chapter 3: Activity 2 (videotape: "Implementation of Microcomputers in Science Teaching")

1. I (did / did not) use this activity with my group.

2. _____ percent of the participants completed this activity

3. This activity was done (during class / as homework).

4. _____ minutes was the average time participants spent on this activity.

5. This activity was very effective.
   SA A DA SDA

6. This activity met the stated objectives.
   SA A DA SDA

7. This activity was at too low a level.
   SA A DA SDA

8. This activity was too advanced.
   SA A DA SDA

9. I would use this activity again to teach similar participants.
   SA A DA SDA

10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

G. Chapter 3: Activity 3 ("Situation Cards")

1. I (did / did not) use this activity with my group.

2. _____ percent of the participants completed this activity

3. This activity was done (during class / as homework).

4. _____ minutes was the average time participants spent on this activity.

5. This activity was very effective.
SA A DA SDA

6. This activity met the stated objectives.
SA A DA SDA

7. This activity was at too low a level.
SA A DA SDA

8. This activity was too advanced.
SA A DA SDA

9. I would use this activity again to teach similar participants.
SA A DA SDA

10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

H. Chapter 3: Activity 4 ("Lesson Plan")

1. I (did / did not) use this activity with my group.

2. ______ percent of the participants completed this activity

3. This activity was done (during class / as homework).

4. ______ minutes was the average time participants spent on this activity.

5. This activity was very effective.
   SA A DA SDA

6. This activity met the stated objectives.
   SA A DA SDA

7. This activity was at too low a level.
   SA A DA SDA

8. This activity was too advanced.
   SA A DA SDA

9. I would use this activity again to teach similar participants.
   SA A DA SDA

10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

I. Chapter 4: Activity 1 (slide-tape: "An Approach to Selecting Software")

1. I (did / did not) use this activity with my group.

2. ______ percent of the participants completed this activity

3. This activity was done (during class / as homework).

4. ______ minutes was the average time participants spent on this activity.

5. This activity was very effective.
SA A DA SDA

6. This activity met the stated objectives.
SA A DA SDA

7. This activity was at too low a level.
SA A DA SDA

8. This activity was too advanced.
SA A DA SDA

9. I would use this activity again to teach similar participants.
SA A DA SDA

10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

J. Chapter 4: Activity 2 ("Software Evaluation")

1. I (did / did not) use this activity with my group.

2. _____ percent of the participants completed this activity

3. This activity was done (during class / as homework).

4. _____ minutes was the average time participants spent on this activity.

5. This activity was very effective.
SA A DA SDA

6. This activity met the stated objectives.
SA A DA SDA

7. This activity was at too low a level.
SA A DA SDA

8. This activity was too advanced.
SA A DA SDA

9. I would use this activity again to teach similar participants.
SA A DA SDA

10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

K. Chapter 4: Activity 3 ("Software Scavenger Hunt")

1. I (did / did not) use this activity with my group.

2. _____ percent of the participants completed this activity

3. This activity was done (during class / as homework).

4. _____ minutes was the average time participants spent on this activity.

5. This activity was very effective.
   SA A DA SDA

6. This activity met the stated objectives.
   SA A DA SDA

7. This activity was at too low a level.
   SA A DA SDA

8. This activity was too advanced.
   SA A DA SDA

9. I would use this activity again to teach similar participants.
   SA A DA SDA

10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

L. Chapter 5: Activity 1 ("Overview of Resources")

1. I (did / did not) use this activity with my group.

2. _____ percent of the participants completed this activity

3. This activity was done (during class / as homework).

4. _____ minutes was the average time participants spent on this activity.

5. This activity was very effective.
   SA A DA SDA

6. This activity met the stated objectives.
   SA A DA SDA

7. This activity was at too low a level.
   SA A DA SDA

8. This activity was too advanced.
   SA A DA SDA

9. I would use this activity again to teach similar participants.
   SA A DA SDA

10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

M. Chapter 5: Activity 2 ("On-line Databases")

1. I (did / did not) use this activity with my group.
2. ______ percent of the participants completed this activity
3. This activity was done (during class / as homework).
4. ______ minutes was the average time participants spent on this activity.
5. This activity was very effective.
SA A DA SDA
6. This activity met the stated objectives.
SA A DA SDA
7. This activity was at too low a level.
SA A DA SDA
8. This activity was too advanced.
SA A DA SDA
9. I would use this activity again to teach similar participants.
SA A DA SDA
10. I recommend the following changes in this activity:

11. I modified or substituted for this activity as follows:

12. Other comments about this activity.

DESCRIPTIVE INFORMATION – PARTICIPANT
ENLIST MICROS

NAME____________________ INSTRUCTOR__________________________

Address____

Teaching Assignment: Level(s)_________________ ____________________

Subject(s)____

_______ Number of years teaching experience (K-6).

_______ Number of years teaching experience (7-12).

_______ Highest degree earned. ____________________________ major

_______ Number of college credits (semester hours) in science.

_______ Number of college credits (semester hours) in education.

_______ Number of college credits (semester hours) in computer science.

_______ Number of college credits (semester hours) in educational computing.

_______ Number of inservice hours in educational computing.

_______ Have you ever used a microcomputer?

_______ If you have ever used a microcomputer, are you a (1) novice, (2) typical user, (3) expert?

_______ Have you ever used a microcomputer in science teaching?

If yes, indicate frequency of use: ________________________

_______ Do you have computer(s) available for your science teaching?

_______ How many?

_______ Do you plan to use a computer in science teaching during the next year?

Explain your experience with and past use of computers for teaching science.

PARTICIPANT CRITIQUE
OF
ENLIST MICROS

NAME____________________ INSTRUCTOR________________________

I. GENERAL CRITIQUE

A. *ENLIST Micros* was very effective in meeting its goals and objectives.

CIRCLE = = > ONE	SA	=	Strongly agree
	A	=	Agree
	DA	=	Disagree
	SDA	=	Strongly disagree

B. *ENLIST Micros* met the stated objectives.

SA A DA SDA

C. *ENLIST Micros* was at too low a level.

SA A DA SDA

D. *ENLIST Micros* was too advanced.

SA A DA SDA

E. I would recommend *ENLIST Micros* to other science teachers who have no experience with computers.

SA A DA SDA

F. I recommend the following changes in *ENLIST Micros:*

G. Other comments about *ENLIST Micros.*

H. Critique of chapters

Rate the overall effectiveness of each chapter in meeting particular goals and objectives. (circle one choice for each item)

1. Chapter 1: Awareness

   a. very effective
   b. effective
   c. somewhat effective
   d. not effective

2. Chapter 2: Applications

   a. very effective
   b. effective
   c. somewhat effective
   d. not effective

3. Chapter 3: Implementation

   a. very effective
   b. effective
   c. somewhat effective
   d. not effective

4. Chapter 4: Evaluation

   a. very effective
   b. effective
   c. somewhat effective
   d. not effective

5. Chapter 5: Resources

   a. very effective
   b. effective
   c. somewhat effective
   d. not effective

IV. CRITIQUE OF ACTIVITIES IN ENLIST MICROS

From the list below, select the single most effective and single least effective activity from *ENLIST Micros* that you completed. Evaluate those activities by providing the information requested in sections IVA and IVB.

