DOCUMENT RESUME

ED 305 251 SE 050 458

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TITLE	An Evaluation of a Teacher-Enhancement Project on Educational Computing.
INSTITUTION	Biological Sciences Curriculum Study, Colorado Springs
SPONS AGENCY	National Science Foundation, Washington, D.C.
PUB DATE	Apr 89
GRANT	NSF-MDR-8470061
NOTE	51p.; Interim report to the National Science Foundation for Year Two of ENLIST Micros II.
PUB TYPE	Reports - Descriptive (141) -- Reports - Research/Technical (143) -- Tests/Evaluation Instruments (160)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Biological Sciences; *Computer Managed Instruction; Computers; Computer Science Education; *Computer Uses in Education; *Inservice Teacher Education; Professional Development; Science Instruction; Secondary Education; *Secondary School Science; Surveys; Teacher Education; Teacher Improvement; Teacher Workshops; *Teaching Methods; Technological Advancement
IDENTIFIERS	*Concerns Based Adoption Model

ABSTRACT

The Biological Science Curriculum Study with support from others conducted a three-year project (ENLIST Micros II) to develop and test a model for implementing educational computing in science courses. Descriptive data on background characteristics, prior experience with microcomputers, and educational level of the leaders and new participants was gathered. Leaders and new participants evaluated the workshops and seminars using questionnaires. The project used the Concerns Based Adoption Model (CBAM) developed by the Research and Development Center for Teacher Education at the University of Texas as the approach to evaluating implementation. Leaders and new participants completed the Stages of Concern Questionnaire and the Microcomputer Use in Science Teaching checklist as pretests and posttests to indicate their concerns about and degree of implementing microcomputers in science teaching. By the end of the second year 100 percent of the leaders and 84.6 percent of the new participants were using microcomputers to manage instruction and 92.3 percent of the leaders and 66.7 percent of the new participants indicated that their students were using microcomputers to learn science. The profiles of the leaders and new participants on the Stages of Concern Questionnaire changed from one typical of non-users toward one appropriate for users of an innovation. (Author/MVL)

An Evaluation of a Teacher-Enhancement Project on Educational Computing

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Interim report to the National Science Foundation
for Year Two of *ENLIST Micros II*

April 1989

This material is based upon work supported by the National Science Foundation under Grant No. MDR-8470061. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author and do not necessarily reflect the views of the National Science Foundation.

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An Evaluation of a Teacher-Enhancement Project on Educational Computing

Abstract

The Biological Sciences Curriculum Study (BSCS) with support from the National Science Foundation (NSF), Colorado Springs Public School District 11, Pikes Peak Board of Cooperative Services, and software publishers is conducting a three-year project (ENLIST Micros II) *to develop a model for implementing educational computing in school science. This paper is a report of the evaluation of the second year of the project.*

During the second year of the project, project staff conducted one two-day workshop and four seminars for 22 teachers who were to be group leaders and five two-day workshops and four seminars for 80 teachers who were new participants in the project. Throughout the year the project staff, group leaders, and new participants worked together to improve the use of microcomputers in science teaching.

Project staff gathered descriptive data on the background characteristics, prior experience with microcomputers, and educational level of the leaders and new participants. Leaders and new participants evaluated the workshops and seminars using questionnaires. The project used the Concerns Based Adoption Model (CBAM) developed by the Research and Development Center for Teacher Education at the University of Texas as the approach to evaluating implementation. Following CBAM procedures, leaders and new participants completed the Stages of Concern Questionnaire *and the* Microcomputer Use in Science Teaching *checklist as pretests and posttests to indicate their concerns about and degree of implementing microcomputers in science teaching.*

The leaders and new participants were experienced teachers with the majority having masters degrees. Most of the leaders had used microcomputers in science teaching prior to the project; more than three fourths of the new participants, however, were non users or novices in educational computing. The leaders and new participants gave the workshops and seminars high ratings. By the end of the second year, 100 percent of the leaders and 84.6 percent of the new participants were using microcomputers to manage instruction and 92.3 percent of the leaders and 66.7 percent of the new participants indicated that their students were using microcomputers to learn science. Furthermore, the profiles of the leaders and new participants on the Stages of Concern Questionnaire *changed from one typical of non users toward one appropriate for users of an innovation.*

Many educational leaders recommend improving and increasing the use of information technologies in science education. The NSF was among the first to recognize that "as the computer becomes 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). Paul DeHart Hurd emphasized 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, NSF, 1982, p. 11). Furthermore, many agencies have included computer literacy in their recommendations (Association for the Education of Teachers of Science, 1985; U.S. Department of Education, 1983; National Science Board Commission of Precollege Education in Mathematics, Science, and Technology, 1983; Education Commission of the States, 1983; National Task Force on Educational Technology, 1986; and, the National Governor's Association, 1986). Science teachers, therefore, should learn to use information technologies to improve the teaching and learning of science.

Research studies during the past five years, however, have found that few science teachers are integrating microcomputers into science education. Surveys of science teachers have found that only 15 to 40 percent of the respondents use microcomputers (Lehman, 1985; Kherlopian and Dickey, 1985; Weiss, 1987; Becker, 1987). These percentages may be optimistic, because when Weiss asked teachers how much they use the computer to provide instruction in science, the respondents indicated that typical science students spent fewer than 15 minutes per week working with computers. The respondents to Lehman's survey indicated that only six percent of their students used microcomputers at least one hour per week, per class. Furthermore, the respondents to Becker's survey indicated that computer usage in science classes occupied only about three to six percent of the instructional time that students spend using computers.

Several researchers recommend that science teachers need more training to implement educational computing (Lehman, 1985; Kherlopian and Dickey, 1985; Weiss, 1987; Lamon, 1987; and Winkler, 1986). Colleges, however, infrequently provide educational computing courses for science teachers. Lehman (1986) found that only 24.5 percent of colleges and universities offered courses on instructional computing for science teachers and that only six percent required any type of field experience with microcomputers in science classrooms. Only 25 percent required courses on educational computing for certification. Lehman concluded that teachers need more hands-on experiences with interfacing probes for experiments, handling laboratory data, developing assignments that use programming to solve science problems, and incorporating simulations into lessons. "Without them, [educational computing courses for science teachers] it appears unlikely that this new technology will have a major impact on science teaching and learning in schools" (Lehman, 1986, p. 124).

Project Goals

The Biological Sciences Curriculum Study (BSCS)–with support from the National Science Foundation (NSF), Colorado Springs School District 11, Pikes Peak Board of Cooperative Services, and software publishers–is conducting a three-year project to develop a model for implementing educational computing in school science. The BSCS established the following goals for the project:

- Develop and test a model of implementing educational computing in school science.
- Train 260 science teachers and administrators in the Pikes Peak region of Colorado to use microcomputers to enhance science learning and teaching.
- Establish a network in the Pikes Peak region to implement educational computing in school science.
- Disseminate a model of implementation for educational computing in school science.

This report presents the evaluation of the second year of the project.

Research on Staff Development and Implementation

Change is a process, not an event is the motto of educators who study the implementation of educational innovations. Educational change is a long and tedious process that does not end with the adoption of a new curriculum or approach to teaching. The decision to change is only the beginning. Hord and Huling-Austin (1987) found that it takes three or more years for teachers to make a substantial change in teaching.

