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ABSTRACT


Abstracts and abstractors' critiques of six science education research studies and six responses to critiques are presented in this issue of "Investigations in Science Education" (ISE). Each of the studies addresses some aspects of teacher education. Areas investigated include: (1) effects of inservice training on student learning; (2) description of incentives that may retain inservice science teachers and recruit prospective teachers; (3) influence of science education as a discipline on the attitudes of preservice teachers; (4) comparison of the effects of lectures versus activity based instruction on teacher attitudes; (5) teacher attitudes toward environmental education; and (6) the effect of a sequence of science courses on preservice elementary teachers' attitude toward and anxiety about teaching science. Responses to critiques involve studies from earlier issues of ISE as well as the current issue's study on preservice elementary teachers attitudes and anxiety toward teaching science. (ML)

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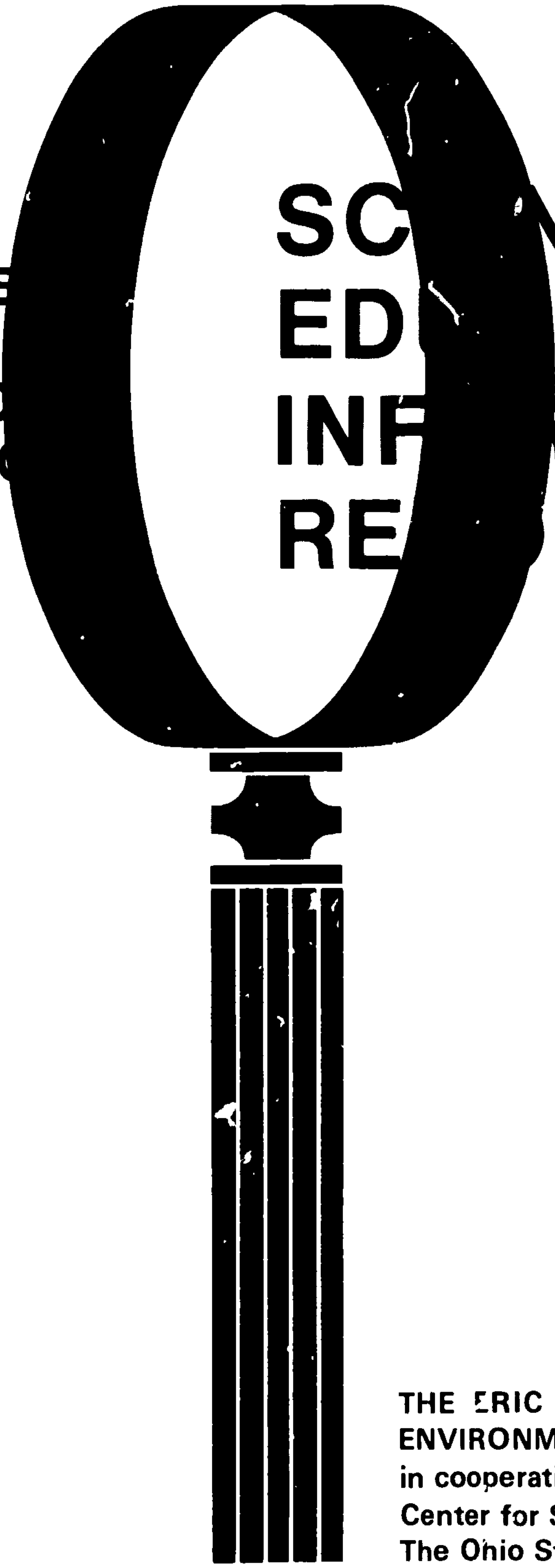

# SCIENCE EDUCATION INFORMATION REPORT



INVESTIGATIONS IN
SCIENCE EDUCATION

Volume 12, Number 2, 1986

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INVESTIGATIONS IN SCIENCE EDUCATION



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INVESTIGATIONS IN
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NOTES FROM THE EDITOR:

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Science education research studies focused on teacher education constitute Volume 12, Number 2 of ISE, along with some reactions to critiques of articles published in earlier issues. The problems investigated vary. They include a study of the effects of inservice training on student learning (Boulanger); a description of some ideas that might be used to retain inservice science teachers and to recruit prospective teachers (Spector); the influence (if any) of science education as a discipline on the attitudes of preservice teachers (Taiwo); the influence of two different types of instruction, lecture vs. activities, on attitudes of preservice elementary teachers (Ginns and Foster); teacher attitudes toward environmental education (McCaw); and the effect of a sequence of science courses on preservice elementary teachers' attitude toward and anxiety about teaching science (Westerback).

Also included are responses to critiques from Westerback as well as from researchers whose work was analyzed in earlier issues of ISE: McNaught, Otto and Schuck, Maloney, Haladyna, and Jungwirth.

Patricia E. Blosser
Editor

Stanley L. Helgeson
Associate Editor

# TEACHER EDUCATION

Boulanger, F. D. "Relationships of an Inservice Program to Student Learning: Naturalistic Documentation." Science Education, 64 (3): 349-355, 1980.

Descriptors--*Academic Achievement; *Evaluation; *Inservice Education; *Junior High Schools; Science Education; *Science Teachers; Secondary Education; Secondary School Science

Expanded abstract and analysis prepared especially for I.S.E. by James Reed Campbell, St. John's University.

## Purpose

This study involved the training of a group of intermediate and junior high school teachers (grades 4-8). It attempted to determine the effects of this training by following the teachers back to the classes and measuring the degree of student growth after 15 lessons had been implemented.

## Rationale

The National Science Foundation has spent millions of taxpayers' funds in providing inservice training to teachers. What are the effects of such training? Do these inservice programs change the teacher? Of greater importance, how much of this training reaches the students of these teachers? Do they carry their training back to their classrooms?

This study attempted to answer these questions by conducting a follow-up study on the classes of teachers trained by a 30 week inservice course.

## Research Design and Procedure

The study involved 899 students in 27 classes at 10 different schools. The NSF Inservice Course consisted of 30 Saturday morning sessions that lasted for three hours each. The focus of the course was to improve the teachers' knowledge o different science processes through an activity-based approach in the physical sciences. All of the lab activities were selected from contemporary elementary science programs. The processes that were selected included the following:

1. Careful Observation
2. Collection of Information
3. Measurement
4. Graphing of Data
5. Analysis and Interpretation of Basic Quantitative Variables (i.e., distance, area, volume, time, mass and speed)

These processes were defined throughout the study as quantitative skills and were incorporated in several different segments of the project. The NSF course involved 19 teachers. The follow-up study included 10 teachers who were willing to implement at least 15 lab activities during an 11-week time segment.

The three basic questions that guided the follow-up study were:

1. What is the relationship between the degree of teacher implementation and student learning?
2. What is the relationship between the students' perception of the classroom environment and student learning?
3. What is the relationship between the students' attitudes toward instruction and learning?

The research design that was used for this study (Cook and Campbell, 1979) can be diagrammed as follows:

$$0_{1a}0_{1b}0_2 \quad x_{1,2} \quad 0_{1a}0_{1b}0_3 0_4$$

The x represents the 11-week package of 15 activity-centered lessons.

The pretests included the following instruments:

$O_{1a}$ - Part 1 - Quantitative Skills

$O_{1b}$ - Part 2 - Simple Proportions - Reasoning Skills

$O_2$ - Classroom Test of Reasoning Skills (Lawson, 1978)

Instructional Variables

$x_1$ - Ratio of objectives implemented for total number of lessons. Measure of quantitative skills presented.

$x_2$ - Ratio of instructional time devoted in each of five areas.

