DOCUMENT RESUME

ED 216 866 SE 037 372

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TITLE Preparing Teachers to Teach Environmental Science: An Evaluation of an NSF Program.
SPONS AGENCY National Inst. of Education (ED), Washington, DC.; National Science Foundation, Washington, D.C.
PUB DATE Mar 82
NOTE 35p.; Paper presented at the Annual Meeting of the American Educational Research Association (New York, NY, March 18-23, 1982).

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Elementary School Science; *Environmental Education; *Inservice Teacher Education; Knowledge Level; Primary Education; *Program Descriptions; *Program Evaluation; Science Education; *Science Programs; Teacher Attitudes
IDENTIFIERS National Science Foundation; *Science Education Research; Texas

ABSTRACT

A description and evaluation of an environmental science inservice education program for teachers of grades 4-6 from central Texas is described. Participants attended 32 class sessions which involved lecture, demonstration, seminars, laboratory work, and discussion. Two full-day and four half-day field trips were also part of the program. The goals of the program were to increase teachers' environmental science knowledge, to help them identify and use appropriate resource materials, and to promote cooperation between the University of Texas at Austin and teachers. Program participants also conducted inservice workshops for their own schools and school systems resulting in a multiplier effect. In order to obtain formative and summative evaluation data, program participants responded to three instruments: one to assess teachers' concerns and changes in concerns about the inservice program, one to measure their attitudes towards science, and another to measure gains in environmental science knowledge. Instruments were administered three different times: pre-treatment, mid-way (16 weeks), and post-treatment (32 weeks). A control group was used. Findings indicate that participants' attitudes changed positively, that they demonstrated a significant increase in knowledge, and that they experienced personal growth and development. (DC)

PREPARING TEACHERS TO TEACH ENVIRONMENTAL SCIENCE: AN EVALUATION OF AN NSF PROGRAM

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Paper presented at the annual meeting of the
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New York City, New York, 1982

ABSTRACT

There are many gaps in the professional preparation of elementary teachers. One of these is science. More training and preparation for science teaching is necessary. Therefore, programs should be designed and implemented to meet teacher-perceived needs.

This paper reports a year long effort designed to improve teachers' knowledge of environmental science and to change their attitudes and concerns about it. The paper describes the assessment techniques utilized to determine teacher need, describes the environmental science program, the research techniques undertaken and the instruments used for collecting data on teacher change. The results of the teacher preparation program on teacher development are reported.

Preparing Teachers to Teach Environmental Science:

An Evaluation of an NSF Model Program[1]

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and

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INTRODUCTION

Over the years teachers have viewed inservice education as something to be tolerated because of job requirements. Whether we like it or not, inservice education or staff development has had a bad name (Barnes and Putnam, 1981). But this is not a new phenomenon. Many professionals feel that it has just not met their perceived needs or expressed interests (Bailey and James, 1978).

During 1975-1976 the National Education Association (NEA) conducted research on what public school teachers thought about their inservice education experiences. They found that a significant percent of those responding were dissatisfied. Expressed criticism included being too general for individual and special needs, little relevance to specific teaching situations, included no teachers in the initial planning stages, and tended to focus on school needs rather than on teacher needs (Bartholomew, 1976).

Howey (1978) conducted a survey of teachers in several states on their inservice education experiences. It was reported that over 75 percent felt that the inservice education that they received was either inadequate or just plain poor. Similar opinions were expressed by Bailey and James (1978) in their

[1]Work reported herein was conducted with the support of the National Science Foundation and the National Institute of Education. The opinions expressed are those of the authors and no endorsement by the National Science Foundation or National Institute of Education is implied.

research.

A primary goal of inservice education has been to bring together teachers and teacher educators for the purpose of professional development. Such development through specific activities and experiences should be designed to meet inservice participants' individual needs in knowledge and/or skill areas. An area in which this function is widely needed is elementary science education.

Many practicing teachers desire to continue their professional preparation and development beyond the initial four year teacher education program. Nowhere is this more evident than at the elementary school level. Many elementary teachers are uncomfortable in teaching science because often they do not have a sufficient knowledge of science content and an understanding of the discipline's concepts and teaching methodologies. Because of this they do not teach the subject and their students become the ultimate losers. Thus science is given short shrift in the elementary school curriculum (Bethel, 1982). In response to this state of affairs the National Science Foundation (NSF) has as one of its functions the improvement of science taught in grades K-12. Thus, the Pre-College Teacher Development in Science Program was initiated in 1959. Federal allocations to the program are distributed nationwide to both colleges and universities, as well as teacher education centers and other state education organizations.

One of the institutions receiving funds has been the Science Education Center at The University of Texas, Austin, established in 1959. One of its goals has been to provide assistance and support for teachers already in service. It has been actively involved in providing staff development opportunities for several years.

Needs Assessment

Research appears to support the idea that teachers need to be directly involved in their professional and educational development (Christensen & Burke, 1982; and Lawrenz, 1974). In order to develop an elementary science education staff development program with teacher involvement, a study was undertaken in the south Texas region. It would first determine the amount of science being taught and whether there was a need for the program. Results revealed that little or no science was taught at all, that is, science was taught on an average of 2 minutes per day (for a detailed description of the assessment procedures see Bethel and Hord, 1981). Once it was determined that there was a need, questions were formulated to determine what topics and concepts were of interest to teachers, what kinds of instructional skills were needed by teachers for science instruction, and what was the best educational setting in which to conduct the staff development. Teacher involvement was gained as almost 90% of the total number of teaching professionals surveyed responded to the questionnaire.

INSERVICE PROGRAM

Based upon the objectives of NSF and the teachers' needs expressed in the survey, the following objectives were identified for the environmental science education program:

1. To improve the knowledge of intermediate, elementary and middle school teachers in grades 4-6 from the central Texas region in Environmental Science.

2. To aid teachers in the identification and use of environmental science education resources appropriate to their level of instruction, which would aid in the teaching of environmental science concepts.

3. To develop and maintain cooperation, communication, and program support between scientists at The University of Texas at Austin and intermediate elementary and middle school teachers in the central Texas region.