Implementation is a complex process that involves all people who have a stake in education. To be successfully implemented, a program requires:

- Leadership from the school principal to provide supportive organizational arrangements that encourage the use of the innovation, opportunities for teacher training and weekly consultation and feedback, and mechanisms to monitor and evaluate the implementation of the innovation.

- Support from a leadership team (lead teacher, principal, and instructional specialist) that sanctions the innovation, provides resources, gives technical coaching and assistance, arranges training, reinforces attempts to change, and puts the program in the spotlight for everyone in the school community.

- Support from an implementation team of fellow teachers that provide peer coaching, support, and encouragement and that share the work.

- Recognition by all people involved that change takes time, that innovations change as they are adapted to local situations, that implementing a new approach to teaching is a difficult process, and that implementation requires resources in the form of time, people, and materials.

Staff developers are responsible for designing programs that will help teachers use new approaches to teaching. Many researchers (Showers, 1988; Joyce and Showers, 1987; Leggett and Hoyle, 1987; Wu, 1987; Garmston, 1987; and Stecher and Solorzano, 1987) have identified procedures or factors for successful staff development. What follows is a synthesis of those recommendations.

Successful staff development programs provide teachers with:

- A comfortable and relaxed environment that is conducive to change.

- The theory and the rationale behind the innovation.

- A detailed description of the innovation.

- Assistance with integrating the innovation into the extant goals and objectives, scope and sequence, and instructional activities.

- Demonstrations (models) of the new teaching behaviors.
- Opportunities over a period of several weeks or months to practice the behaviors with fellow teachers and with students and to receive corrective and supportive feedback, peer coaching.
- Opportunities to discuss the innovation with fellow implementors and how it is changing their teaching.
- Guidance from teachers whc have mastered the innovation.
- Assistance, whenever it is needed, with solving problems associated with implementing the innovation.
- Continued and consistent support for the life of the innovation.
- Assistance with managing the logistics, hardware, software, and learning materials.

Furthermore, Paul Kuerbis and Susan Loucks-Horsley (1989) gleaned from the literature three approaches to helping teachers improve their use of microcomputers. They are the following: training, with peer coaching; peer dialogue; and action research. Joyce and Showers (1982, 1988) have studied training designs that help teachers adopt new teaching behaviors. According to their research, effective training presents the theory and rationale for the new teaching strategy, demonstrates the strategy, provides opportunities for the teachers to practice the strategy under controlled conditions, and has the teachers practice the strategy in the classroom with observation and feedback by a colleague (peer coaching). Peer coaching is the component most frequently missing from training sessions, yet Joyce and Showers have found that it is critical to the success of the training.

Engaging teachers in planned, thoughtful dialogue is another way to help teachers adopt new strategies. According to Kuerbis and Loucks-Horsley (1989), the goal is to encourage teachers to *reflect* on their current teaching practices so that they will improve their planning before and after lessons, their thinking and decision making during teaching, and their beliefs, attitudes, and theories about teaching.

The teacher as researcher is the third model of staff development that Kuerbis identified from the literature. Rich (1983) provided evidence that action research results in teachers who are willing to change, who focus on finding out what their students know and then try to help them, and in teachers who ask more questions and listened more. Simmons (1985) reports that teachers who engage in research change their thinking skills, habits, or styles, develop new theories of action in the classroom, and change their practices. Furthermore, Lieberman (1986) reports that action research can stimulate reflection about teaching, promote interaction among colleagues, increase teachers' interest in applying research findings, and give teachers a sense of empowerment.

Design and Procedures

Project activities. The BSCS conducted the second year of the project during 1 June 1987 - 31 May 1988. Figure 1 illustrates the relationships among project activities. Ellis and

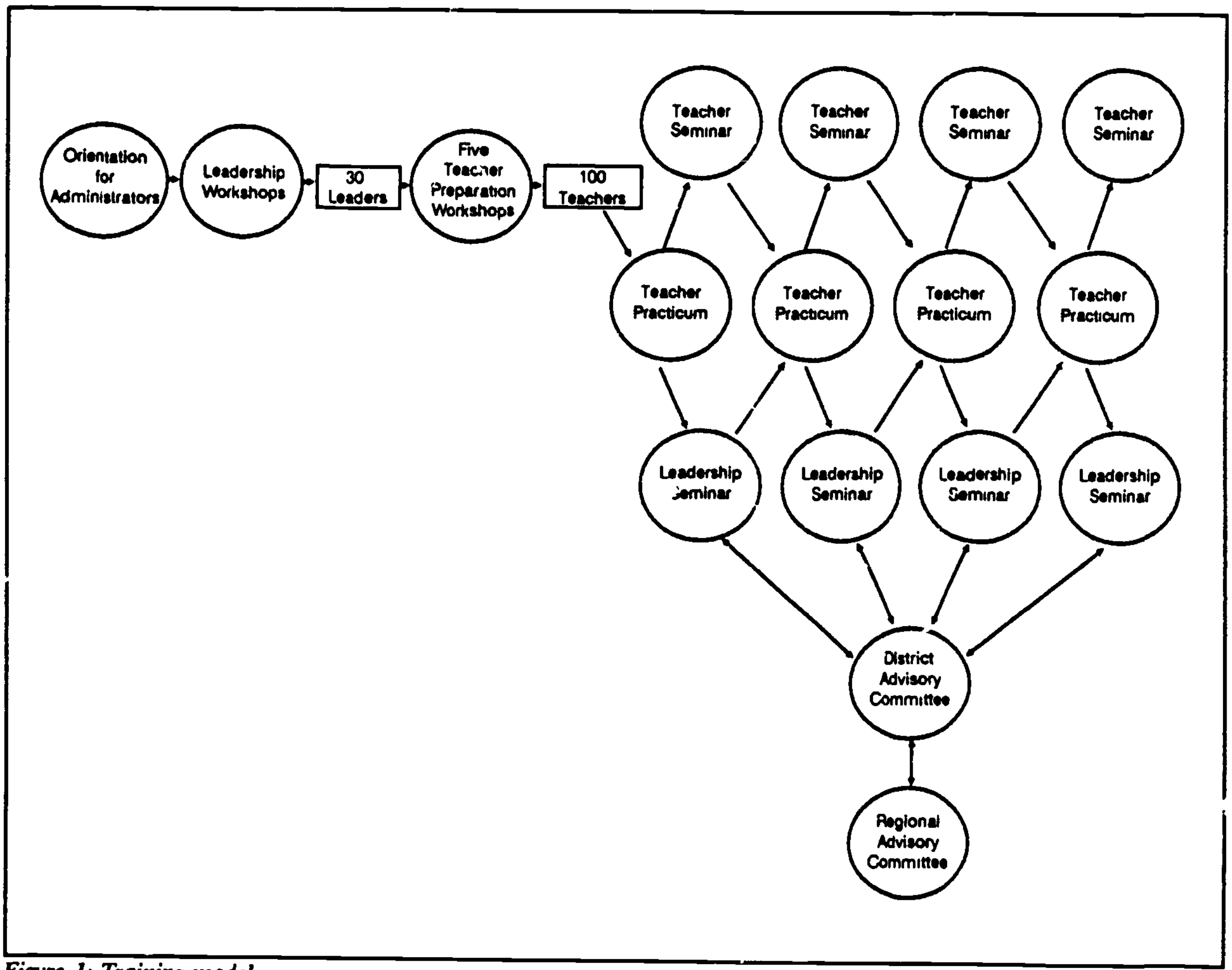

Figure 1: Training model

Kuerbis (1988) described the activities in detail in the report for year one of the project. The first activity was to orient the building and district administrators to the commitments that they, the district, the participating teachers, and the BSCS were making to the project. Three activities were directed at teacher preparation–Teacher Preparation Workshops, Teacher Practicums, and Teacher Seminars. Leadership training activities during year two included Leadership Workshops and Leadership Practicums. Networking activities included establishing an advisory committee for the Pikes Peak region to facilitate the exchange of ideas and services among the cooperating districts. The activities that support teacher preparation–planning, curriculum development, network building, dissemination, software review, and evaluation–occur throughout the three years of the project and depend on feedback from the participants to delineate specific tasks.