The post tests included:

$O_{1a}$, $O_{1b}$ - Parallel forms of the pretests

$O_3$ - My Class - Student perception of classroom environment (5 subscales) (Anderson, 1973)

$O_4$ - Student perception of instructional approach (Boulanger, 1978)

The investigator did not use a control group and was, therefore, not able to use a true experimental or even a quasi-experimental design. Instead, he selected a correlational design based on the assumption that the diversity of the sample of schools and classrooms would provide "causal connections" between the dependent and independent variables. In addition to the 10 trained teachers, the study added 6 untrained interested colleagues who agreed to implement 15 lessons during the 11-week time segment.

For the duration of the study each teacher could select his/her lessons from a pool of available lessons which emphasiz d the five quantitative skills listed above.

After each implemented lesson the teachers completed a self-report form which asked them to check the quantitative skill(s) that they had taught in the lesson. The form also asked the teachers to indicate the number of minutes that was spent in the following: lecture-discussion, student investigations, worksheets, science reading, student structured time. This self-report device enabled the investigator to collect data on the quantitative skills that each teacher emphasized and also on the amount of time devoted to the different types of instruction.

The dependent variables were:

1. Quantitative Skills - Part I
2. Reasoning Skills - Part II
3. Total Score

The independent variables were:

1. Student Perception of Classroom Environment (My Class, Anderson, 1973)

   Subscales:
   a. Satisfaction
   b. Friction
   c. Competitiveness
   d. Difficulty
   e. Cohesiveness
2. Student Perception of Instructional Approach (Boulanger, 1978)
3. Classroom Test of Formal Reasoning (Lawson, 1978)
4. Ratios of Quantitative Skills Emphasized by Teachers:
   a. Careful Observation
   b. Collection of Information
   c. Measurement
   d. Graphing of
   e. Analysis, Interpretation
5. Ratios of Time Spent by Teachers:
   a. Teacher Lecture-Discussion
   b. Student Investigations
   c. Worksheet w/o Manipulatives
   d. Science Reading
   e. Student Structured Time

Findings

1. The Classroom Test of Formal Reasining was initially to be used as a controlling variable, but due to its small correlation with the dependent variables (r = 0.03), it was included among the predictor or independent variables.
2. Student Perception of Classroom Environment:
   a. When the total post test score was used as a dependent variable, the competitiveness scale was found to be significantly related (r = 0.38, < 0.05 level). Three other scales were significant at the 0.10 level (friction, difficulty, cohesiveness).
   b. When the Simple Proportions (Part II) scores were used as the dependent variable, all but one of the five scales produced significant correlations (< 0.05 level). But even this scale (difficulty) was found to be significant at the 0.10 level. Overall, the five scales were found to be in the expected direction for all but the cohesiveness scale (Heartel, 1979).
3. Student Perception of Instruction Approach. For the correlation of the total score there was no significance relation (r - 0.08), but for the Simple Proportion - Part II scores there was a significant (0.05 level) correlation (r = 0.29). This instrument also had four subscales, three having substantial correlations (i.e. student perception of the instruction as interesting r = 0.40; in a preferred mode r = 0.23; of appropriate difficulty r = 0.28; and clearly presented r = 0.07).
4. Instructional Objectives
   a. Quantitative Skills. Again, partial correlations were presented for the total scores, and Part II - Simple Proportions scores with each of the five skills used as lesson objectives. Two items proved to be significant for the total score correlations (Measurement 0.05; Analysis, interpretation 0.10). For the Part II data four of the skills were found to produce significant correlations (< 0.05), and the fifth, graphing of data, was significant at the 0.10 level.

b. Time Categories. Only one item was significant for both dependent variables - a negative correlation with science reading. Time spent in science investigations had the highest mean, and had correlation at the 0.10 level for both dependent variables.

## Interpretations

The investigator found that well-developed process skills can lead to a "more generalized skill" in comparing and completing proportions. The author expresses the view that the data fit into the Piagetian paradigm. He also feels that the instruction in the five quantitative skills can aid the cognitive development of students--especially in a low competitive, low friction, high satisfaction classroom environment.