The needs assessment revealed that teachers were very much interested in environment-related concepts. They desired to know more about such topics as eco-systems, environments, minerals and rocks, air pollution, water pollution, communities, energy conservation, conservation law, and ecology of Texas. Therefore, these topics were included in the course content along with environmental law, geology of the Southwest and land management.

There were a total of 32 class sessions in the program. Participants attended all classes, each of which were 2-1/2 hours long. The lectures, demonstrations, and seminars usually required 75 minutes. The laboratory sessions lasted for 60 minutes followed by a 15-20 minute post-lab discussion to bring closure to the session and to clarify questions raised by the participants. There were also two full-day field trips as well as four half-day field trips.

The materials and learning activities utilized in the class sessions were developed by the project director, inservice teachers, Texas Education Agency personnel, and members of the university's multidisciplinary faculty who served as resource personnel, including:

1. a biologist
2. a geologist
3. a botanist
4. an environmental chemist
5. an ecologist
6. a science educator
7. an environmental geologist
8. a conservationist

To enhance the instructional program, university scientists having expertise in many of the program topics were invited to present mini-lectures for the participants. The purpose for having the scientists was two-fold: (1) to present the latest in environmental science knowledge and technology, and (2) to introduce the university scientists who could serve as future resource persons to the participants and their environmental science education programs conducted in the schools.

In order to provide program activities and materials that would be more relevant to the teachers and their expressed needs, the data, which were collected as a measure of change in participants for summative evaluation purposes, were also used as formative feedback to the program director. The data made it possible to better understand and respond to participants' needs as they experienced the inservice change process. Thus, program modifications were designed and targeted toward the changing concerns of the teachers.

During the course of the program two week-end field trips were made. The first of these was a collecting trip in the fall. The trip covered the central Texas region. The focus of this trip was the geology of the region. Participants collected and identified rocks and minerals which would be used later in a rock study lesson.

A field trip was conducted again during the spring semester, to a state park. In addition to observing the flora and fauna of the park, activities from an outdoor biology program were used by program participants. These activities were taken from the Outdoor Biology Instructional Strategies program designed specifically to be used with students in grades 4, 5, and 6. A complete list of the flora and fauna observed in the park was made for later distribution to all participants. The list could be used by the teachers with their classes when participating in future field trips.

A unique aspect of the program was the conducting of inservice workshops by the participants for other teachers in their respective schools and school systems. This was referred to as the "multiplier" effect. The overall purpose was for the participants to share their knowledge and expertise not only with their students but with their colleagues and, ultimately, colleagues' students. In this manner the cost-effectiveness of the NSF environmental science education program would be enhanced in terms of the number of people involved with the total program. The number of workshops given by the participants was 30 which were attended by a total of 418 inservice teachers. If each teacher worked with an average of 27 students, then a total of approximately 11,286 students would be exposed to some kind of science instruction and in particular, environmental science.

RESEARCH METHODS AND TECHNIQUES

In order to understand the effects of the inservice program and to realize a measure of its success, a study was designed to obtain formative and summative evaluation data from the program participants. In this manner, results from ongoing data collection could be used as a diagnostic basis for instituting changes, thus insuring the refinement of the program to meet the immediate needs of the teachers. The study would reveal, in addition, the participants' concerns, attitudes, and knowledge relative to environmental science as a post measure at the conclusion of the program.

Instrumentation

Three instruments were selected to provide data. In order to determine teachers' concerns about the innovative science program and how concerns might change as a result of the inservice program, the Stages of Concern Questionnaire (SoCQ) was selected. Second, to measure teachers' attitudes toward science and how they might be affected by the staff development intervention, the Environmental Education Questionnaire (EEQ) was chosen. Third, an environmental science content instrument was used in order to assess the gain in knowledge of the participants as a result of their participation in the environmental science program. The underlying concepts and assessment tools for these three measures are described below.

Stages of Concern Questionnaire. The Concerns-Based Adoption Model (CBAM) is a valuable conceptual framework which can be utilized by those responsible for teacher preparation programs. It can be used in planning and delivering programs and in monitoring and facilitating teacher change and growth. This framework was developed at the Research and Development Center for Teacher Education at The University of Texas at Austin, and resulted from many years of research on change in schools and colleges. The CBAM provides an approach to the study of teacher change by focusing on the growth of individuals over time. It describes teachers as they first begin and then gain experience with using new subject matter (or any new or innovative product or practice) in teacher preparation programs.

A cornerstone of the model is Stages of Concern (SoC) (Hall, George & Rutherford, 1977), a conceptualization of the way the concerns of individual teachers change as they become knowledgeable about and involved with new content, programs, processes or educational practices in their schools.

Concern is defined as the feelings, attitudes, thoughts, ideas or reactions an individual has related to a new practice. The work of Fuller (1969) resulted in the labeling of self, task, impact concerns--the concerns of preservice teachers as they progressed from first preservice teacher education experiences to being experienced inservice teachers. Fuller's work was the foundation upon which CBAM research on Stages of Concern was built. This research resulted in the identification of seven Stages of Concern About the Innovation (Figure 1).

Stages of Concern (SoC) describes the kinds of concerns which the

FIGURE 1

STAGES OF CONCERN ABOUT THE INNOVATION*

6 *REFOCUSING*: The focus is on exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the innovation.

5 *COLLABORATION*: The focus is on coordination and cooperation with others regarding use of the innovation.

4 *CONSEQUENCE*: Attention focuses on impact of the innovation on student in his/her immediate sphere of influence. The focus is on relevance of the innovation for students, evaluation of student outcomes, including performance and competencies, and changes needed to increase student outcomes.

3 *MANAGEMENT*: Attention is focused on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organizing, managing, scheduling, and time demands are utmost.

2 *PERSONAL*: Individual is uncertain about the demands of the innovation, his/her inadequacy to meet those demands, and his/her role with the innovation. This includes analysis of his/her role in relation to the reward structure of the organization, decision making, and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.

1 *INFORMATIONAL*: A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about himself/herself in relation to the innovation. She/he is interested in substantive aspects of the innovation in a selfless manner such as general characteristics, effects, and requirements for use.