Chapter 1: Awareness

Introduction: Videotape — "Using the computer in Science Teaching"
Activity 1: Slide-tape — "Computer Awareness"
Activity 2: Computer program — "Maze"

Chapter 2: Applications

Activity 1: Computer programs — "Applications"

Chapter 3: Implementation

Activity 1: Slide-tape — "Implementation: Problems and Solutions"
Activity 2: Videotape — "Implementation of Microcomputers in Science Teaching"
Activity 3: "Situation Cards"
Activity 4. "Lesson Plan"

Chapter 4: Evaluation

Activity 1: Slide-tape — "An Approach to Selecting Software"
Activity 2: "Software Evaluation"
Activity 3: "Software Scavenger Hunt"

Chapter 5: Resources

Activity 1: "Overview of Resources
Activity 2: "On-line Databases"

A. Most effective activity = TITLE __________ ______________________

1. I (did / did not) complete this activity.

2. _____ minutes was the amount of time I spent on this activity.

3. This activity was very effective.
   SA A DA SDA

4. This activity met the stated objectives.
   SA A DA SDA

5. This activity was at too low a level.
   SA A DA SDA

6. This activity was too advanced.
   SA A DA SDA

7. I recommend this activity to another science teacher who has no experience with computers.
   SA A DA SDA

8. I recommend the following improvements in this activity:

9. This activity was effective because:

10. Other comments about this activity.

B. Least effective activity = TITLE ____________________

1. I (did / did not) complete this activity.

2. _____ r nutes was the amount of time I spent on this activity.

3. This activity was very effective.
SA A DA SDA

4. This activity met the stated objectives.

SA A DA SDA

5. This activity was at too low a level.
SA A DA SDA

6. This activity w·ıs too advanced.
SA A DA SDA

7. I recommend this activity to another science teacher who has no experience with computers.
SA A DA SDA

8. I recommend the following improvements in this activity:

9. This activity was effective because:

10. Other comments about this activity.

TEST OF COMPUTER LITERACY OF SCIENCE TEACHERS DEVELOPED FOR ENLIST MICROS

FORM A

NAME________________________________ DATE__________________

INSTRUCTOR____

MULTIPLE CHOICE

Read each question carefully and then circle the letter for the most appropriate answer.

1. A doctor's use of the microcomputer to generate mailing labels for billing would be described best as:

   A. information storage and retrieval
   B. simulations and modeling
   C. process control
   D. data processing
   E. none of the above

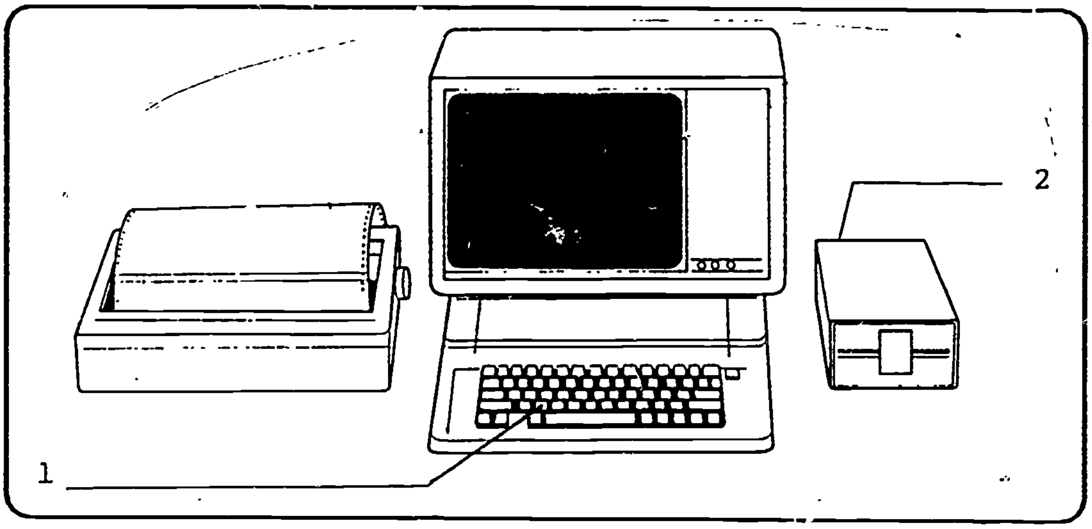


Figure 1

2. Component 1 figure 1 is the

   A. keyboard
   B. disk drive
   C. printer
   D. monitor

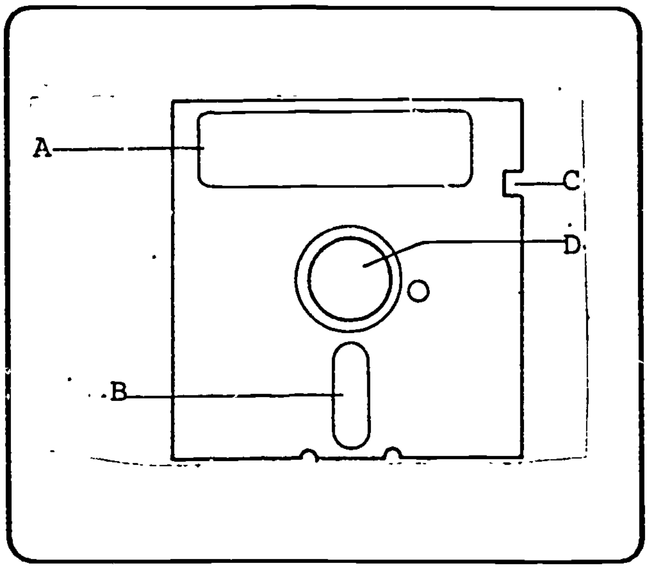


Figure 2

3. In figure 2, which letter points to the part of the disk where the disk drive actually reads and records the data?

   A. label
   B. contact hole
   C. write-protect notch
   D. drive hole

4. Which of the following fields makes use of the computer?

   A. communications
   B. science
   C. education
   D. business and education
   E. all of the above

5. You spell a command incorrectly. Which of the following error messages is likely to occur?

   A. I/O error
   B. syntax error
   C. out of range error
   D. file not found error
   E. file mismatch error

6. With an Apple II microcomputer that is turned off, which of the following is the correct order of events for booting a software program?

   A. Insert the disk; turn on the power; close the drive door.
   B. Open the drive door; turn on the power; insert the disk; close the drive door.
   C. Turn on the power; open the drive door; insert the disk; close the drive door.
   D. Open the drive door; insert the disk; close the drive door; turn on the power.

7. Of the following ways the computer can be used in education, which is an example of using the computer to manage instruction?

   A. drill and practice
   B. word processing
   C. simulation
   D. computer-based instrumentation

8. A program that presents questions about the parts of the skeletal system to help the student learn the names of the bones is an example of:

   A. drill and practice
   B. word processing
   C. simulation
   D. problem solving
   E. none of the above

9. If a student in grade seven is unable to advance in class because of lack of mastery of measuring length using the metric system, and all of the other students are now working on a new topic, which application(s) below could help the student and free more of the teacher's time to work with the rest of the class?