## ABSTRACTOR'S ANALYSIS

This study focused attention on one of the most neglected areas of research--inservice education. Most of the research studies reported at conferences or in the different journals concern theoretical developments or preservice education. There is a dearth of studies about the training of experienced teachers. This is unfortunate because the mean age of teachers in many areas of the country is above 40 years of age. The re-training of teachers with ten or twenty years of experience presents a very different set of problems for the teacher-trainer. What works well for preservice teachers might not work at all with these teachers. What is needed is a much broader base of research in this area. This study should be a contribution to such base.

This study also has implications as a federally-funded project. Taxpayers do have a right to know that inservice training does have some effects. The most important effects are upon the children. This study does make the transition from the training of teachers to the implementation of lessons in the teachers' own classrooms and finally to student growth. Stake and Easley (1978) found that very little of the national curriculum projects reached the classroom level. This study does represent a way of dealing with such a problem.

One of the major strengths of this study was the consistent institutionalization of a set of process objectives. The investigator selected lab activities which emphasized five process skills and made them one of the focal points of the inservice training project. These "quantitative skills" were then pre and post tested at the classroom level with a specially designed instrument. The same set of objectives were monitored by the self-report measure that was completed after each lesson. This method of quantifying both the instructional time and the objectives employed was a simple, yet ingenious, way to get important information.

This reviewer suggests one way to make the self-reporting device even more accurate. That is, randomly visit the classes during the implementing of the lessons. Simply by tabulating the objectives that were utilized and by measuring the minutes spent in the different activities, it would be possible to validate the accuracy of the teacher reports. Such visits might also be used to assure the researcher that the teachers are implementing the lessons as intended.

Another strength of the study was the emphasis on an important cognitive skill--simple proportional reasoning. The use of a sound instrument to measure the childrens' cognitive level and the follow-through to see the degree that the children improved their reasoning after the treatment elevated the study to a higher level of importance. The investigator found that the overall cognitive level of the students did not regress on the dependent variables to any significant degree but the plan to use such a variable as a control is a recommended practice and should be encouraged in other studies.

Another strength of the study was in the high caliber of the instruments that were used. This reviewer checked the reliability and validity of several of the instruments (Lawson, 1978; Anderson, 1973; Boulanger, 1978) and found them to be of high quality. In the brief article where the study was presented, reliability data were presented for each instrument. This is a practice that should be routinely required.

The brevity of the report did present a problem because some of the data were quite important and should have received mention. For example, Table III presented data on the time spent in the different instructional activities. The category that received the lowest ratio was that of science reading; the category with the highest ratio was the student investigation area.

These two items convey the image of the students actively engaged in lab experiences instead of simply "reading about science." This is both a major accomplishment of the study and also important if the children are to improve their cognitive skills. Both items should have been mentioned in the article.

The reviewer was unable to determine why a control group was not used in this study. True experimental design would require the random assignment of the students, but such a practice is very difficult to accomplish in 10 different schools with an inservice population. However, the next best compromise would be to get a group of non-trained teachers in the same school with similar teaching assignments. These teachers could administer all the instruments that the other teachers used but would not administer the 15 process lessons.

Such a control group would be useful in making any comparisons with the students that did receive the process lessons. What if there were no differences between such a control group and the group that received the treatment? A nonsignificant difference would imply that the developmental cognitive process cannot be easily altered in a short 11-week time span. But what if the investigator were to uncover the finding that the treated group was superior to the control group after the treatment? This result would strengthen the contribution made by the study.

This reviewer questioned the need to include six untrained teachers in the sample. Why didn't the investigator simply use them as a control group? Another question along the same lines, why did the investigator not analyze the trained and the untrained teachers as two distinct groups? The researcher put the two groups together to "increase the variance." By mixing the two groups of classes into one study we are not able to answer any of the following questions: If the untrained teachers had the same levels of achievement, was the inservice training really needed at all? Were there any differences in the process objectives or in the time ratios for the trained and untrained teachers? How much of the inservice training was transmitted by the trained teachers? Could this be isolated?