0 *AWARENESS*: Little concern about or involvement with the innovation is indicated.

*Original concept from G.E. Hall, R.C. Wallace, Jr., & W.A. Dossett, *A Developmental Conceptualization of the Adoption Process within Educational Institutions* (Austin, Tex.: Research and Development Center for Teacher Education, The University of Texas, 1973).

individual teacher may experience over time, related to the new program or practice (innovation). The stages range from initial information and self concerns (Stages 1 and 2), where individuals would be expressing such things as, "What is this innovation and how will I be affected by it?" to concerns related to task (Stage 3), "How can I make this innovation work?" to concerns for impact (Stages 4, 5, and 6), "How will using this innovation affect my students?" Individuals experience a variety of concerns at any one time; however, the degree of intensity of different concerns will vary depending on the individual's knowledge and experience.

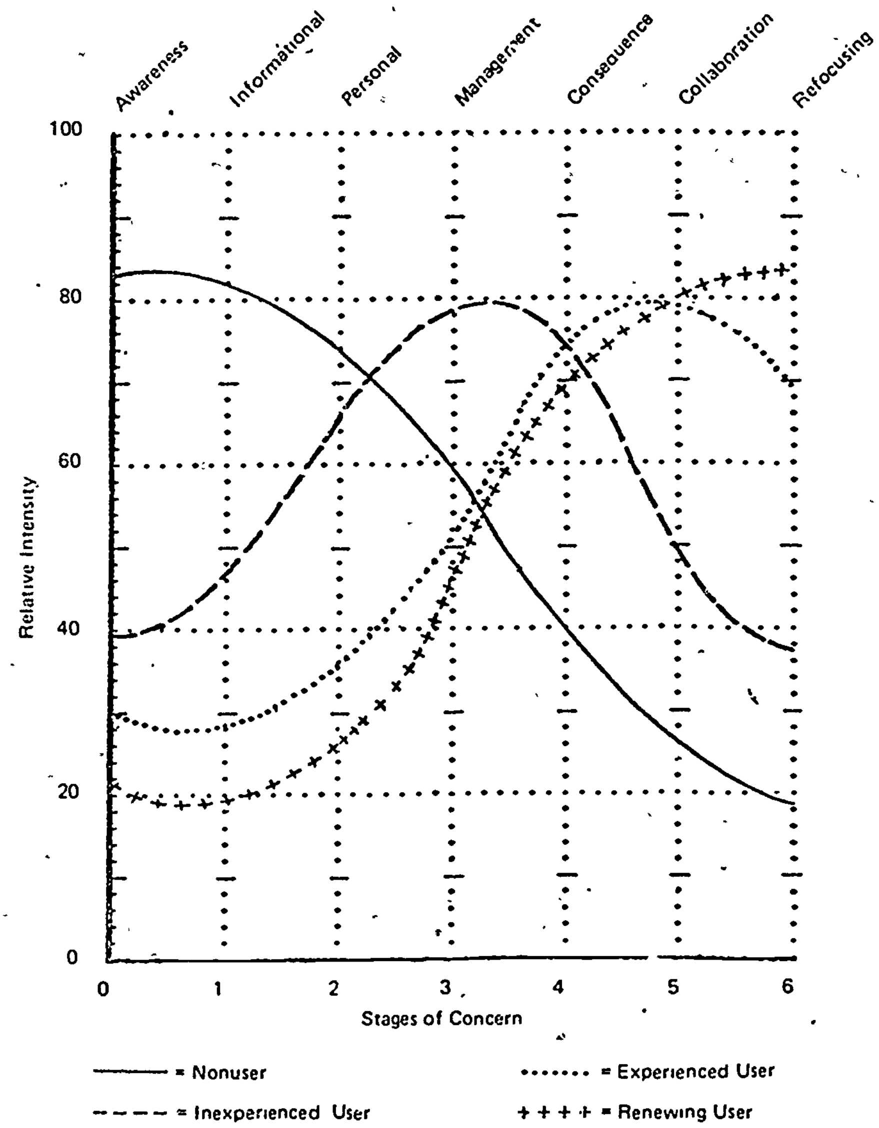
Therefore, teachers seldom have concerns at only one stage. Typically teachers who are not yet users of an innovation will have concerns high on Stages 0, 1 and 2 (Figure 2). They are mainly concerned about gaining information (Stage 1) or about how using the innovation will affect them personally (Stage 2). Stage 3 Management concerns become higher and more intense as they begin to use the innovation. Then, when teachers become experienced and skilled, the tendency is for concerns at Stages 4, 5, and 6 to become more intense with Stages 0, 1, 2, and 3 decreasing (Hall, George & Rutherford, 1977).

The Stages of Concern About the Innovation Questionnaire (SoCQ) (Hall, George & Rutherford, 1977) is used to measure the seven Stages of Concern. This psychometrically rigorous paper and pencil measure is used for research and program evaluation and consists of 35 items. Teachers indicate their degree of concern by responding on a Likert scale for each of the items. Percentile scores and a profile of concerns for the individual or for groups results from scoring these data manually or by computer program.

Environmental Education Questionnaire. Teachers' attitudes toward environmental science education were assessed through use of the Environmental Education Questionnaire (EEQ) instrument (Jaus, 1978). Attitude is defined as a

FIGURE 2

Hypothesized Development of Stages of Concern



predisposition to respond favorably or unfavorably toward an object, concept, or idea. In other words, a person may respond toward the concept "environmental science education" in a favorable, neutral, or unfavorable manner. The EEQ measures a person's attitude or predisposition toward environmental science education with a score between 20 and 100 (very positive). A score of 60 would indicate a neutral attitude toward environmental education. Thus movement toward the high end of the scale would indicate a more pronounced positive attitude while movement toward the low end would indicate an increasingly negative attitude.

The instrument includes a five category Likert-type scale with responses from "strongly agree" to "strongly disagree." Jaus (1978) used the test-retest method to report the reliability of the instrument. An alpha reliability of .89 was reported for the combined groups on the pretest. The content validity of EEQ was established in the initial study by Jaus (1978). A total of 78 items were submitted to five science education professors and two social sciences professors. The judges were asked to rank statements, suggestions, and/or positive attitudes toward environmental science education. The original item pool (78) was reduced to those statements receiving perfect agreement among the judges. This resulted in a final instrument containing 20 items.