Evaluation. Project staff and members of the advisory committee carefully evaluated the leadership and teacher preparation activities that took place during the second year. Project staff used a formative evaluation procedure to provide information to help revise training strategies, materials, and implementation procedures. Project staff also used the Concerns Based Adoption Model (CBAM), developed at the Research and Development Center for Teacher Education at The University of Texas at Austin, to design and evaluate the implementation. Leaders and participants provided the following information to help evaluate the project:

- *Descriptive data.* Leaders and participants provided information about themselves–such as their teaching assignment, their teaching experience, their training in science, education, and computing, and their prior use of microcomputers.

- *Critique of training workshops.* Immediately following the workshops for leaders and participating teachers, the leaders and participants completed a survey of their perceptions of the effectiveness of their respective training workshops.

- *Critique of training seminars.* Immediately following the seminars for leaders and participating teachers, the leaders and participants completed a survey of their perceptions of the effectiveness of their respective training seminars.

- *Stages of Concern.* Leaders and participants completed the *Stages of Concern Questionnaire* developed by CBAM prior to training and at the end of the school year.

- *Innovation Configuration.* Leaders and participants completed a checklist, developed according to CBAM guidelines, to describe their use of microcomputers during the year and the factors that impeded more and better use of microcomputers. The checklist that the leaders completed during the spring of 1987 was an earlier version than the one they completed during the spring of 1988. The participating teachers completed the same version of the checklist prior to and following the full year of training.

Results

Tables 1-5 present summaries of the leaders' responses to the evaluation instruments. Leaders participated in teacher-training activities during the first year of the project and became leaders during the second year. The 22 leaders were experienced teachers with an average of 14.9 years of teaching experience; two-thirds had a masters degree. Nearly three-fourths of the leaders had more than one year of experience using microcomputers, and more than 85 percent characterized their experience with microcomputers as being intermediate or higher. The leaders gave the workshops and seminars consistently high ratings. During the first two years of the project, the composite leader's profile for *Stages* *of Concern* changed from one of a typical non user to one of a beginning user and then toward one of a routine user. By the end of the second year, 92.3 percent of the leaders indicated that their science students were using microcomputers and 100 percent of the leaders indicated they were using microcomputers to manage instruction.

Tables 6-9 present summaries of the participating teachers' responses to the evaluation instruments. These 80 teachers were participating in the teacher-training activities for the first time. More than 60 percent of the 80 participants who completed the evaluation forms had masters degrees, and they had an average of 11.6 years of teaching experience. Nearly half of the teachers had never used microcomputers in science teaching, and more than three fourths indicated that they were non users or novices at educational computing in school science. The teachers gave high ratings to the teacher enhancement workshops and seminars. From the beginning to the end of the training, the teachers indicated a three-fold increase in their students' use of microcomputers in learning science. From the beginning to the end of training, teachers' use of microcomputers to manage instruction increased from 49.6 percent to 84.6 percent. The participants indicated they and their students were using microcomputers in several ways to enhance the learning and teaching of science. Of special interest is that nearly half of the teachers indicated that their students used the computer to gather data (microcomputer-based laboratory) and to record and display data as tables or graphs.

Conclusions

The project staff and advisory committee concluded that the second year of the project was a success, and they used the evaluation data to design the training and implementation strategies for the third year of the project. The results of this project will help science educators develop implementation projects to integrate educational computing in school science and to increase the use of other educational innovations, such as new approaches to science curricula or to science teaching. With support from NSF, the BSCS is planning to replicate the implementation model developed in this project at sites throughout the United States.

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Table 1

Descriptive Information for Leaders

n = 22

Assignment	
22.8%	K-6 Teacher
18.2%	6-9 Teacher
22.8%	9-12 Teacher
0.0%	7-12 Teacher
36.4%	Administrator
Gender	
50.0%	Male
50.0%	Female
Highest Degree	
36.4%	Bachelor
63.6%	Masters
Years of Teaching = 14.9	
Number of Years at Present School = 7.6	
Years Using Microcomputers	
0.0%	Never
21.5%	One year
26.3%	Two years
10.5%	Three years
10.5%	Four years
31.6%	Five years or more
Experience with Microcomputers	
0.0%	Non user
11.8%	Novice
70.6%	Old hand
0.0%	Past user

Have Had Formal Training in Using Microcomputers in Science Teaching = 78.9%

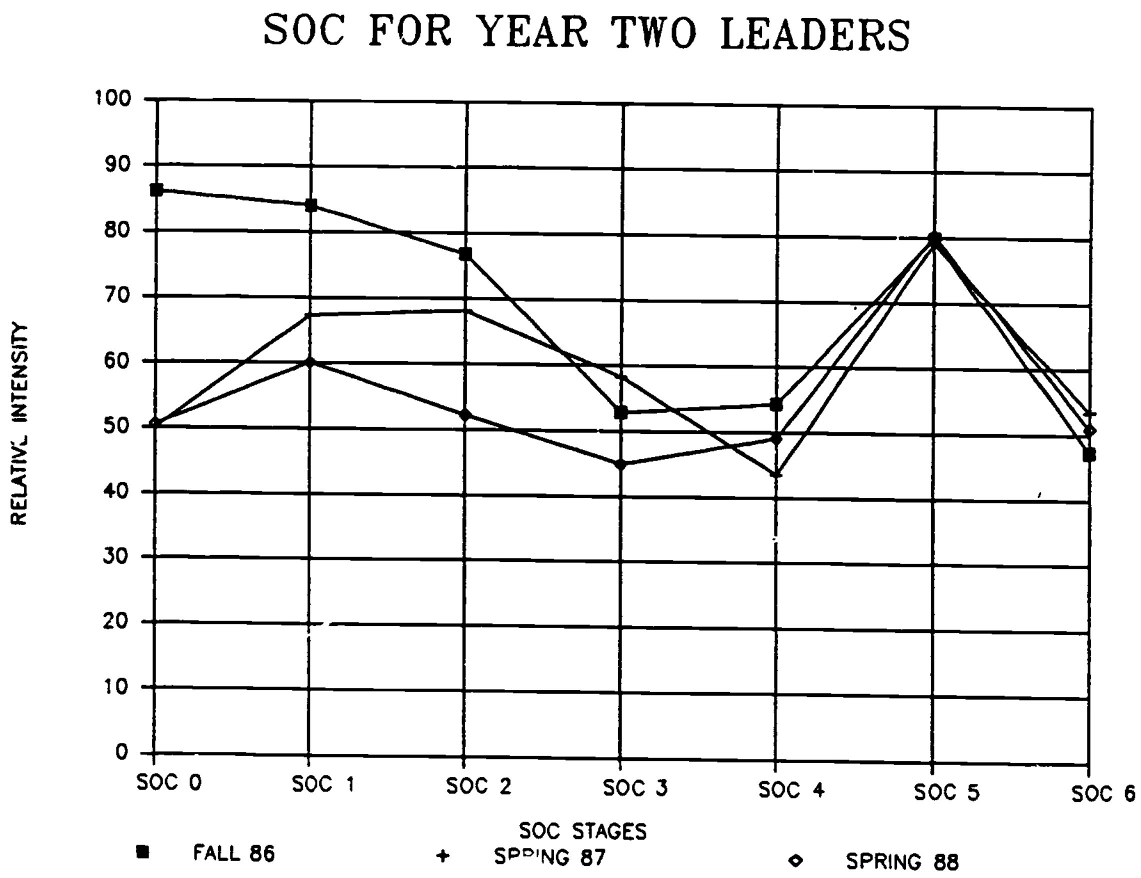
Are Implementing Other Innovation = 61.1%