Another curious item about the study was the use of the 0.10 and 0.05 levels of significance. Most researchers use the 0.05 and 0.01 levels of significance; and the reader could better understand why these levels were selected if some reason was provided. Perhaps the investigator was attempting to avoid type II error.

Another item which inspired questions was the practice of letting the teachers select the 15 lessons from the available pool. Were all the lessons in the pool equivalent? Do experienced teachers just require such a pool? Is a teacher's flexibility a prerequisite for his/her participation in the study? In order to accommodate experienced teachers, researchers might have to make similar compromises. However, the ideal would be to have all the teachers implement the same set of lessons. Otherwise, some lessons, which require skills such as graphing, might be selected by some teachers but not by others. These differences would tend to confuse the mean ratios that are presented for all the objectives at the end of the study.

Another unanswered question for this reviewer is why were partial correlations presented for the total scores and Part II scores of the dependent variable but not the Part I scores? Similarly, this reviewer was puzzled why the investigator stopped his analysis with partial correlations when the SPSS package presents such usable regression tests. This study could have been extended by using regression analysis. It would have been helpful to see how much of the variance was explained by each of the predictor variables.

In summary, this study does make a contribution in an area where much more research is needed. The basic idea of conducting follow-up studies with the students of trained teachers should be used much more.

It is the opinion of this reviewer that successful inservice training might require a good deal of experimentation and research before we will be able to demonstrate an impact on student behavior.

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Descriptors--Educational Improvement; Educational Quality; *Elementary School Science; Elementary Secondary Education; *Incentives; National Surveys; Science Education; *Science Teachers; *Secondary School Science; *Teacher Education; *Teacher Improvement; Teaching Occupation

Expanded abstract and analysis prepared especially for I.S.E. by Robert Yager, University of Iowa.

## Purpose

The purpose of this study was the generation of ideas that could be used by state and local school systems to retain "good" science teachers in the classroom and to attract new people to science teaching. No definition of "good" was attempted while the effort for attracting "new" people indicated that "quality" new people were desired.

## Rationale

The study arises from the intense national concern for the crisis conditions which have existed in science education throughout the 80's. Most leaders (and members of the general public) assert that the crisis is threatening our economy, our defense, and the quality of our lives. The study identifies the shortage of qualified science teachers as central to the problem. The study is an attempt to gather information that can be used by others as various incentives are undertaken to resolve the acknowledged crisis situation. The research is related in design to previous attempts to asses what is occurring at any point in time that affects a particular problem/crisis. The particular crisis and the survey of current state leaders is a new study and not related in content or context to "previous research." However, the qualitative design and the current need provide the framework for the investigation.

Research Design and Procedure

State science consultants were contacted concerning science education issues reported to be on the Legislature's agenda in Florida. This agenda included:

a) encouraging good science teachers to remain in the classroom;
b) updating the knowledge of present science teachers;
c) bringing new people into science teaching from areas in which there are a surplus of teachers;
d) bringing new people into science teaching from outside the teaching profession; and
e) encouraging high-ability undergraduates to enter science teaching.

These state consultants were asked for information regarding incentives in use, being proposed, or those needed in their respective states. They were also asked for information about persons (from both the public and private sectors) who are involved in discussions and who are considering potential actions to ameliorate the crisis in science education. Follow-up telephone inquiries were made to persons in states where there was no response to written inquiries. In the end there were no responses (in writing or by telephone) from twenty states. And, six states reported that there were no activities relevant to the study to report. Thus, the analysis was accomplished with information from 24 states.