Environmental Science Content Questionnaire. In order to determine the participants' gain in environmental science content, an assessment instrument was constructed. It contained items to be covered in each of the topic areas determined by the needs assessment described elsewhere. The format of the knowledge instrument was multiple choice. The reliability of the instrument was determined by the test-retest method. Results of the test-retest method resulted in a reliability coefficient of .86. This was judged to be sufficient for the purposes of this study.

Assessment Procedures

The research study was designed so that data would be collected at three points: pre-treatment, mid-way (16 weeks), and post-treatment (32 weeks). In addition to collecting data from the sample of teachers in the treatment group, a control group was established from whom concerns, attitude data, and content knowledge would be obtained for comparison purposes.

In order to minimize error variance between groups related to systematic differences among individual teachers within the two samples, the control group was generated from subjects paired with the treatment group subjects. Each participant was requested to select a teaching colleague in the same grade within their school so far as this was possible. These subjects served as the control group. Because of the similar context it was hypothesized that the control group's situation and experiences would approximate that of the participants.

RESULTS OF THE STUDY

As reported above, data were collected using the concerns (SoCQ) instrument with both the experimental and control groups, the attitude (EEQ) instrument with both the treatment and control group, and the environmental science knowledge assessment questionnaire with both of the groups. Comparisons of the two groups' concerns and attitudes scores were made at the beginning of the in-service program, at the mid-point (16 weeks), and at the conclusion of the program (32 weeks). Comparison of the groups' environmental science knowledge scores was made both at the beginning and at the conclusion of the program. ANOVA methods were used to analyze the data and a significance level of 0.01 was selected.

Findings from the Environmental Science Content Questionnaire

Comparisons between the pre-test means of the control and treatment groups of the science content questionnaire were calculated to see if there were any significant differences between the groups prior to the treatment (Table 1). An analysis of variance (ANOVA) was performed on the data using the statistical package in social sciences (SPSS, 1975). There were no significant differences on content pretest between the group means at the $p \leq .01$ level of significance. Noting the pre-test scores of 37.63 for the control group and 37.87 for the experimental group, the difference in these baseline data was negligible.

TABLE 1

GROUP MEANS ON THE CONTENT EXAM (PRE-TEST)

CONTROL	EXPERIMENTAL
37.63	37.87

At the end of the inservice program (32 weeks) the environmental science content questionnaire was readministered to both the experimental and control groups immediately following the 32nd class meeting. A comparison of the groups' means were calculated using ANOVA. Significant differences were found between the two groups on the post-test content questionnaire (Tables 2,and 3).

TABLE 2

GROUP MEANS ON THE CONTENT EXAM (POST-TEST)

CONTROL	EXPERIMENTAL
38.73	55.23

TABLE 3

ANOVA OF CONTENT EXAM (32nd Week)

SOURCE	SS	DF	MS	F
MAIN EFFECT	6796.68	1	6796.68	58.47*
RESIDUAL	11392.71	98	116.25	
TOTAL	18189.39	99		

*p ≤ .0000

Thus there was a significant improvement in the scores of the environmental science participants at the conclusion of the program. This was significant at the .0000 level. A corresponding improvement was not seen in the mean score of the control group. It is safe to conclude that the treatment did have a significant effect on the participants' knowledge of environmental science concepts.

Findings from EEQ

Comparison of the experimental and control group means on the EEQ revealed there was a significant difference between the two groups at the beginning of the environmental science program (Tables 4 and 5). This was perplexing at first. But a review of the procedures used in the study revealed a possible explanation. Since all of the teachers participating had volunteered and requested to be in the program, they naturally had an interest in science and science instruction as well as a more positive attitude toward science. Those teachers chosen to participate in the study as members of the control group were chosen by the participants and did not necessarily have an interest in the program or environmental science. Thus their scores on the EEQ would not be as high as the treatment group. The results of the analysis would support this assumption.

Mean scores of the two groups were compared at the conclusion of 16 weeks on the EEQ instrument. Significant differences were found between the control and experimental groups in favor of the experimental group (Tables 6 and 7). There was a significant improvement in the group mean score of the treatment group.

Finally, a comparison of the two groups' mean scores on the EEQ instrument was undertaken. A significant difference was found on the EEQ in favor of the treatment group at the .0000 level of significance (Tables 8 and 9). Thus attitudes did improve steadily over time within the treatment group while the attitudes of the control group members changed little over time in spite of constant contact with individual members of the treatment group.

Findings from SoCQ

In this section, the composite profiles of the experimental group* are presented and discussed. Then the individual profiles of three teachers, as

*The two researcher-authors experienced the ultimate trauma/mortification: the SoCQ control group data were lost during the computer data processing and to date have not been recovered.

TABLE 4

GROUP MEANS ON THE EEQ (PRE-TEST)

CONTROL	EXPERIMENTAL
81.60	86.31

TABLE 5

ANOVA OF EEQ (PRE-TEST)

SOURCE	SS	DF	MS	F
MAIN EFFECT	552.19	1	552.19	8.89*
RESIDUAL	6086.56	98	62.11	
TOTAL	6638.75	99		

*p ≤ .0036

TABLE 6

GROUP MEANS ON THE EEQ (16th Week)

CONTROL	EXPERIMENTAL
81.63	89.60

TABLE 7

ANOVA OF EEQ (16th Week)

SOURCE	SS	DF	MS	F
MAIN EFFECT	1585.94	1	1585.94	27.44*
RESIDUAL	5663.77	98	57.79	
TOTAL	7249.71	99		

$*p \leq .0000$

TABLE 8

GROUP MEANS ON THE EEQ (32nd Week)

CONTROL	EXPERIMENTAL
81.96	92.19

TABLE 9

ANOVA OF EEQ (32nd Week)

SOURCE	SS	DF	MS	F
MAIN EFFECT	2614.17	1	2614.17	45.81*
RESIDUAL	5591.99	98	57.06	
TOTAL	8206.16	99		

*$p \leq .0000$

examples, are examined and interpreted. Teacher growth and development occurred, as reflected by their change in concerns during the inservice preparation program.