Table 2

Leaders
Evaluation of Inservice

Low 1 . . . . 2 . . . . 3 . . . . 4 . . . . 5 High	*Workshop*	*Seminars*
	n = *81*	*n* = *79*
Were the objectives, goals and requirements of this course well defined and specified?	4.69	4.42
To what extent do you feel the course objectives were attained?	4.77	4.30
To what extent do you feel that the content of this course was well organized and sequentially developed in order to assure optimum learning?	4.77	4.30
To what extent do you feel this course has contributed to your professional development?	4.62	4.40
To what degree do you feel that you will be able to incorporate what you have learned in this inservice into your own assignment?	4.77	4.35
With respect to your professional development how does this inservice compare with similar college courses you have taken?	4.54	4.45
Was the subject matter presented effectively by the instructor?	4.85	4.60
Did the instructor exhibit broad background and knowledge of subject matter?	4.85	4.85
Rate the materials used in this inservice (text, films, handouts, etc.).	4.77	4.55
How would you rate this course in recommending it to another teacher/administrator?	4.85	4.75
Should this inservice be offered again?	4.92	4.85

Table 3



SOC 0 = Awareness
SOC 1 = Informational
SOC 2 = Personal
SOC 3 = Management
SOC 4 = Consequence
SOC 5 = Collaboration
SOC 6 = Refocusing

Table 4a

Leaders
Microcomputer Use in Science Teaching
Spring 1987

Percentages for Categorical Variables
n = 14

Micros are available	100.0
Where micros located	
one in room	41.7
two or more in room	0.0
temporarily in room	75.0
one or more outside rm.	41.7
computer lab	58.3
other	8.3
Use Micros in science	100.0
Frequency of use sci.	
100 %	0.0
75 %	0.0
50 %	25.0
25 %	25.0
less than 25 %	50.0
Use in other subjects	91.7
Management uses	
Testing	61.5
Grade recording	76.9
Developing print mat.	100.0
Developing software	23.1
Inventory	46.2
Prescribing learning	30.8
Data analysis	38.5
Administration	61.5
Other	0.0
Science tool uses	
Lab instrument	70.0
Data recording	60.0
Statistics	20.0
Data base	30.0

Telecommunications	0.0
Building models	40.0
Printing reports	70.0
Other	10.0
Instructional uses	
Drill and Practice	83.3
Simulations	91.7
Games	33.3
Tutorials	83.3
Interactive video	0.0
Remediation	33.3
Core instruction	33.3
Enrichment	66.7
Other	8.3
Grouping	
Demonstration	69.2
Individuals	76.9
Small groups	76.9
Whole groups	38.5
Other	7.7
Do teach about micros	33.3
Computer topics	
History of computing	0.0
Awareness	50.0
Operation	100.0
How computers work	50.0
How used in science	50.0
Other	0.0
Do teach programming	7.7
If yes for the previous item, purpose of student programs	
Students write programs	0.0
To solve science problems	100.0
To develop instruc. soft	0.0
To develop manage. soft.	0.0
Other	0.0
***ENLIST Micros* good**	92.3
Trained others	75.0

Table 4b

Leaders
Microcomputer Use in Science Teaching
Spring 1987

Means for Continuous Variables
n = 14

Computer availability	
Number of Apple II	5.8
Number of IBM pc	0.1
Number of Mac	0.0
Number of Radio Shack	0.0
Number of Commodore	2.0
Number of Others	0.1
Software availability	
Number of science soft.	6.1
Number of manage. soft.	1.2
Software $ for you	33.8
Software $ for district	200.0
No. of teachers helped	4.0

Table 4c

Leaders
Microcomputer Use in Science Teaching
Spring 1987

Percentages for Barriers
n = 14

Supplies available	100.0
Poor or no support	
Department chair	33.3
Principal	25.0
Computing supervisor	57.1
Curriculum supervisor	44.4
Superintendent	70.0
Technician support	46.2
Fellow teachers	38.5
Other	0.0
Significant barriers	
Personal interest	0.0
Personal knowledge	7.7
Personal time	61.5
Equipment and supplies	38.5
Software	76.9
Support	23.1
Student interest	0.0
Other	15.4
If barriers removed more use	100.0

Table 5

Leaders
Microcomputer Use in Science Teaching
Spring 1988

Categorical Data in Percentages
n = 14

1.	How are microcomputers made available to science students in your class(es)?	
	a. One or more microcomputers are available in classroom for students in science at all times.	50.0
	b. Many microcomputers are located in a computer laboratory available for student use in science on a limited basis.	71.4
	c. One or more microcomputers are available outside of classroom for student use in science on a limited basis.	21.4
	d. One or more microcomputers are temporarily available in classroom for student use in science.	42.9
	e. No microcomputers are available for student use in science.	0.0
2.	How are microcomputers made available to you for planning, preparing, and managing science instruction?	
	a. A microcomputer is always available in the classroom for managing science instruction.	35.7
	b. A microcomputer is available whenever you are free to use it in managing science instruction.	50.0
	c. A microcomputer is available for managing science instruction on a limited basis, when scheduled in advance.	21.4
	d. A microcomputer is occasionally available for managing science instruction.	14.3
	e. No microcomputers are available for you to use for managing science instruction.	0.0

3.	How much science software is available for student use in science?	
	a. Software is always available for use by students with most units taught in science.	7.7
	b. Software is available on a temporary basis for use by students with most units taught in science.	7.7
	c. Software is always available for use by students with some units taught in science.	38.5
	d. Software is always available on a temporary basis for use by students with some units taught in science.	46.2
	e. No software is available for student use in science.	0.0
4.	How much software is available for your use in planning, preparing, and managing science teaching?	
	a. There is sufficient software for managing science instruction always available to you.	35.7
	b. There is sufficient software for managing science instruction, but it is available on a limited basis to you.	7.1
	c. There is some software for managing science instruction available to you, but more is needed.	50.0
	d. There is some software for managing science instruction available on a limited basis to you, but more is needed.	7.1
	e. No software is available to you for managing science instruction.	0.0
5.	How much time do you spend per week per science class teaching science?	
	a. Science instruction averages at least 250 minutes per week during the school year.	64.3
	b. Science instruction averages 200-249 minutes per week during the school year.	14.3
	c. Science instruction averages 150-199 minutes per week during the school year.	7.1
	d. Science instruction averages 100-149 minutes per week during the school year.	14.3
	e. Science instruction averages less than 100 minutes during the school year.	0.0