The data were in the form of minutes from meetings, final reports, bills filed and/or passed by state legislatures, statements from governors, news releases, summaries of incentives and activities recommended by state science consultants. Other data were notes recorded during telephone interviews conducted by the researcher. The data gathered directed the design as the study evolved. The classification of the information and the hypotheses that emerged arose from the data themselves. Incentives, proposed actions, and assumptions about the crisis were identified and recorded. Multiple documents from a given state were searched for consistencies. The same processes of identification, categorization, and comparison were repeated to combine data from all respondent states. As new data were amassed, they were examined for degree of fit with emergent categories. New categories were generated as needed. A constant comparative method was used to stimulate insights possible from the data; this also led to the simultaneous discovery of significant categories and the identification of properties within categories that provided information on courses, conditions, consequences, dimensions, processes, and possible relationships. Hypotheses describing the relationships were generated and used to form a structural model used by policy makers across the nation.

## Findings

A model of the personnel dimension of the crisis in precollege science education, active steps to mitigate the crisis, and incentives with potential to stimulate action emerged from the data. It was presented schematically as follows with the number indicating the frequency in terms of states reporting the situation:

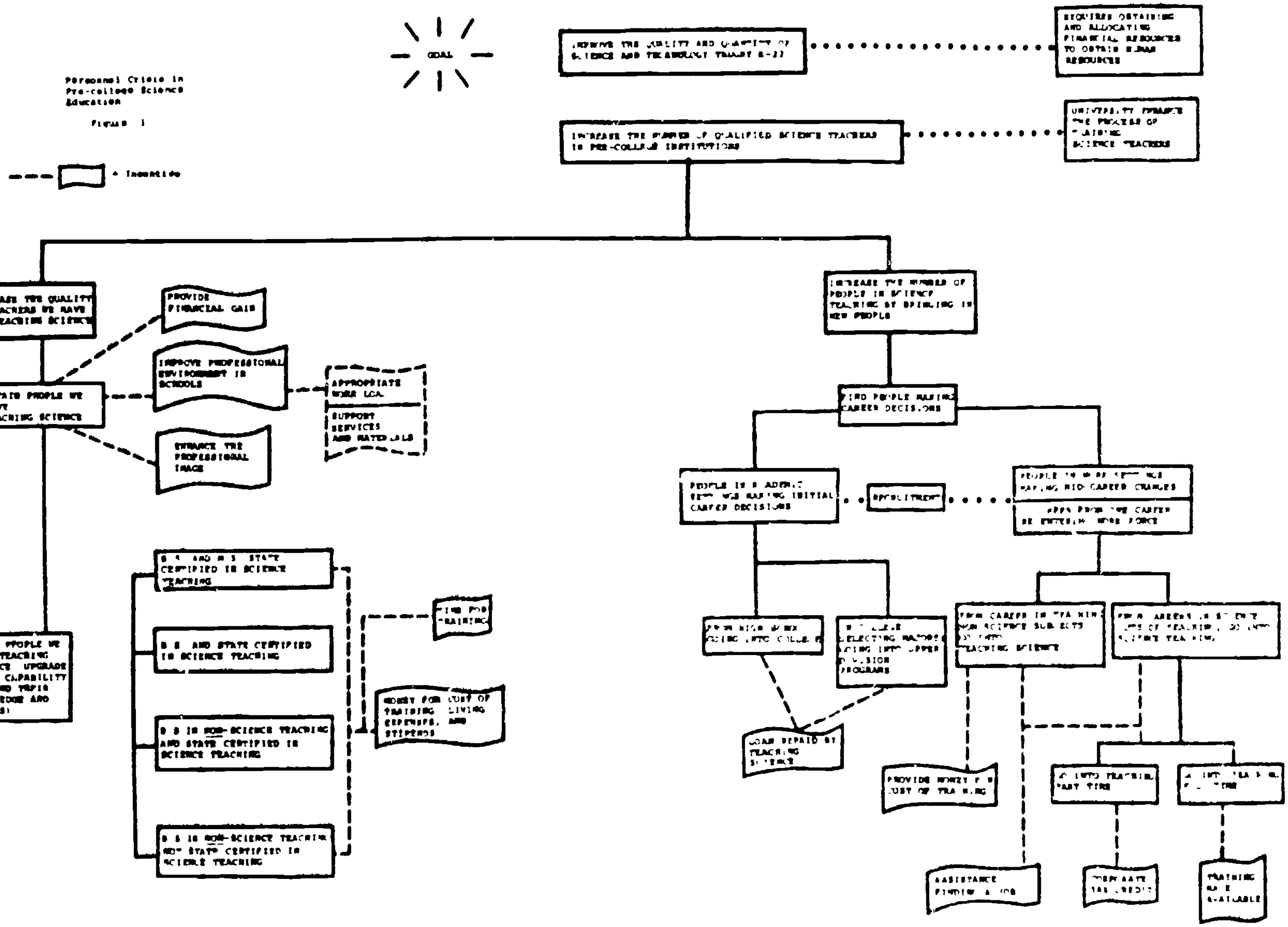


Figure 1. The personnel dimension of the crisis in precollege science education

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The investigator reported a continuum of states from those indicating no perceived needs for incentives (and no teacher shortage), to those states perceiving needs and considering the development of a mechanism to explore the problem, to those states that have explored the problem, and ones making recommendations to policymakers and lawmakers, to other states which have passed mandates and have incentives in place.

Interpretations

The investigator used the investigation and the results to make the following assertions which are interpretations, extensions, and/or elaborations of the results and the process used. The major ones include:

1) Establishing systems to help people from business, industry, and retirees, and teachers coming from nonscience teaching positions find placement in teaching jobs could also be used to relocate present science teachers who wish to change jobs and to place new people from undergraduate programs.
2) The strategies suggested as incentives to retain the people currently teaching science can also serve as incentives to bring new people into science teaching.
3) To make those loan programs for attracting high-achieving undergraduates into teaching cost effective, it is essential to provide psychological rewards in the work place which would convince people to remain in the classroom past the few years required to repay their loans.