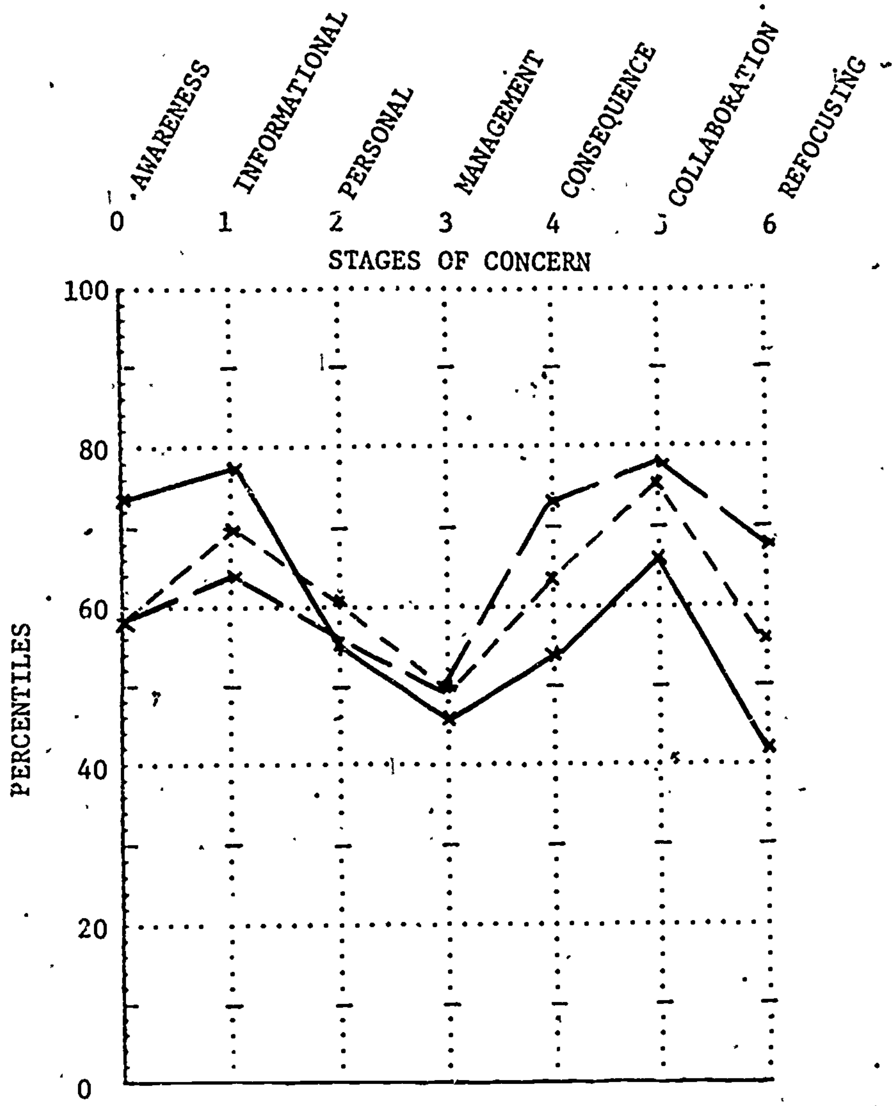
Experimental group. In Figure 3 the experimental group concerns profiles are presented. The three profiles are exhibits of the group's concerns expressed before, at mid-point and at the conclusion of the 32 week teacher preparation program. The pre-program profile is typical of "nonusers." The most intense teacher concerns in September prior to the program were Stage 0 Awareness and Stage 1 Information. Stage 5 Collaboration is the third most intense concern suggesting that teachers had interest in working with others. Since these teachers would be expected to work with other teacher colleagues back at their respective schools, this was understandable.

The high Stage 0 score would suggest that the teachers knew little about the program and generally were "unaware" of its content, methods, etc. The score on Stage 1 was considerably higher than on Stage 2, suggesting that teachers were much more interested in program information than they were concerned about themselves personally, as related to the preparation program. A profile such as this typically suggests openness and readiness to learning new knowledge and skills without undue personal threat.

At program mid-point in February and continuing in May the profiles indicate a decrease on Stages 0, 1 and 2. Stage 3 Management concerns points remain nearly congruent over time, while Stage 4 Consequence, 5 Collaboration and 6 Refocusing reflect an elevation in intensity of these "impact" concerns. The decrease in earlier stages and increase in later stages was viewed as a positive trend. At the mid-point when the intensities were shifting, teachers would have some experience using their new science knowledge and skills in their classrooms.

Figure 3

Group Profile of Experimental Group



Pre ______

Mid - - - -

Post __ __ __

While the mean group profiles were useful in revealing where the group was in their concerns, the table of percentile scores and standard deviations (Table 10) suggests considerable variation from the mean by the teachers. Therefore a review of individual teacher profiles provided useful information about individual teacher change and revealed the success of the preparation program in changing teacher concerns about the environmental science education program. It also aided program leaders in planning and decision making about the training. The examples of individual teachers' concerns follow.

Teacher L. The pre-, mid- and post-program profiles of Teacher L are shown in Figure 4. Teacher L began the program with high Stage 0, 1, 2 and 3 concerns and low Stage 4, 5 and 6 concerns. This profile is generally typical of persons before beginning to actually use a new program in the classroom. The higher than typical Management concerns may suggest that the teacher is already thinking about her/his busy day and how to include new activities and knowledge.

At mid-point in the program Information and Management concerns drop considerably while Consequence and especially Collaboration concerns rise a great deal. It would seem that this teacher's self and task concerns have been sufficiently addressed and alleviated so that impact concerns could increase.

At the program's conclusion, Information and Management concerns elevate, suggesting a need for further intervention. However, Consequence concerns rise dramatically to equal the Collaboration intensity. Clearly the impact concerns over the period of the program have changed upward a great deal, while self and task concerns have a net reduction. This teacher appears to be focused on what would be useful for students and in working with other teachers to benefit students.