6. How much time do science students spend using the microcomputer?	
a. Most students use the microcomputer for at least 45 minutes in most science units.	15.4
b. Most students use the microcomputer for at least 45 minutes in one or a few science units.	46.2
c. At least 25 percent of the students use the microcomputer for at least 45 minutes in most science units.	7.7
d. At least 25 percent of the students use the microcomputer for at least 45 minutes in one or a few science units.	23.1
e. Students never or rarely use microcomputers	7.7
7. How often do you use microcomputers to plan or manage science instruction?	
a. You use several microcomputer applications most of the time during the school year.	57.1
b. You use one or two microcomputer applications most of the time during the school year.	21.4
c. You use several microcomputer applications some of the time during the school year.	21.4
d. You use one or two microcomputer applications some of the time during the school year.	0.0
e. You never use the microcomputer to manage	0.0
8. How often do you use the microcomputer in the following ways to manage instruction? (in one or more units)	
a. developing, administering, or scoring student tests.	84.6
b. recording student grades and progress science instruction.	85.7
c. developing print materials for student activities.	100.0
d. developing software for student activities.	63.8
e. organizing and inventorying supplies and equipment.	50.0
f. prescribing and directing student activities.	84.6
g. computing and performing analysis of data about students.	83.3
h. preparing administrative paperwork.	91.7

9. How often do your students use the microcomputer in the following ways as a tool to enhance the learning of science? (in one or more units)

a. to gather data as a laboratory instrument.	92.3
b. to record and display data as tables or graphs.	92.3
c. to calculate and display statistics.	82.7
d. to organize and retrieve data in a database.	70.0
e. to retrieve information from a source with a telephone hookup.	8.3
f. to build and study models for phenomena and systems.	50.0
g. to prepare printed documents and reports from investigations by students.	84.6

10. How often do you use the microcomputer in the following ways to provide science instruction to students? (in one or more units)

a. drill and practice	83.3
b. simulations	100.0
c. games	62.6
d. tutorial	100.0
e. interactive videodisc	0.0
f. remediation	54.5
g. core instruction	91.7
h. enrichment	91.7

11. How often do you use the following methods of grouping to make microcomputers available to your students? (in one or more units)

a. demonstrations	92.3
b. individual work	100.0
c. small groups	100.0
d. whole class working on multiple computers	50.0

12. Which of the following activities do you use to teach students about microcomputers?

a. history of computers	14.3
b. awareness of role in society	21.4
c. how to operate a computer	50.0
d. how a computer works	28.6
e. how a computer is used in science	71.4
f. no activities about computers	28.6

13. Which of the following programs do you have your science students write?

a. simple programs	35.7
b. programs to solve science problems	28.6
c. educational software to teach science	28.6
d. programs to manage instruction	7.1
e. no programming activities	50.0

14. How much assistance and encouragement does your administration provide for your use of microcomputers in science teaching? (adequate, strong, or maximum support)

a. department chair	81.9
b. building principal	61.6
c. educational computing supervisor	70.0
d. curriculum supervisor	66.6
e. superintendent	54.6

15. How much technical support is available to help you use microcomputers in science teaching? (adequate, strong, or maximum support)	81.8
16. How much technical support do your fellow teachers give you for your use of microcomputers in science teaching? (adequate, strong, or maximum support)	91.7

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

a. personal lack of interest	0.0
b. personal lack of knowledge and skills	0.0
c. time to preview courseware, order courseware, and plan an prepare lessons.	57.1
d. availability of microcomputers.	57.1
e. availability of software.	57.1
f. availability of supplies.	28.6
g. support from administrators.	35.7
h. support from teachers.	0.0
i. technical support.	7.1
j. interest of students	0.0
k. no significant barriers	0.0

18. If the significant barriers were removed would you use the microcomputer (more)?	100.0
19. Have you helped other teachers begin using microcomputers? (Yes)	92.9
If yes, how many have you helped.	36.4

Table 6

Descriptive Information for Participants

n = 80

Assignment

51.9%	K-6 Teacher
26.6%	6-9 Teacher
20.3%	9-12 Teacher
01.3%	7-12 Teacher
00.0%	Administrator

Gender

36.7%	Male
63.3%	Female

Highest Degree

01.3%	Associate
45.6%	Bachelors
63.6%	Masters

Years of Teaching = 11.6

Years at Present School = 6.2

Years Using Microcomputers in Science Teaching

49.4%	Never
17.7%	One
16.5%	Two
08.9%	Three
02.5%	Four
05.1%	Five or more

Experience with Microcomputers

35.1%	Non user
41.9%	Novice
20.3%	Intermediate
00.0%	Old hand
02.7%	Past user

Have Had Formal Training in Using Microcomputers in Science Teaching = 27.8%

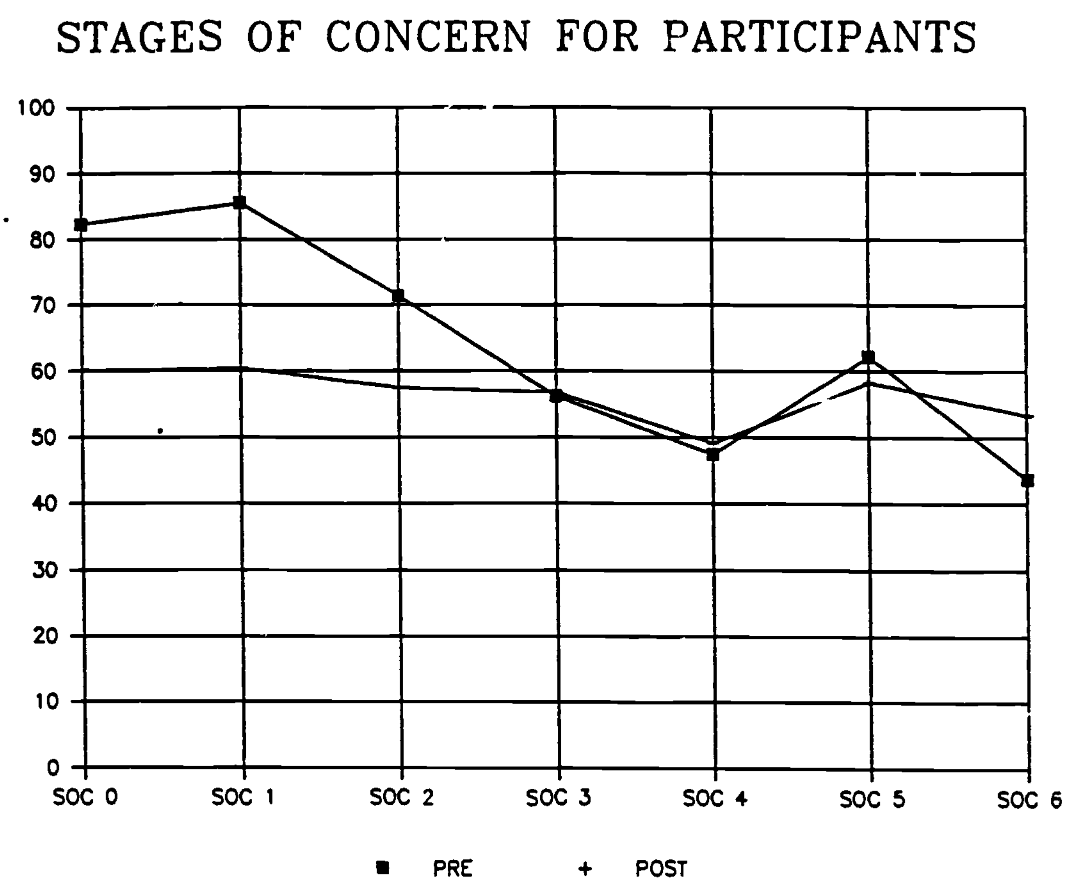
Are Implementing Other Innovation = 11.4%