   A. drill and practice
   B. computer interfacing
   C. tutorial
   D. word processing
   E. both A and C

10. Which of the following would be an efficient use of one microcomputer in an elementary school?

   A. drill and practice for all students on a first-come first-served basis
   B. keep the microcomputer in the library so anyone can use it when needed
   C. keep the microcomputer in a room for use by teachers and administrators for record keeping and word processing
   D. all of the above

11. Which of the following goals of science education is reduced in importance because of the use of information technologies?

    A. learning generalizable concepts
    B. learning factual information
    C. learning skills to access information
    D. learning skills to use information to solve problems

12. Which of the following resources is most likely to have the most up-to-date information to support microcomputers in science teaching?

    A. Computers in Mathematics and Science Teaching (quarterly journal)
    B. *Computer Literacy* (book, 1982)
    C. RICE (on-line database)
    D. Proceedings of the National Educational Computing Conference 1983

TRUE or FALSE

Read each statement carefully and then indicate whether it is true or false by circling the appropriate response to the left of the statement.

True
False
13. A computer program is a series of instructions to a computer that translates into steps to solve a problem.

True
False
14. When a computer gives an unsatisfactory response to your input, it is not usually the computer's fault because a computer can only do what the instructions in the program tell it to do.

True
False
15. Microcomputers can be used to gather data in a laboratory situation.

True
False
16. Drill and practice is not an appropriate use of the computer to provide instruction in basic skills in science education.

True
False
17 The following scenario is an example of an effective way to integrate computer courseware into a lesson: A teacher establishes a computer station and small groups of students rotate through the station to interact with a simulation of an experiment. The experiment is simulated because the experiment is not practical to conduct in the classroom.

True
False

18. The following scenario is an example of an effective pre-computer activity: prior to inviting the students who are having difficulty identifying parts of the body to use a drill and practice program on human anatomy, the teacher presents a lesson on human anatomy.

True
False

19. If you find a review of a science courseware package that rates the material positively, then you can assume the material will be appropriate for the needs of your classroom.

True
False

20. The most valid method of evaluating software for a district is to use third party reviews.

TEST OF COMPUTER LITERACY OF SCIENCE TEACHERS DEVELOPED FOR ENLIST MICROS FORM B

NAME________________________________ DATE__________________

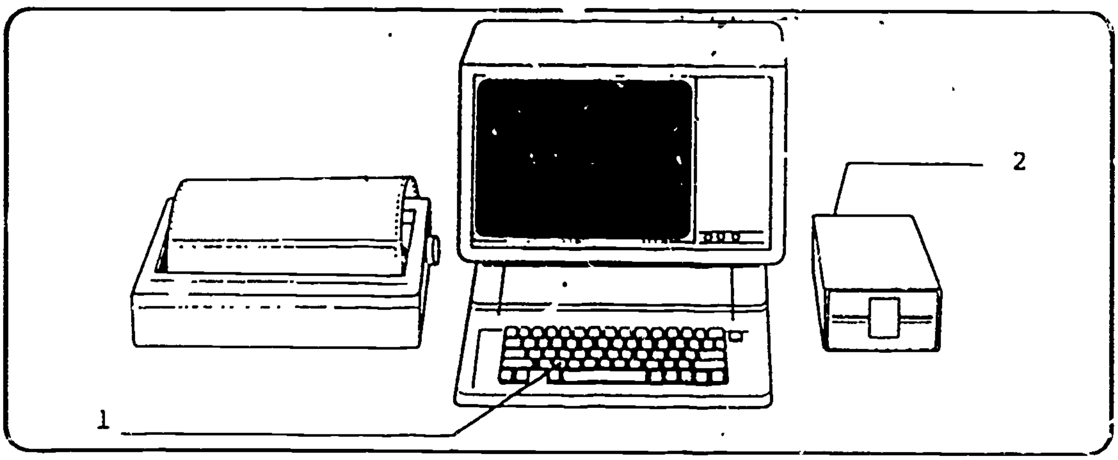
INSTRUCTOR____

MULTIPLE CHOICE

Read each question carefully and then circle the letter for the most appropriate answer.

1. By entering mathematical formulas and sample data, an engineer designed a graphic display that represents a complex series of chemical reactions that can not be seen through other means or are too dangerous to perform in the laboratory. This application is an example of:

   A. information storage and retrieval
   B. simulation and modeling
   C. process control
   D. data processing
   E. none of the above



2. Component 2 figure 1 is the

Figure 1

   A. keyboard
   B. disk drive
   C. printer
   D. monitor

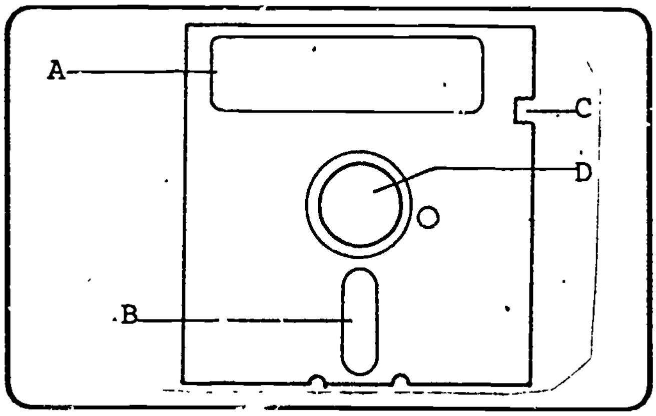


Figure 2

3. In figure 2, which letter points to the part of the disk that can be covered to prevent the disk from being erased accidentally.

   A. label
   B. contact hole
   C. write-protect notch
   D. drive hole

Commands to Flip a Coin

a. Open the right hand exposing the coin.
b. Place the coin in the right hand.
c. Look at the face of the coin that is visible and determine if it is heads or tails.
d. Catch the coin in the right hand.
e. Throw the coin into the air imparting a rotational force with the wrist that causes the coin to tumble.

Figure 3

4. Figure 3 lists a series of steps needed to flip a coin. Which of the sequences of steps below would successfully flip the coin?

   A. b, e, d, c, a
   B. b, e, d, a, c
   C. b, d, e, c, a
   D. e, d, a, c, b
   E. c, b, e, d, a

5. When using a program that displays a statement on the screen requesting you to input your age, you fib and input 13, the computer responds by displaying "You sly devil!" Which choice explains best the computer's response?

   A. Thirteen is an unlucky number
   B. The program was written to respond that way if the value entered was less than the expected age for a teacher.
   C. Somehow, the computer knows.
   D. The computer program truncates all numbers below 100; therefore, 13 equals zero.

6. Which of the following fields uses the computer for data processing?

   A. communications
   B. science
   C. education
   D. business and education
   E. all of the above

7. You unknowingly place a damaged disk in the disk drive and boot the system. Which of the following error messages is likely to occur?

   A. I/O error
   B. syntax error
   C. out of range error
   D. file not found error
   E. file mismatch error

Steps to Boot a Program

a. Close the drive door
b. Open the drive door
c. Insert the disk into the drive.
d. Turn on the computer.

Figure 4

8. Figure 4 lists a series of steps that may be necessary for booting a software program on an Apple II microcomputer that is turned off. What is the correct order of events for booting a computer?

   A. c, e, a, d
   B. b, c, e, d
   C. d, c, a, e
   D. b, c, a, d

9. Of the following ways the computer can be used in education, which is an example of using the computer to manage instruction?