Teacher J. Figure 5 exhibits the analysis of SoCQ data of Teacher J. Looking at these data by stages over the three data collection points, we

Table 10: Mean Percentile Scores with Standard Deviation

Stages	0	1	2	3	4	5	6
Pre							
Percentile Scores	73	78	59	47	55	65	43
Standard Deviation	21	18	24	26	27	28	28
Mid							
Percentile Scores	59	70	61	50	64	76	57
Standard Deviation	19	20	23	25	23	21	27
Post							
Percentile Scores	57	65	55	50	71	79	67
Standard Deviation	19	17	25	23	21	21	22

Figure 4

Teacher L

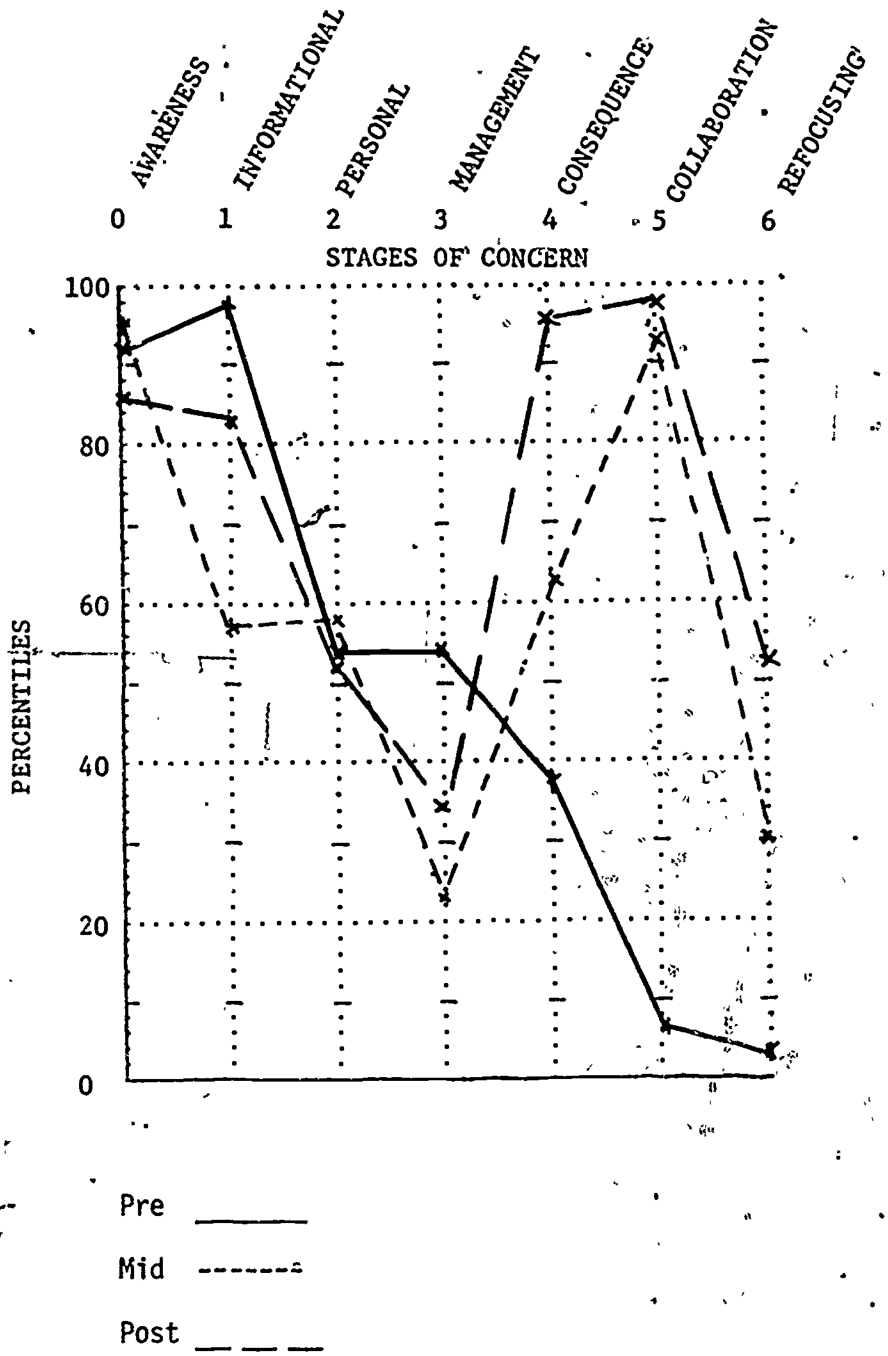
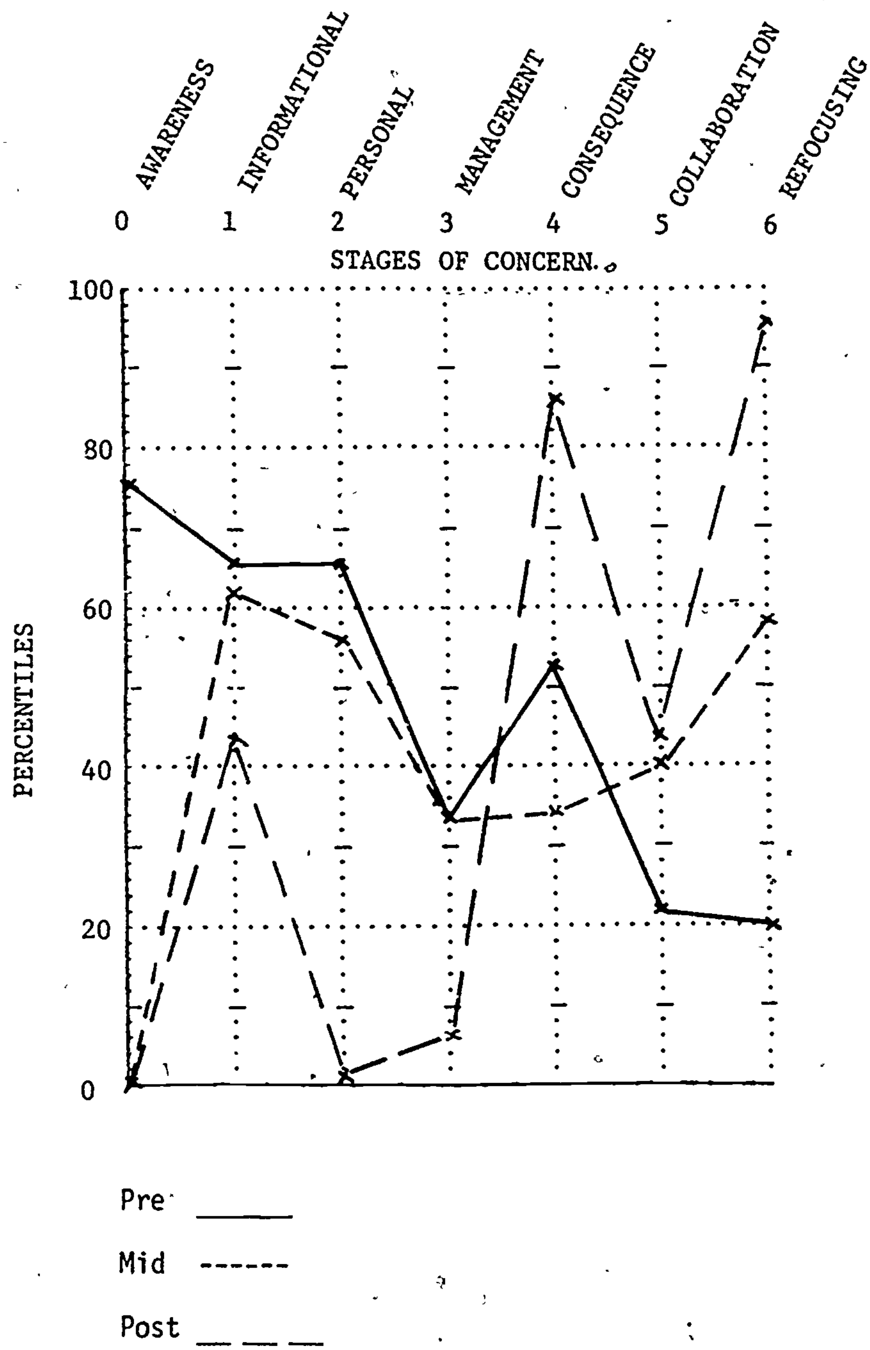