Table 7

Participants
Evaluation of Inservice

Low 1 . . . . 2 . . . . 3 . . . . 4 . . . . 5 High	*Workshop* *n = 81*	*Seminars* *n = 79*
Were the objective goals and requirements of this course well defined and specified?	4.55	3.60
To what extent do you feel the course objectives were attained?	4.43	3.80
To what extent do you feel that the content of this course was well organized and sequentially developed in order to assure optimum learning?	4.43	3.70
To what extent do you feel this course has contributed to your professional development?	4.30	3.40
To what degree do you feel that you will be able to incorporate what you have learned in this inservice into your own assignment?	4.18	3.90
With respect to your professional development how does this inservice compare with similar college courses you have taken?	4.38	3.70
Was the subject matter presented effectively by the instructor?	4.53	3.50
Did the instructor exhibit broad background and knowledge of subject matter?	4.83	4.35
Rate the materials used in this inservice (text, films, handouts, etc.).	4.78	4.03
How would you rate this course in recommending it to another teacher/administrator?	4.54	3.80
Should this inservice be offered again?	4.75	4.13

Table 8



SOC 0 = Awareness
SOC 1 = Informational
SOC 2 = Personal
SOC 3 = Management
SOC 4 = Consequence
SOC 5 = Collaboration
SOC 6 = Refocusing

Table 9

Participants' Checklist
Microcomputer Use in Science Teaching

Categorical Data in Percentages
n = 80

	Pre	Post
1. How are microcomputers made available to science students in your class(es)?		
a. One or more microcomputers are available in classroom for students in science at all times.	20.5	30.4
b. Many microcomputers are located in a computer laboratory available for student use in science on a limited basis.	55.1	50.6
c. One or more microcomputers are available outside of classroom for student use in science on a limited basis.	9.0	11.4
d. One or more microcomputers are temporarily available in classroom for student use in science.	39.7	55.7
e. No microcomputers are available for student use in science.	9.0	0.0
2. How are microcomputers made available to you for planning, preparing, and managing science instruction?		
a. A microcomputer is always available in the classroom for managing science instruction.	20.5	30.4
b. A microcomputer is available whenever you are free to use it in managing science instruction.	35.9	35.4
c. A microcomputer is available for managing science instruction on a limited basis, when scheduled in advance.	32.1	29.1
d. A microcomputer is occasionally available for managing science instruction.	9.0	12.7
e. No microcomputers are available for you to use for managing science instruction.	10.3	1.3

3.	How much science software is available for student use in science?		
	a. Software is always available for use by students with most units taught in science.	3.9	3.8
	b. Software is available on a temporary basis for use by students with most units taught in science.	5.3	9.0
	c. Software is always available for use by students with some units taught in science.	21.1	33.3
	d. Software is always available on a temporary basis for use by students with some units taught in science.	36.8	47.4
	e. No software is available for student use in science.	32.9	6.4
4.	How much software is available for your use in planning, preparing, and managing science teaching?		
	a. There is sufficient software for managing science instruction always available to you.	10.4	22.7
	b. There is sufficient software for managing science instruction, but it is available on a limited basis to you.	1.3	5.3
	c. There is some software for managing science instruction available to you, but more is needed.	22.1	32.0
	d. There is some software for managing science instruction available on a limited basis to you, but more is needed.	28.6	26.7
	e. No software is available to you for managing science instruction.	37.7	13.3
5.	How much time do you spend per week per science class teaching science?		
	a. Science instruction averages at least 250 minutes per week during the school year.	29.9	20.8
	b. Science instruction averages 200-249 minutes per week during the school year.	22.1	24.7
	c. Science instruction averages 150-199 minutes per week during the school year.	13.0	26.0
	d. Science instruction averages 100-149 minutes per week during the school year.	20.8	13.0
	e. Science instruction averages less than 100 minutes during the school year.	14.3	15.6

6. How much time do science students spend using the microcomputer?

a. Most students use the microcomputer for at least 45 minutes in most science units.	1.3	6.7
b. Most students use the microcomputer for at least 45 minutes in one or a few science units.	10.4	38.7
c. At least 25 percent of the students use the microcomputer for at least 45 minutes in most science units.	1.3	0.0
d. At least 25 percent of the students use the microcomputer for at least 45 minutes in one or a few science units.	9.1	21.3
e. Students never or rarely use microcomputers	77.9	33.3

7. How often do you use microcomputers to plan or manage science instruction?

a. You use several microcomputer applications most of the time during the school year.	9.0	20.5
b. You use one or two microcomputer applications most of the time during the school year.	19.2	28.2
c. You use several microcomputer applications some of the time during the school year.	15.4	30.8
d. You use one or two microcomputer applications some of the time during the school year.	6.4	5.1
e. You never use the microcomputer to manage	50.4	15.4

8. How often do you use the microcomputer in the following ways to manage instruction? (in one or more units)

a. developing, administering, or scoring student tests.	42.3	53.8
b. recording student grades and progress science instruction.	50.0	63.8
c. developing print materials for student activities.	67.1	79.7
d. developing software for student activities.	18.4	21.8
e. organizing and inventorying supplies and equipment.	18.4	19.2
f. prescribing and directing student activities.	23.6	47.4
g. computing and performing analysis of data about students.	32.0	45.5
h. preparing administrative paperwork.	47.4	62.8

9. How often do your students use the microcomputer in the following ways as a tool to enhance the learning of science? (in one or more units)

a. to gather data as a laboratory instrument.	9.1	46.1
b. to record and display data as tables or graphs.	15.6	49.4
c. to calculate and display statistics.	10.4	28.0
d. to organize and retrieve data in a database.	10.4	32.9
e. to retrieve information from a source with a telephone hookup.	1.3	4.0
f. to build and study models for phenomena and systems.	9.1	24.0
g. to prepare printed documents and reports from investigations by students.	20.8	52.3

10. How often do you use the microcomputer in the following ways to provide science instruction to students? (in one or more units)

a. drill and practice	18.6	78.4
b. simulations	37.7	89.2
c. games	31.3	70.3
d. tutorial	18.1	76.7
e. interactive videodisc	5.3	11.4
f. remediation	13.3	43.1
g. core instruction	13.5	41.7
h. enrichment	39.0	85.1