4) A teacher's decision to leave or remain in the classroom is more than salary; often the primary factor is the degree of satisfaction the teacher derives from his/her position.
5) States may find matching assignments to expertise will be one of the most cost effective incentives to retain high quality teachers.

6) It is essential that much emphasis be placed on incentives for the best teachers who have devoted many years to quality science teaching and remained current at their own expense in both time and money; such incentives should provide these people with the opportunity for continued growth.

7) Existing state certification standards need to be updated to include all the competencies necessary to ensure that teachers are qualified to teach science in the eighties and beyond.

## ABSTRACTOR'S ANALYSIS

It is important that such assessment be conducted as problems are identified and actions undertaken. Science education is a field where public criticisms and demands for immediate corrective actions are intense. The study represents a needed response to the current situation. The description of qualitative research techniques is a contribution and the particular use of it an excellent example.

The study is related to other attempts of synthesizing information from a variety of sources that are used to make actions more meaningful and desired directions more consistent with specific evidence. The collection of first hand information, specific written materials, and the telephone contacts represent a procedure that is particularly important when undertaking such studies. The cross-checks, the emergence of categories and hypotheses to verify, and the use of personal interviews are strengths that emphasize the advantages of the general technique over the use of a pre-determined questionnaire for collecting opinions and perceptions.

It would be valuable to circulate the information, especially the figure displaying the results, to the science consultants (and other leaders) for reactions. Also, it would be of interest to see how the persons contributing the information felt about the classification of their own actions/initiatives and the interpretations made. In a sense this could be another study while also providing a mechanism for accomplishing some of the objectives stated by the investigator.

Some tabulation of the numbers of reports from specific states in the various information categories would be useful in weighing the validity of the results. Some indication of the structure used in telephone interviews would also have been a valuable addition to the report.

Inclusion of specific comments from some states was of interest. However, it was not always clear whether this was a representative sample, whether it was provided to illustrate the nature of the data, or whether it was intended to assure readers of the validity of the classification/interpretation scheme used.

The author was free to offer personal notes, interpretations, and asides. This adds to such research reports. However, such additions were made sparingly and not always with a clear idea of why and/or how they fit with the positions/directions advocated. Such additions should, whenever possible, add to the logic, the direction, the suggested use of the information.