Figure 5

Teacher J



note a nearly "perfect" decreasing in intensity of Stages 0, 1, 2 and 3 and increase in Stages 4, 5, 6 -- with the exception on Stage 4 at data collection point 2. On this scale the concerns score drops at point 2, then escalates noticeably on the final data collection point. At the program completion this teacher's highest two peaks are on impact Stages 4 and 6. Considerable growth and development may be inferred in this "case."

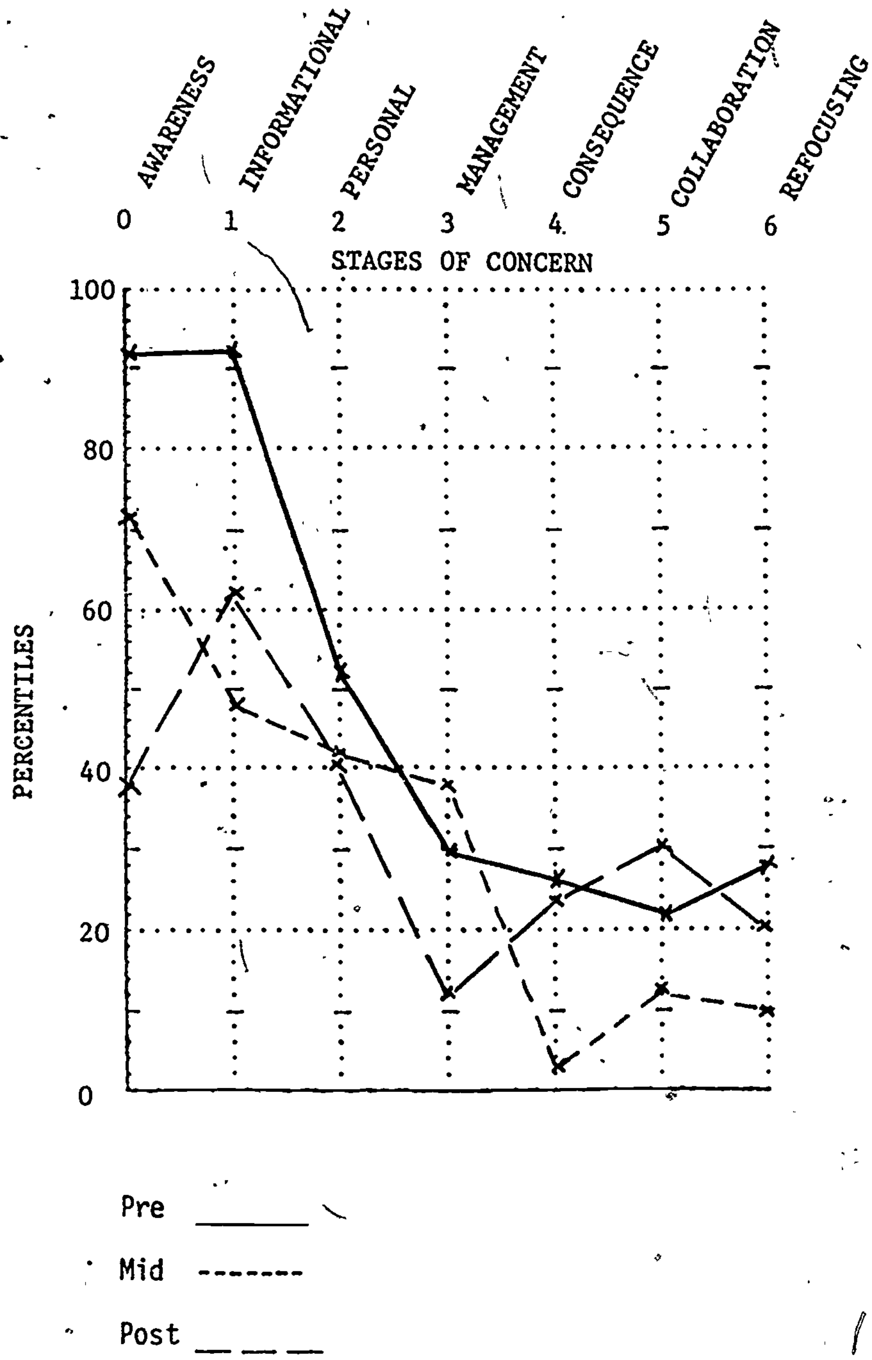
Teacher B. This teacher's profiles (see Figure 6) suggest that the person at the outset was concerned about getting information and while that concern has dropped in intensity, Information concern remains the highest peak. It would appear that more information needs to be provided to this teacher. Personal concerns have decreased, as have Management. Stages 4, 5, and 6 dropped at mid-point, but were significantly higher at the final data point. The impact concerns contrasted with the Stage 1 intensity further reinforces a need for some informational-type intervention.