   A. drill and practice
   B. computer-based testing
   C. simulation
   D. computer-based instrumentation

10. Identify the most appropriate application for this situation: students will determine the mean and standard deviation of a set of data.

    A. drill and practice
    B. data analysis
    C. simulation
    D. problem solving
    E. tutorial

11. If a student has quickly mastered the basics of a topic while the remainder of the class needs additional time and practice on the topic, which application below could help the student gain greater understanding of how the basic information is applied while freeing the teacher to work with the rest of the class?

    A. drill and practice
    B. computer interfacing
    C. tutorial
    D. word processing
    E. simulation

12. Here is a teaching situation. You have the following:

    - one computer with printer
    - 32 students
    - a computer simulation of genetic crosses that can print the results of the crosses
    - a unit on genetics designed for 15 hours of instructional time
    - a requirement that five hours of instructional time be reserved for lecture/discussion
    - a requirement that students solve a genetics problem that requires one hour on the computer

    What is the best grouping of students to use the computer that allows all of the students sufficient time to solve the problem, and that keeps the groups as small as possible?

    A. 32 individual students
    B. 16 groups of two students
    C. eight groups of four students
    D. whole class as one group

13. Below are listed several sources of information. Which of the sources is the most complete for identifying science courseware?

A. The Science Teacher
B. RICE
C. a catalog from a vendor of science software
D. The Apple Educator's Newsletter

14. Which of the following databases provides the best information on research in education?

A. The Source
B. RICE
C. CompuServe
D. ERIC

TRUE OR FALSE

Read each statement carefully and then indicate whether it is true or false by circling the appropriate response to the left of the statement

True
False
15. One strength of the microcomputer is that it can evaluate a student response to an open-ended question and provide appropriate feedback tailored to the student response. (Similar to a good teacher probing a student's understanding of a concept.)

True
False
16. A simulation is not an appropriate way to provide instruction in basic skills in science education.

True
False
17. The following scenario is an example of an effective way to integrate computer courseware into a lesson: following an introductory lecture/discussion on nutritional requirements for humans, pairs of students work at computers with a program that asks them to input their dietary intake and then calculates and reports any nutritional deficiencies.

True
False
18. As the use of information technologies increases in schools, learning factual information will be reduced in importance.

True
False

19. The following scenario is an example of an effective post-computer activity: following the use of a simulation program, the teacher gathers the students into a large group to discuss the concepts presented by the computer program.

True
False

20. The software selected by a district-wide committee three years ago is likely to be appropriate for your science classroom this semester since another science teacher from your school was on the selection committee.

COMPUTER OPINION SURVEY

Instructions: Please indicate how you feel about the following statements. Use the scale below to indicate your feelings. Mark the appropriate circle on the answer sheet.

1 = Strongly agree	4 = Slightly disagree
2 = Agree	5 = Disagree
3 = Slightly agree	6 = Strongly disagree

1.	Having a computer available to me would improve my productivity.	1 2 3 4 5 6
2.	If I had to use a computer for some reason, it would probably save me time and work.	1 2 3 4 5 6
3.	If I use a computer, I could get a better picture of the facts and figures.	1 2 3 4 5 6
4.	Having a computer available would improve my general satisfaction.	1 2 3 4 5 6
5.	Having to use a computer could make my life less enjoyable.	1 2 3 4 5 6
6.	Having a computer available to me could make things easier for me.	1 2 3 4 5 6
7.	I feel very negative about computers in general.	1 2 3 4 5 6
8.	Having a computer available could make things more fun for me.	1 2 3 4 5 6
9.	If I had a computer at my disposal, I would try to get rid of it.	1 2 3 4 5 6
10.	I look forward to a time when computers are more widely used.	1 2 3 4 5 6
11.	I doubt if I would ever use computers very much.	1 2 3 4 5 6
12.	I avoid using computers whenever I can.	1 2 3 4 5 6
13.	I enjoy using computers.	1 2 3 4 5 6
14.	I feel that there are too many computers around now.	1 2 3 4 5 6
15.	Computers are probably going to be an important part of my life.	1 2 3 4 5 6
16.	A computer could make learning fun.	1 2 3 4 5 6
17.	If I were to use a computer, I could get a lot of satisfaction from it.	1 2 3 4 5 6
18.	If I had to use a computer, it would probably be more trouble than it was worth.	1 2 3 4 5 6
19.	I am usually uncomfortable when I have to use computers.	1 2 3 4 5 6
20.	I sometimes get nervous just thinking about computers.	1 2 3 4 5 6
21.	I will probably never learn to use a computer.	1 2 3 4 5 6
22.	Computers are too complicated to be of much use to me.	1 2 3 4 5 6
23.	If I had to use a computer all the time, I would probably be very unhappy.	1 2 3 4 5 6
24.	I sometimes feel intimidated when I have to use a computer.	1 2 3 4 5 6
25.	I sometimes feel that computers are smarter than I am.	1 2 3 4 5 6
26.	I can think of many ways that I could use a computer.	1 2 3 4 5 6

USE OF MICROCOMPUTERS IN SCIENCE TEACHING

Teacher________________________ Site________________

Date of Interview________________ School______________

Rater__________________________ ID Number____________

HELLO, I AM KIM SMITH. I AM CALLING SELECTED TEACHERS IN THE EAST ALABAMA REGION TO FIND OUT HOW WELL SOME OF THE WORKSHOPS AND INSERVICE PROGRAMS ARE MEETING THE NEEDS OF TEACHERS IN THIS REGION. ONE PURPOSE OF THIS CALL IS TO FIND OUT IF A SPECIFIC WORKSHOP YOU ATTENDED AT THE EAST ALABAMA REGIONAL INSERVICE CENTER HAS HELPED YOU TO DO YOUR JOB BETTER. USING THE INFORMATION COLLECTED FROM THESE INTERVIEWS, THE INSERVICE CENTER HOPES TO EVALUATE THE EFFECTIVENESS OF PAST WORKSHOPS AND IMPROVE ITS WORKSHOP OFFERINGS.

I WOULD LIKE TO INTERVIEW YOU BECAUSE OF SPECIFIC WORKSHOPS YOU HAVE ATTENDED. RESULTS OF THIS INTERVIEW WILL BE GIVEN TO AN INDEPENDENT RESEARCHER AND CODED BEFORE IT IS SHOWN TO ANYONE ELSE. NEITHER YOUR NAME NOR YOUR SCHOOL'S NAME WILL BE CONNECTED WITH YOUR ANSWERS TO INTERVIEW QUESTIONS. THE INTERVIEW WILL TAKE ABOUT 20 MINUTES. DO YOU HAVE ANY QUESTIONS?

1. How many students are enrolled in school where you teach?________________
2. What grade levels are taught in your school?________________
3. What percent of students in your school are black?________________
4. How many teachers work in the building where you teach?________________
5. What grade level(s) do you teach?