11. How often do you use the following methods of grouping to make microcomputers available to your students? (in one or more units)

a. demonstrations	25.3	82.4
b. individual work	32.0	80.3
c. small groups	32.9	91.7
d. whole class working on multiple computers	19.5	49.3

12. Which of the following activities do you use to teach students about microcomputers?

a. history of computers	11.7	13.3
b. awareness of role in society	20.8	29.3
c. how to operate a computer	53.2	68.0
d. how a computer works	36.4	37.3
e. how a computer is used in science	10.4	44.0
f. no activities about computers	40.3	22.7

13. Which of the following programs do you have your science students write?

a. simple programs	13.9	12.9
b. programs to solve science problems	2.8	4.3
c. educational software to teach science	12.5	12.9
d. programs to manage instruction	1.4	2.9
e. no programming activities	81.9	81.4

14. How much assistance and encouragement does your administration provide for your use of microcomputers in science teaching? (adequate, strong, or maximum support)

a. department chair	46.5	68.4
b. building principal	48.3	71.8
c. educational computing supervisor	50.0	67.8
d. curriculum supervisor	39.2	56.3
e. superintendent	34.0	44.7

15. How much technical support is available to help you use microcomputers in science teaching? (adequate, strong, or maximum support)	48.0	67.1
16. How much technical support do your fellow teachers give you for your use of microcomputers in science teaching? (adequate, strong, or maximum support)	51.3	74.0

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

a. personal lack of interest	1.3	0.0
b. personal lack of knowledge and skills	48.7	13.0
c. time to preview courseware, order courseware and plan and prepare lessons	73.1	72.7
d. availability of microcomputers	59.0	53.2
e. availability of software	83.3	77.9
f. availability of supplies	35.9	32.5
g. support from administrators	14.1	18.2
h. support from teachers	5.1	2.6
i. technical support	17.9	18.2
j. interest of students	1.3	0.0
k. no significant barriers	2.6	5.2

18. If the significant barriers were removed would you use the microcomputer (more)?	100.0	98.7
19. Have you helped other teachers begin using microcomputers? (Yes)	51.3	73.3
If yes, <u>how many</u> have you helped.	8.2	3.9

Appendix A

School Districts Participating in Year Two

Academy School District 20
Colorado Springs, Colorado

Calhan School District RJ1
Calhan, Colorado

Cheyenne Mountain School District 12
Colorado Springs, Colorado

Colorado Springs School District 11
Colorado Springs, Colorado

Falcon School District 49
Peyton, Colorado

Fountain/Fort Carson School District 8
Fountain, Colorado

Harrison School District 2
Colorado Springs, Colorado

Lewis-Palmer School District 38
Monument, Colorado

Manitou Springs School District 14
Manitou Springs, Colorado

Widefield School District 3
Colorado Springs, Colorado

Woodland Park School District RE-2
Woodland Park, Colorado

Appendix B

Members of the Project Advisory Committee

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Appendix C

Microcomputer Use in Science Teaching Checklist

USE OF MICROCOMPUTERS IN SCIENCE TEACHING

Name ______________________ District ______________________

Date ______________________ School ______________________

Grade level K 1 2 3 4 5 6 7 8 9 10 11 12 Admin
[circle the appropriate grade level(s)]

Subjects taught ____

1. How are microcomputers made available to science student in your class(es)?

_____ One or more microcompu er availa' e in classroom for students use in science at all times.

_____ Many microcomputers located in a computer laboratory available for student use in science on a limited basis.

_____ One or more microcomputers available outside of classroom for student use in science at all times.

_____ One or more microcomputers temporarily available in the classroom for student use in science.

_____ No microcomputers are available for student use in science.

2. How are microcomputers made available to you for planning, preparing, and managing science instruction?

_____ A microcomputer is always available in the classroom for managing science instruction.

_____ A microcomputer is available whenever you are free to use it in managing science instruction.

_____ A microcomputer is available for managing science instruction on a limited basis, when scheduled in advance.

_____ A microcomputer is occasionally available for managing science instruction.

_____ No microcomputers are available for you to use for managing science instruction.

3. How much science software is available for student use in science?

_____ Software is always available for use by students with most units taught in science.
_____ Software available on a temporary basis for use by students with most units taught in science.
_____ Software is always available for use by students with some units taught in science.
_____ Software is available on a temporary basis for use by students with some units taught in science.
_____ No software is available for student use in science.

4. How much software is available for your use in planning, preparing, and managing science teaching?

_____ There is sufficient software for managing science instruction always available to you.
_____ There is sufficient software for managing science instruction, but it is available on a limited basis to you.
_____ There is some software for managing science instruction available to you, but more is needed.
_____ There is some software for managing science instruction available on a limited basis to you, but more is needed.
_____ No software is available to you for managing science instruction.

5. How much time do you spend per week per science class teaching science?

_____ Science instruction averages at least 250 minutes per week during the school year.
_____ Science instruction averages 200-249 minutes per week during the school year.
_____ Science instruction averages 150-199 minutes per week during the school year.
_____ Science instruction averages 100-149 minutes per week during the school year.
_____ Science instruction averages less than 100 minutes per week during the school year.

6. How much time do science students spend using the microcomputer?

_____ Most students use the microcomputer (individually or in a group) for at least 45 minutes in most science units.

_____ Most students use the microcomputer (individually or in a group) for at least 45 minutes in one or a few science units.

_____ At least 25 percent of the students use the microcomputer (individually or in a group)

_____ for at least 45 miutes in most science units.

_____ At least 25 percent of the students use of the microcomputer (individually or in a group) for at least 45 minutes in one or a few science units.

_____ Students never or rarely use microcomputers.

7. How often do you use microcomputers to plan, or manage science instruction?

_____ You use several microcomputer applications most of the time during the school year to plan and manage science instruction and to prepare instructional materials for science.

_____ You use one or two microcomputer applications most of the time during the school year to plan and manage science instruction or to prepare instructional materials for science.

_____ You use several microcomputer applications some of the time during the school year to plan and manage science instruction and to prepare instructional materials for science.

_____ You never use the microcomputer applications some of the time during the school year to plan and manage science instruction or to prepare instructional materials for science.

_____ You never use the microcomputer to manage science instruction.

8. How often do you use the microcomputer in the following ways to manage instruction? (Check the space that applies.)

Most units	One or two units	Never	
_____	_____	_____	developing, administering, or scoring student tests
_____	_____	_____	recording student grades and progress
_____	_____	_____	developing print materials for student 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

9. How often do your students use the microcomputer in the following ways as a tool to enhance the learning of science? (Check the space that applies.)

Most units	One or two units	Never	
____	____	____	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

10. How often do you use the microcomputer in the following ways to provide science instruction for students? (Check the space that applies.)

Most units	One or two units	Never	
____	____	____	drill and practice
____	____	____	simulations
____	____	____	games
____	____	____	tutorial
____	____	____	interactive videodisc
____	____	____	remediation
____	____	____	core instruction
____	____	____	enrichment

11. How often do you use the following methods of grouping to make microcomputers available to your science students? (Check the space that applies.)