In summary the results of the teacher inservice preparation program reveal that attitudes of the participants were altered in a more favorable direction. Specifically, the attitude of the environmental science program (treatment group) participants did improve consistently over time toward science and environmental science. These results are critical because research has demonstrated quite convincingly that if teachers harbor negative or at least neutral attitudes toward a subject they tend not to teach that subject or spend much class time on the subject (Blackwood, 1964; Fulton, Gates, & Krockover, 1980; Hone & Carswell, 1969; Spooner & Simpson, 1979; Stollberg, 1969; and Washton, 1971). This happens all too frequently in elementary science instruction.

There was a significant improvement in the participants' knowledge of environmental science concepts. A major problem in terms of the preparation of elementary teachers is the lack of adequate science instruction. Usually

Figure 6

Teacher B



elementary education majors are required to take no more than three-six semester hours in science (=2 courses). In many cases teacher education programs require no science content courses. Thus no science is taught and the ultimate losers are the students. Teachers cannot be expected to teach a subject for which they have little or no background preparation.

Finally, the analysis of the SoCQ results reveal that the concerns of the teachers changed, another indication that teacher growth and development have occurred. As used in this study the SoCQ was an effective diagnostic instrument for determining the concerns of the participants, then altering the program to meet both individual and group concerns and needs. Thus the program could be tailored without using outdated and wasteful trial and error methods with little chance of success.

IMPLICATIONS AND IMPORTANCE TO INSERVICE

Use of the data collected in this study was important in designing and implementing an inservice program to meet teachers' expressed needs, interests, and academic requirements. The data collected during the course of this program over one year recognized and verified the need for teacher development programs designed to address where teachers are with respect to academic preparation and teaching skills. It also addressed the concerns of teachers toward an innovative program in environmental science. Further, the results of the study verified the value and effectiveness of teacher preparation programs in environmental science. This is a subject that is beginning to enjoy increasing popularity at the elementary school level.

Few appropriate and technically accurate diagnostic instruments have been available to staff developers in order to design and implement relevant staff development programs. A review of the research literature related to inservice education appears to support this position (Cruickshank, Lorish, & Thompson, 1979; and Giffin, 1979). The instruments selected and applied in this program evaluation have overcome this serious and vexing problem as they have done in the past (e.g. Bethel and Hord, 1981). The results from the evaluation of the program are in face a measure of the effectiveness of an inservice program which has been implemented through utilization of quantitative data collected on teachers' concerns, knowledge, and attitudes during the course of the environmental science program.

Teacher change takes time. Attempts to accomplish change through "one-shot" workshops or staff development sessions of short duration are doomed to failure. Failure of this sort only adds to the long list of failures that literally cover the inservice education terrain. We can no longer afford to fail if the needs of teachers are to be met. Thus, time must be an important factor, to note that it will take time through inservice to affect change in teachers' knowledge and teaching behavior related to science instruction. Thus staff developers must design and spread learning activities over time in order to begin to experience success.

Another factor that must be recognized and addressed is the changing needs and perceptions of teachers. The concerns results reveal that teachers' needs do change over time, especially as the inservice program responds to and meets teacher initial concerns. This is evidenced as the teachers become first knowledgeable about and then users of an innovation such as environmental science. The changes do take time. And the time required to facilitate change is directly related to the complexity of the change.

Another important factor to be considered when working with a group of professionals is that their data varies by individuals. The data collected by SoCQ, EEQ and the Content assessment instruments are not only useful but vital in helping to diagnose, plan and deliver inservice education to individual teachers. For example, teachers with high informational or personal concerns about the environmental science program will not be interested in program management factors or student outcomes. Their attention will be focused on understanding the program, the concepts and perhaps the teaching methodologies required for successful classroom implementation.

Another unique use of the SoC results in this study was the review of teacher responses for the purpose of planning instruction and selecting appropriate activities. For example, lectures could be designed to emphasize content or a combination of content and practical application in the classroom with students. As a formative evaluation device, the SoC instrument was indispensable in monitoring the environmental science program and for making decisions about modifications in the program, program support, activities, and training.

FUTURE STUDIES AND ADDITIONAL NEEDS

Follow-up to the present study needs to take place through an investigation of the amount of science participants teach, topics selected and taught, as well as the length of science instruction (e.g. hours, days, weeks). This information would provide an index of concrete outcomes of the inservice program.

Determining the amount of collaboration that takes place between participants of the programs and their colleagues at their school, as well as the nature and continuation of inservice training which the participants provide to their colleagues and which was designed as part of the program are important questions for study. Teachers feel very comfortable in receiving inservice from their colleagues because of the recognition factor in their identification with relevant and common problems. Knowledge of the number and amount of such inservice will aid in determining the cost-effectiveness of the inservice program, so vital in light of the diminishing number of dollars available from federal sources such as the NSF.

Doubtless there are further refinements that can be made to this inservice science program which has now been in existence for two years. The changing needs and requirements of the participants will demand refinements. This is one program designed to provide inservice science education to elementary and middle school teachers which will continue to be adapted based on input from the teachers involved.

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