   K 1 2 3 4 5 6 7 8 9 10 11 12

6. What science subjects do you teach?

____ general science
____ biology/life
____ physical science
____ chemistry
____ physics
____ health
____ administrator
____ other job____

7. How many different daily teaching preparations do you have?________________

8. What is your level of certification?

____ B
____ A
____ AA
____ none

9. How many inservice sessions have you attended during the past two years?____

10. What single inservice session that you have attended during the past two years provided you with the most useful skills and/or knowledge?

title/topic:______________________________________
location:____
justification:_____________________________________

11. What type of workshop would you like to see offered by the East Alabama Inservice Center?____

12. What are some skills or knowledge you need to improve that inservice sessions might address?

NOW LETS TALK ABOUT SOME MICROCOMPUTERS. I WOULD LIKE TO FIND OUT ABOUT WHETHER OR NOT YOU USE THEM, HOW YOU USE THEM IF YOU DO, AND WHAT INTERFERES WITH USING THEM. PLEASE BE CANDID AND HONEST IN YOUR RESPONSES. I PROMISE TO KEEP YOUR RESPONSES CONFIDENTIAL.

1 Do you have microcomputers available in your school?
____yes ____no

If yes, how many of each type do you have available?

____ Apple II
____ IBM pc
____ MacIntosh
____ Radio Shack
____ Commodore
____ Other ________________________________

If yes, how are the computers distributed?

____ one is in my room all of the time
____ several are in my room all of the time
____ one or more available on temporary basis
____ all computer are available in computer lab

14. Are you using a microcomputer in science teaching?
____yes (go to 14a) ____no (go to 14b)

a. If yes, how often do you use a microcomputer in science teaching?
____ less than once a quarter
____ 2-8 times a quarter
____ one a week
____ 2-4 times per week
____ nearly every day

GO TO QUESTION 15

b. It no, are you using a microcomputer in teaching other subjects or for other purposes?

If yes, describe the other uses:

SKIP TO QUESTION 21

15. For which of the following tasks do you use the microcomputer to organize and manage instruction?

____ developing, administering or scoring student tests
____ recording students grades and progress
____ developing print materials for students activities
____ developing software for student activities
____ organizing and inventorying supplies and equipment
____ prescribing and directing student activities
____ computing and performing analysis of data about students
____ preparing administrative paperwork

16. In which of the following ways is the microcomputer used in your class as a tool to enhance the learning of science?

____ to gather data as a laboratory instrument
____ to record and display data as tables or graphs
____ to calculate and display statistics
____ to organize and retrieve data in a database
____ to retrieve information from a source with a telephone hookup
____ to build and study models for phenomena and systems
____ to prepare printed documents and reports from investigations by students

17. In which of the following ways is the microcomputer used in your class to deliver instruction?

____ drill and practice
____ simulations
____ tutorial
____ interactive videodisc
____ remediation
____ core instruction
____ enrichment

18. In which of the following methods do you make microcomputers available to your students?

____ demonstration
____ small groups
____ whole class in the computer lab

19. Are any of the microcomputer activities in your science course designed to teach the students about microcomputers?
____yes ____no

If yes, what are your goals for teaching about microcomputers?

____ history of computer
____ awareness of the role in society
____ how to operate a computer
____ how a computer works
____ how a computer is used in science
____ other(s) ________________________________

20. Do you have your students write computer programs?

____ to learn how to write simple programs
____ to learn how to use the computer to solve simple problems in science
____ to develop educational software to teach science to other students
____ to develop programs to help you manage instruction
____ other ________________________________

21. Do you have any software and supplies available for using microcomputers in your science teaching? ____yes ____no

If yes, how much do you have available?

____ number of pieces of software for science instruction
____ number of pieces of software for managing instruction
____ expenditure each year for software and supplies you can use

22. How much assistance and encouragement does your administration provide for your use of microcomputers in science teaching?

(1) maximum (2) strong (3) adequate (4) poor (5) none

_____ department chair
_____ building principal
_____ educational computing supervisor
_____ curriculum supervisor
_____ superintendent
_____ other ________________________________

23. How much technical support is available to help microcomputers in science teaching?

_____ maximum
_____ strong
_____ poor
_____ none

24. How much support do your fellow teachers give you for your use of microcomputers in science teaching?

_____ maximum
_____ strong
_____ poor
_____ none

25. What are the most significant barriers to increasing your use of microcomputers in science teaching?

_____ personal lack of interest
_____ personal lack of knowledge
_____ time available to plan and prepare for use
_____ availability of equipment and supplies
_____ support from administration and other teachers
_____ interest of students
_____ other________________________________

26. If the existing barriers were removed, would you use the microcomputer
_____the same _____more _____less?

27.Do you remember participating in a workshop called ENLIST-Micros?
____yes ____no

If yes, did you attend all of the sessions?____yes ____no

28. Do you feel that your participation in the ENLIST-Micros workshop effected your use of computers? ____yes ____no

If yes, what has been the effect?

What specific computer uses can you attribute to your participation in the *ENLIST Micros* workshop?

29. Have you used skills acquired in the ENLIST-Micros workshop to help other teachers begin to use microcomputers?
____yes ____no

If yes, how many have you helped? ____________

What skills did you help the other teacher(s) acquire?

30. What is the most valuable use of microcomputers for teachers?

31. Can you suggest topics for teacher workshop that should be offered by the East Alabama Inservice Centers?

32. Do you have any questions for me or other information you would like to share on the subjects we have discussed?

USE OF ENLIST MICROS

Name ______________________________ Date ________________

Address ____________________________ Work phone____________

____

____

1. Job title:

   ____ Professor in science
   ____ Professor in education
   ____ Science teacher (K-12)
   ____ Science department chairperson
   ____ Science supervisor (K-12)
   ____ Building administrator
   ____ District administrator
   ____ Other ______________________________

2. Which of the following ways have you used *ENLIST Micros*?

   ____ No use
   ____ Personal education
   ____ Informally sharing with teachers and colleagues
   ____ Preservice course on educational computing
   ____ Inservice course on educational computing
   ____ Part of a preservice course for science teachers
   ____ Part of an inservice course for science teachers
   ____ Informal workshop for inservice teachers
   ____ Other ______________________________

3. Describe below each way you have used *ENLIST Micros,* include each of the following that apply: the number of teachers and colleagues participating in each session, the number of hours of instruction, the title and purpose of the course, and follow-up activity you have implemented.

4. Do you have names and addresses or telephone numbers of the teachers who have used *ENLIST Micros*?

_____ Yes _____ No

5. If you have shared the curriculum with other trainers, please describe in detail their names and use.

6. Please describe below any use of the materials that you plan for next year.

7. Comments and suggestions

Appendix 3

Dissemination Activities

DISSEMINATION ACTIVITIES

Articles

Ellis, J.D. Improving science instruction with microcomputers. *Research Matters...To the Science Teacher.* National Association for Research in Science Teaching.

Ellis, J.D. The BSCS and educational computing in the sciences. *The American Biology Teacher,* February 1986, 48(2).

Ellis, J.D. and Kuerbis, P.J. Computer literacy for science teachers. In L.W. Trowbridge & R.W. Bybee, *Becoming a Secondary School Science Teacher, Fourth Edition.* Columbus: Merrill Publishing Company, 1986, pp. 150-153.

Curriculum materials

ENLIST Micros: Text (experimental edition). Colorado Springs, Colorado: Biological Sciences Curriculum Study, 1986.

ENLIST Micros: Leader's guide (experimental edition). Colorado Springs, Colorado: Biological Sciences Curriculum Study, 1986.