Most units	One or two units	Never	
____	____	____	demonstrations
____	____	____	individual work
____	____	____	small groups
____	____	____	whole class working on multiple computers simultaneously

12. Which of the following (if any) activities do you use to teach students about microcomputers?

_____ history of computers
_____ awareness of role in society
_____ how to operate a computer
_____ how a computer works
_____ how a computer is used in science
_____ no activities about computers

13. Which of the following (if any) programming activities do you have your science students write?

_____ simple programs
_____ programs to solve science problems
_____ educational software to teach science
_____ programs to manage instruction
_____ no programming activities

14. How much assistance and encouragement does your administration provide for your use of microcomputers in science teaching? (fill in blank with the appropriate number)

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

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

15. How much technical support is available to help you use microcomputers in science teaching?

_____ maximum
_____ strong
_____ adequate
_____ poor
_____ none

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

_____ maximum
_____ strong
_____ adequate
_____ poor
_____ none

17. What are the most significant barriers (if any) to increasing your use of microcomputers in science teaching?

_____ personal lack of interest
_____ personal lack of knowledge and skills
_____ time to preview courseware, order courseware, and plan and prepare lessons
_____ availability of microcomputers
_____ availability of software
_____ availability of supplies
_____ support from administrators
_____ support from teachers
_____ technical support
_____ interest of students
_____ no significant barriers

18. If the existing barriers were removed, would you use the microcomputer

_____ the same _____ more _____ less?

19. Have you helped other teachers begin using microcomputers?

_____ yes _____ no If yes, how many have you helped? _______________

20. Do you have any questions or other information you would like to share on the subjects addressed in this interview/questionnaire?

____

____

____

Appendix D

Stages of Concern Questionnaire

Using Microcomputers in Science Teaching

Concerns Questionnaire

Name ____

In order to identify these data, please give us the last four digits of your Social Security number:

___ ___ ___ ___

The purpose of this questionnaire is to determine what people who are using or thinking about various programs are concerned about at various times during the innovation adoption process. The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years experience in using them. Therefore, **a good part of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time.** For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0 1 2 3 4 5 6 (7)
This statement is somewhat true of me now.	0 1 2 3 (4) 5 6 7
This statement is not at all true of me at this time.	0 (1) 2 3 4 5 6 7
This statement seems irrelevant to me.	(0) 1 2 3 4 5 6 7

Please respond to items in terms of **your present concerns,** or how you feel about your involvement or potential involvement with *Using Microcomputers in Science Teaching.* We do not hold to any one definition of this innovation, so please think of it in terms of your **own perception** of what it involves. Since this questionnaire is used for a variety of innovations, the name *Using Microcomputers in Science Teaching* never appears. However, phrases such as "the innovation," "this approach," and "the new system" all refer to *Using Microcomputers in Science Teaching.* Remember to respond to each item in terms of **your present concerns** about your involvement or potential involvement with *Using Microcomputers in Science Teaching.*

SoC Questionnaire Items - Using Microcomputers in Science Teaching

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

1. I am concerned about students' attitudes toward this innovation. 0 1 2 3 4 5 6 7
2. I now know of some other approaches that might work better. 0 1 2 3 4 5 6 7
3. I don't even know what the innovation is. 0 1 2 3 4 5 6 7
4. I am concerned about not having enough time to organize myself each day. 0 1 2 3 4 5 6 7
5. I would like to help other faculty in their use of the innovation. 0 1 2 3 4 5 6 7
6. I have a very limited knowledge about the innovation. 0 1 2 3 4 5 6 7
7. I would like to know the effect of reorganization on my professional status. 0 1 2 3 4 5 6 7
8. I am concerned about conflict between my interests and my responsibilities. 0 1 2 3 4 5 6 7
9. I am concerned about revising my use of the innovation. 0 1 2 3 4 5 6 7
10. I would like to develop working relationships with both our faculty and outside faculty using this innovation. 0 1 2 3 4 5 6 7
11. I am concerned about how the innovation affects students. 0 1 2 3 4 5 6 7
12. I am not concerned about this innovation. 0 1 2 3 4 5 6 7
13. I would like to know who will make the decisions in the new system. 0 1 2 3 4 5 6 7
14. I would like to discuss the possibility of using the innovation. 0 1 2 3 4 5 6 7
15. I would like to know what resources are available if we decide to adopt this innovation. 0 1 2 3 4 5 6 7
16. I am concerned about my inability to manage all the innovation requires. 0 1 2 3 4 5 6 7
17. I would like to know how my teaching or administration is supposed to change. 0 1 2 3 4 5 6 7
18. I would like to familiarize other departments or persons with the progress of this new approach. 0 1 2 3 4 5 6 7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

19. I am concerned about evaluating my impact on students. 0 1 2 3 4 5 6 7

20. I would like to revise the innovation's instructional approach. 0 1 2 3 4 5 6 7

21. I am completely occupied with other things. 0 1 2 3 4 5 6 7

22. I would like to modify our use of the innovation based on the experiences of our students. 0 1 2 3 4 5 6 7

23. Although I don't know about this innovation, I am concerned about things in the area. 0 1 2 3 4 5 6 7

24. I would like to excite my students about their part in this approach. 0 1 2 3 4 5 6 7

25. I am concerned about time spent working with nonacademic problems related to this innovation. 0 1 2 3 4 5 6 7

26. I would like to know what the use of the innovation will require in the immediate future. 0 1 2 3 4 5 6 7

27. I would like to coordinate my efforts with others to maximize the innovation's effects. 0 1 2 3 4 5 6 7

28. I would like to have more information on time and energy commitments required by this innovation. 0 1 2 3 4 5 6 7

29. I would like to know what other faculty are doing in this area. 0 1 2 3 4 5 6 7

30. At this time, I am not interested in learning about this innovation. 0 1 2 3 4 5 6 7

31. I would like to determine how to supplement, enhance, or replace the innovation. 0 1 2 3 4 5 6 7

32. I would like to use feedback from students to change the program. 0 1 2 3 4 5 6 7

33. I would like to know how my role will change when I am using the innovation. 0 1 2 3 4 5 6 7

34. Coordination of tasks and people is taking too much of my time. 0 1 2 3 4 5 6 7

35. I would like to know how this innovation is better than what we have now. 0 1 2 3 4 5 6 7

Using Microcomputers in Science Teaching

PLEASE COMPLETE THE FOLLOWING:

1. What level is your assignment? _____K-6 ______6-9 ______9-12 _____K-12
2. Female ______ Male ______
3. Age: ____20-29 ____30-39 ____40-49 ____50-59 ____60-69
4. Highest degree earned:

________Associate _______Bachelor _____Masters _____Doctorate

5. Number of years teaching: ____________
6. Number of years in present school: ____________
7. How long have you been using <u>microcomputers</u> in <u>science</u> teaching, not counting this year?

_______never ______one year _______two years ______three years ______four years ______five years or more

8. In your use of microcomputers in science teaching, do you consider yourself a:

____nonuser ____novice ____intermediate ____old hand ___past user

9. Have you received any formal training in using microcomputers in science teaching (workshops, courses)?

yes ________ no ________ If yes, please describe briefly.

____

____

10. Are you currently in the first or second year of use of some major innovation or program other than using microcomputers in science teaching?

yes ________ no ________ If yes, please describe briefly.

____

____

11. Please check to see that you have written the last four digits of your Social Security number on the front page of this questionnaire. Thank you for your help.