ENLIST Micros: Video programs (experimental edition). Colorado Springs, Colorado: Biological Sciences Curriculum Study, 1986.

ENLIST Micros: Computer software Parts I, II, and III (experimental edition). Colorado Springs, Colorado: Biological Sciences Curriculum Study, 1986.

Presentations

Baird, W.E., Ellis, J.D. and Kuerbis, P.J. ENLIST Micros: Training science teachers to use microcomputers. A paper presented at the 60th annual meeting of the National Association for Research in Science Teaching, Washington, DC, April 1987.

Crovello, T.J. and Ellis, J.D. Computers in Biology education: The United States. A paper presented at the annual meeting of the Commission for Biology Education of the International Union of Biological Science at Hanasaari, Epsoo, Finland, September 1986.

Ellis, J.D. and Kuerbis, P.J. Development and validation of essential computer literacies for science teachers. A paper presented at the 1985 annual NARST meeting, French Lick Springs, Indiana, April 1985, ED #255373.

Ellis, J.D. and Kuerbis, P.J. Essential computer literacy competencies for science teachers and implications for teacher training. Presentation at the annual meeting of the Southwest-Association for Educators of Teachers of Science, Denton, Texas, January, 1985.

Ellis, J.D. and Kuerbis, P.J. ENLIST Micros: Encouraging the literacy of science teachers in the use of microcomputers. Presentation at the annual meeting of the Southwest- Association for Educators of Teachers of Science, Wichita, Kansas, October, 1985.

Ellis, J.D. and Kuerbis, P.J. The Development of a test of computer literacy for science teachers in grades K-12. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Francisco, March 1986, ED #266952.

Kuerbis, P.J. ENLIST Micros: A project to prepare K-12 science teachers to use the microcomputer for instruction. A paper presented at the annual meeting of the National Council of States on Inservice Education (NCSIE), Denver, Colorado, November 22, 1985.

Kuerbis, P.J. ENLIST Micros: An NSF supported program to train science teachers to use the microcomputer. A paper presented at the annual meeting of the Association of Teacher Educators, Atlanta, Georgia, February 24, 1986.

Kuerbis, P.J. ENLIST Micros: An NSF supported program to train science teachers to use the microcomputer. A paper presented at the annual meeting of the American Association of Colleges of Teacher Education, Chicago, Illinois, February 27, 1986.

Workshops and courses

Ellis, J.D. and Donovan, E. Using microcomputers in science education. Workshop at the annual meeting of the Colorado Association of Science Teachers, Colorado Springs, Colorado, February, 1985.

Ellis, J.D. Microcomputer applications in the sciences. College course at the University of Colorado, Colorado Springs, Colorado, Fall, 1985.

Ellis, J.D. Computer literacy for science teachers: the BSCS ENLIST Micros Project. Workshop at the annual meeting of the National Association of Biology Teachers, Orlando, Florida, October, 1985.

Ellis, J.D. and Kuerbis, P.J. Computer literacy for science teachers. Workshop at the national meeting of the National Science Teachers Association, San Francisco, California, March, 1986.

Ellis, J.D. and Kuerbis, P.J. Using the computer to enhance biology teaching. Workshop at the annual meeting of the National Association of Biology Teachers, Baltimore, Maryland, October, 1986.

Ellis, J.D. and Kuerbis, P.J. Using the computer to enhance science teaching. Workshop at the regional meeting of the National Science Teachers Association, Indianapolis, Indiana, October, 1986.

Ellis, J.D. and Kuerbis, P.J. Using the computer to enhance science teaching. Workshop at the regional meeting of the National Science Teachers Association, Las Vegas, Nevada, November, 1986.

Ellis, J. Applications in the sciences. College course at the University of Colorado, Colorado Springs. Colorado, Spring, 1986.

Ellis, J.D. Microcomputer applications in the sciences. College course at the University of Colorado, Colorado Springs, Colorado, Spring, 1987.

Ellis, J.D. and Kuerbis, P.J. Using the computer to enhance science teaching. Workshop at the national meeting of the National Science Teachers Association, Washington, D.C. March, 1987.

Ellis, J.D. and Kuerbis, P.J. Computers in science: Micro-based software for labs. Workshop at the annual meeting of the Colorado Association of Science Teachers, Colorado Springs, May, 1987.

Publicity notices

BSCS. NSF funds development of computer literacy materials. *BSCS 85 Newsletter,* April 1985, p. 1.

BSCS. ENLIST Micros update. *BSCS 85 Newsletter,* October 1985, pp. 3-4.

BSCS. ENLIST Micros update. *BSCS 86 Newsletter,* March 1986, p. 6.

BSCS. NSF funds teacher training for ENLIST Micros project. *BSCS 86 Newsletter,* October 1986, p. 5.

BSCS. Leadership training begins. *BSCS 87 Newsletter,* March 1987, p. 7.

Appendix 4

Responses to Survey of Use

RESPONSES TO SURVEY OF USE

The capital letters below were used as a cross-reference to specific questionnaires. (Example: answers to questionnaire "A" are "A" under each category.)

NOTE: These responses were taken directly from the respondents' questionnaires.

1. Job title

   A. Science teacher (K-12) biology

   B. Science teacher (K-12)

   C. Professor in education

   D. Professor in education

   E. Science teacher (k-12)/science department chairperson

   F. Other: state science supervisor

   G. Professor in education

   H. Professor in science

   I. Professor in science

   J. Professor in science

   K. Science teacher (K-12)/ other: graduate assistant completing phd in science education (elementary education)

   L. Professor in education

   M. Professor in science

   N. Science supervisor (K-12) (7-12)

   O. Other: lecturer in science education - (teacher of future teachers)

   P. Science teacher (K-12)

   Q. Other: substitute teaching this year - have not used it.

   R. Science department chairperson

   S. Professor in science/professor in education (for science methodology course, Ed 45)

T. Professor in science

U. SciEnce Teacher (K-12) seventh, life science.

V. Professor in education

W. District administrator

X. Other: community college biology instructor, Broward Community College North

Y. Professor in science

Z. Professor in science

AA Carolyn Roddy-Department of Teacher Education-Univ. of Dayton/See paperwork she sent, questionnaire was not sent back.

AB. Science department chairperson

AC. Professor in science

AD. Science teacher (K-12)/science department chairperson

AE. Assistant Professor in Education

2. **Which of the following ways have you used *ENLIST Micros?***

A. Personal education

Informally sharing with teachers and colleagues

Other: A.P. Biology Institute

B. No use (sorry)

C. Part of a preservice course for science teachers/Part of an inservice course for science teachers/Informal workshop for inservice teachers.

D. Informally sharing with teachers and colleagues at previous institution.

E. No use

F. Personal education/Informally sharing with teachers and colleagues.

G. Informally sharing with teachers and colleagues/Part of a preservice course for science teachers.

H. Preservice course on educational computing.

I. No use - never went beyond initial reading - haven't expanded our use of Apple computers.

J. Informally sharing with teachers and colleagues/Preservice course on educational computing/Inservice course on educational computing/Part of a preservice course for science teachers/Part of an inservice course for science teachers.

K. Part of a preservice course for science teachers/Informal workshop for inservice teachers/Other: Used in the science methods course required in elementary education

L. Part of a preservice course for science teachers

M. No use

N. Informally sharing with teachers and colleagues/Inservice course on educational computing/Part of an inservice course for science teachers.

O. Personal education/Part of an inservice course for science teachers.

P. No use, I received only the preface from the curriculum. I only looked at it.

Q. No use

R. No use-we have NOT received any materials

S. Personal education/Part of a preservice course for science teachers

T. Informally sharing with teachers and colleagues/Part of a preservice course for science teachers/Part of an inservice course for science teachers

U. Personal education/Other: Use with students to teach Life Science in computer l ab.

V. Preservice course on educational computing/Part of a preservice course for science teachers

W. Inservice course on educational computing/Part of an inservice course for science teachers

X. Personal education/Informally sharing with teachers and colleagues/ Part of a preservice course for science teachers

Y. Personal education/Informally sharing with teachers and colleagues

Z. Personal education

AA. Workshop

AB. Personal education/Informally sharing with teachers and colleagues/Inservice course on educational computing/Part of a preservice course for science teachers/Part of an inservice course for science teachers/Informal workshop for inservice teachers.

AC. Preservice course on educational computing/Part of a preservice course for science teachers.

AD. Personal education/Informally sharing with teachers and colleagues/Inservice course on educational computing/Informal workshop for inservice teachers

AE. Other: You sent me only the NARST paper from French Lick Springs and an invitation. I did not have a "proper" or the "right" - classes to use the material. Please keep me informed on both the research and the product.

3. **Describe below each way you have used *ENLIST Micros,* include each of the following that apply: the number of teachers and colleagues participating in each session, the number of hours of instruction, the title and purpose of the course, and follow-up activity you have implemented.**

A. As the master teacher working with a college professor, a list of objectives was presented to a group of (approximately 20) A.P. Biology teachers, and copies of the list were distributed.

C. Two workshops (total N=47)for inservice teachers through East Alabama Regional Inservice Center in Oct. 1985 and Feb. 1986. Each workshop was 15 hours long. Follow-up minimal, but some participants have come back for more computer inservice training.

Summer 1986 graduate course used materials with 7 inservice teachers as part of a computer applications seminar: "Microcomputer Applications in Secondary Science." No follow-up, but one student will help instruct summer '87 institute (see item #6).

Use *ENLIST Micros* guidebook 3 times in CTS 410K "Programs in Secondary Science" - secondary methods course required for preservice AV seniors. Total N=45. Some of these students borrow *ENLIST Micros* (commercial) software to use as interns.

D. Seminar.

E. I polled teachers at my school and found too little interest to pursue. As I recall I never got the materials.

F. I have shared this with people that I have come into contact with from time to time. I have also used it for my own enlightenment and found it very good.

G. 1. Students in secondary science methods class in spring of 1986 devoted approximately 15 hours to activities from the program. The tapes and disks were used. There were 19 students involved - each returned a sheet commenting upon the instruction.

2. I have shown the materials to a number of colleagues, but none has used the materials so far as I know. I did not use *ENLIST Micros* with the spring 1987 science methods class because there were 26 students enrolled and more time was needed for peer teaching.

H. Used video tape and Disk 1 to intro applications to computer literacy classes.

J. We have used this program for 5 semesters in our secondary methods in science course (15-20 students per semester). Also, used in same elementary methods courses, 3 times (30 students each time)

I used this program in 2 inservice programs for teachers; about 40 teachers were involved.

K. I used the program in the science methods course for undergraduates. I used it for 15-18 hours in the course. There were 31 students enrolled in the course. I completed the entire course which was described in the *ENLIST Micros* book.

I presented a very small portion of the *ENLIST Micros* in the Computers in Education Conference which is held annually at ASU - under the direction of Dr. Gary Bitter. (Spring 1986) (1 hour)

I also used parts of the *ENLIST Micros* in some workshops for teachers in the spring and summer of 1986. The workshops were geared for ways of using computers in the classroom. (4 hours total)

L. Approximately 15 hours of instruction

Approximately 25 preservice teachers

Preservice science education (methods) post-tested students at end of experience.

N. 1. November 26, 1985 - *ENLIST Micros:* Computer Use in Science Education for Secondary Teachers. 28 teachers, 6 hours. Teachers took home the *ENLIST Micros* text, *ENLIST Micros* disks I, II and III and commercial software to finish program and review programs.

2. January 7, 1986 - *ENLIST Micros*: Computer Use in Science Education for Elementary Teachers. 29 teachers, 6 hours. Follow-up same as above.

3. February 25, 1987 - Computers in the Science Classroom. 25 teachers Grades 7-9. Continuing on March 19 and April 22, 1987. Organized by the Central Valley Teacher Education/Computer Center.

4. March 10, 1987 - Biology First Year Inservice. 35 teachers organized by the Central Valley Teacher Education/Computer Center.

O. Course: Educational Technology for Biology Teachers (students) 8 hrs, 8 students. Used during a 2 hour lecture of Micros.

S. The *ENLIST Micros* program has been used in my Methods of Science Teaching (Ed 45) offered in the spring semester concurrently with student teaching. A combination of lecture, hands on experience, and follow-up discussion on the topic is carried but for approximately two weeks.

On average, 3-4 student teachers participate in each session. The sessions last an average of 1 3/4 hrs but student teachers are encouraged to use the computer as often as possible.

T. Bio 371/571 - Preservice course for biology teachers - (topics & tech) Teaching Strategies for Biology Teachers. Test site with this course of undergraduate & graduate biology preservice teachers with some inservice participation. 1985 - 15 teachers/students (15 + hours)/1986 - (10 hours) 16 students/teachers./1987 - 28 preservice teachers (science), graduate students & faculty (2). Class 391/591 Computer Applications for Science Teachers. 4 hours (6-10 pm) Thur for. two weeks. Used *ENLIST Micros* in 1st session for 1 1/2 hours each. Addition work on evaluation and resources is planned. Total time for course is expected to equal 10 hours.

U. Reading "Cooperative Learning" article, I have set objectives for learning concepts in Life Science. When in the computer lab, class will work on a concept from the unit's lessons and goals.

About 22-32 students go to the lab for about 2 hours of instruction with micro computers. Will do 9 units for the semester covering topics of plants, animals, microbes, heredity, and ecology.

Selected instructional objectives of the unit are reinforced and processed using collaborative efforts of students. They get prior learning activities and develop notes/outlines to structure a sequence of acquired knowledge.

Students profit from working together to share and gain information to assist their grades for the class.

V. A total of 31 preservice teachers were involved in the program. They worked with *ENLIST Micros* for at least 20 hours during a science methods course. This course culminated their preservice education by reiterating some prior information but mainly by filling in the gaps of information not covered by previous courses. *ENLIST Micros* allowed many of these preservice teachers to overcome their "computer anxiety".

W. Please find enclosed:

a. List of *ENLIST Micros* Workshop Participants,

b. Description of the Ten-Hour Inservice conducted by our teachers,

c. Letter to the Teacher Education Department, University of Dayton

X. I presented a 2 hr workshop (Computers in Biology Teaching) for students in a biology methods course at Florida Atlantic University - Dr. Herbert Stewart was the instructor for this 3 hr undergraduate course. Number of students: approximately 15. Diskettes were demonstrated & distributed for personal use.

Y. I have read the materials and shared it with Mr. Keith Morrill in our department.

Z. I have read and gone through the material myself. To help plan the use of computers in a grade school. Unfortunately, they will be MAC'S.

AA. See paperwork

AB. 1. Inservice Workshop on use of computers for elementary school science - 20 participants, 6-2 hr sessions. Follow-up: individual consultations as needed.

2. Inservice Workshop on use of computer programs in secondary school science - 18 participants, 6-2hr sessions. Follow-up: Individual consultations as necessary.

3. Preservice Science in the Elementary School class, 3-1hr sessions-24 participants. Follow-up: student teaching use of computers.

4. Preservice: Science in the Elementary School Class, 3-1hr sessions - 12 participants. Follow-up: student teaching observations of usage.

5. Preservice Teaching and Learning - Biology Class - 8 students, 3-1.5 hr sessions. Follow-up: Practicing usage of computers.

AC. From imperfect memory - all preservices winter '86 - 20 participants - 16 hours - Intro to Science Ed. - No follow-up/ fall'86 - 48 participants - 16 hours Intro to Science Ed- no follow-up - part of preservice course.

AD. Field test through an inservice course in educational computing - 10 participants - 12 hrs of instruction - title of course: *ENLIST Micros* - to introduce & encourage science teachers to use micro computers in their classroom.

Inservice workshop for county district's teachers - 32 participants - 3 hours of in struction - Title: Using Computers in the Science Classroom - To introduce teachers to the uses of Micro computers in their classroom.

Presentation at a state educational computing conference - 30 participants - 1 hour of instruction - Title: Using Computers in the Science Classroom - Purpose: same as above.

Informally sharing with colleagues - 2 participants

4. **Do you have names and addresses or telephone numbers of the teachers who have used *ENLIST Micros*?**

YES - 8

NO - 14

X. Dr. Herbert Stewart/Biology Dept./Florida Atlantic Univ./Boca Raton,FL 33431

5. **If you have shared the curriculum with other trainers, please describe in detail their names and use.**

C. Mentioned it on CHYM:NET (Project SERAPHIM with John Moore). Referred inquiries to Jim Ellis at BSCS.

Presented summary paper at 1986 meeting of Science Education Section of Alabama Academy of Science.

D. Dr. Michael Brody/Shibles Hall/University of Maine/Orono, ME 04469.

F. N/A

H. N/A

L. No

N. Anne Gymer - Consultant, Madera County Office of the Superintendent of Schools borrowed *ENLIST Micros* materials to conduct a computer inservice for 20 Madera County School teachers.

S. N/A

T. Shared the materials with the permission of BSCS, with Lynn James, Chemistry Professor. who used them in teaching a summer workshop for teachers in 1986.

Have xeroxed copy of this form and letter for his response to you.

U. N/A

Y. Mr. Keith Morrill read the materials to assist him in learning about the Apple IIe.

AA. See paperwork

AB. None

AC. I conducted it myself

6. **Please describe below any use of the materials that you plan for next year.**

A. Not at this time.

C. Summer 1987 "Institute for High School Chemistry Teachers" funded by ECIA, Chapter II at Auburn University will use *ENLIST Micros* guidebook as a small part of 6 weeks course in science teaching methods.

D. Incorporate in science methods.

E. N/A

I. I plan to pass the material to Capt. Dave Andrews (same address). He will be working our Apple applications in Biology.

K. I would like to use the *ENLIST Micros* in the science program in the College of Education but I am only a graduate student. I see much value that could be gained from this program!

L. None

N. I plan to continue offering inservices and software preview/review for using computers in science education.

O. I shall use it as a part of course for a science teachers (educational technology). It's information could be used when I write a book how to teach Biology and Geography in comprehensive and in secondary school.

S. We will use the same basic approach...but more of our student teachers are computer literates so we are using more "canned" software from CAI, SIMI, etc.

T. Spring course 1988 - appl. of microcomputer in science teaching. Plan to use *ENLIST Micros* material as in 1987 if possible.

U. Have begun to develop my own software program with authoring systems and graphic packages.

Goal is to have 3 software programs for each Life Science unit.

V. Since I had to return the materials, I was unable to continue working with the *ENLIST Micros* program. However, I will be at San Diego State University in the College of Education next fall, and would like to not only use *ENLIST Micros* in my own classes but encourage others to do likewise.

X None to date

Y. None at this point

AB. Continued usage in preservice science courses for both elementary and secondary teachers. Possible inservice workshops in the area.

AC. Same course changed to fall semester only

AD. Informal sharing due to an upcoming leave of absence, my use will be limited next year.

7. **Comments and suggestions**

A. Thank you for sending the material-(The only material I received was printed material.) I thought that it was good and that other teachers also appreciated it. I did not use it to any degree beyond just sharing it, however.

B. I simply have not had the opportunity to train other science teachers who were total novices - they're users. Wanted specifics.

C. I would like to keep about 30 copies of the *ENLIST Micros* guidebook on hand here at AV for both preservice & inserviceuse. Attrition has resulted in loss of about 10 copies. How can I get 10 more to keep 30 on hand? We look forward to continued use of *ENLIST Micros* materials here. What is *EM II*?

D. Materials were left with Dr. Brody; I would appreciate a set since I've been assigned secondary science methods.

G. I was favorably impressed with the materials and would use them on a regular basis if more time were available for the methods class. Given all of the topics which must be covered and the need to reinforce presentation -interaction skills developed in earlier courses, it is not possible to devote more than 6 hours to computer usage.

Here at KSU we have instituted a media course - to be required of all students - which will introduce preservice teachers to computer use. Word processing, record keepingand software evaluating will be components of the course.

J. We plan to continue the use of *ENLIST Micros* in our secondary and elementary methods in teaching science.

He also adds in a separate letter: We have used the *ENLIST Micros* program in our secondary program for the last 3 semesters. This impacts about 50 students. I have shared the materials with both of our new faculty members and they indicate that they will be using them next year. Please keep us posted on future development of this program.

K. As I commented on #6 it should be part of the methods course for science but I really have no input into course development at this time. Being a former teacher this program has much to offer please keep me posted as to its growth and changes.

L. I felt the materials were not user friendly. Materials developed by MECC, I felt were superior because they were user friendly.

N. Excellent introduction to computer use in science teaching. We developed and went into the use of the computer in the science lab, e.g., Science Tool Kit, Resistance Measure, Voltage Input Unit, Photo Meter, Temperature Measurement, Thermocouple, pH Meter, etc.

O. I would be very grateful for software and videotapes.

T. Anxious to see revised edition. Hopefully more advanced section will be included such as Interfacing, etc.

V. I would encourage you to also address the needs of the teacher who is familiar with computers but needs additional assistance. I am on the National Science Teachers Association Science Supervisors Committee, and we are planning a short course for the next national meeting which will include information concerning computer usage. I am in charge of this particular area and would appreciate you contacting me so that I might include information about *ENLIST Micros* in the short course.

AB. I feel that this is by far the best and most understandable program available today! I would appreciate receiving copies of your final format so that I can keep current on the project. Good luck in your attempts to secure a publisher for these materials. It should not be difficult as a large market for it exists among teachers at all levels.

AC. I have provided formative feedback previously. Lots of supporting materials needed for reference & support.