The report is offered as a definitive study with few suggestions or qualifications concerning the small number of states involved where relatively few provided large quantities of information. Were multiple checks considered for states with no response and/or those reporting no concern and no action? How much more data were produced from states where the investigator had several presonal contacts and/or special means for gaining more information?

Perhaps some follow-up study is needed. Perhaps the investigator should have reflected on next steps in the study. Perhaps she should have related the results to specific perceived problems.

Many are classifying the problems and concerns by levels. Such levels include problems perceived at the local level, the policy level, and the purpose or goal level. Others are looking upon the problems of quantity and quality of teachers very differently. This study may have had more impact if the problems and responses in states had been specified and analyzed in such a manner.

We also seem to have a terminology problem. What is a crisis? What is a quality teacher? What is an improvement? What is scientific literacy? What are the causes of crisis? Have the parameters of crisis been examined and defined adequately? What makes a teacher "good"?

The study is ti.ely, interesting, and useful. It represents the kind of research with immediate utility for a variety of professionals. It illustrates qualitative techniques that are not only becoming more popular but necessary as certain questions are considered. It demonstrates how observational data can be collected, analyzed, and used. New meaning is developed concerning current situations and problems.

Taiwo, Diran. "The Influence of Previous Exposure to Science Education on Attitudes of Preservice Science Teachers Toward Science Teaching." Journal of Research in Science Teaching, 17 (4): 315-320, 1980.

Descriptors--*Experiential Learning; Higher Education; Preservice Teacher Education; *Prior Learning; *Science Education; Science Teachers; *Sex Differences; *Teacher Attitudes

Expanded abstract and analysis prepared especially for I.S.E. by Ann E. Haley-Oliphant, University of Cincinnati.

## Purpose

The author's primary purpose of this study was "to find out whether or not previous exposure to science education as a discipline significantly influences one's attitude toward science teaching" (p. 316). The secondary purpose was "to determine whether or not a subject's gender significantly influences his or her attitude toward science teaching" (p. 316). Finally, the author's third purpose was to determine "which of the two dependent variables (previous exposure to science education and gender) is more related to the degree of favorableness of one's attitude toward science teaching" (p. 316).

## Rationale

The rationale for this study was based on a literature review of the attitudinal research with an emphasis on attitudinal studies done in the area of science education. The researcher expanded on previous studies that found a correlation between previous exposure to science and positive attitudes toward science by designing a study to see if "a relationship exists between previous exposure to science education as a discipline and one's attitude toward science teaching" (p. 315).

## Research Design and Procedures

The study was an ex post facto study and was begun by performing a content analysis of the aims of the Science Meth[illegible] course at the University of Ife in Nigeri[illegible]. A 20-item questionnaire was prepared, judged by a "corps of three judges," (p. 316) and reduced to a 10-item questionnaire. The questionnaire dealt with items that were to judge the participants' attitudes toward science teaching.

The sample consisted of 120 randomly selected preservice science teachers. The follcwing table provides the relevant background of the participants in relation to this study:

TABLE 1

Percentage of Participants Based on Gender and Previous Exposure to Science Education as a Discipline.

| Characteristic | Percentage |
| --- | --- |
| Male | 61 |
| Female | 39 |
| Science ed. exposure | 35 |
| No science ed. | 65 |

The study instrument (10-item questionnaire) was administered to the subjects. They were not to sign their names, thereby enabling them to respond candidly to the survey. The researcher notes the following: "It should, however, be added that copies of the instrument reacted to by the subjects were coded for identification purposes" (p. 317).

Data were analyzed through use of a biserial correlational operation for the first hypothesis, point-biserial correlational operation for the second hypothesis, and by a partial correlation coefficient operation for the third hypothesis with the subsequent use of a t-test to determine the significance of the partial correlation coefficients. The significance was set at the $p < 0.01$ level.

## Findings

1. Over 50 percent of the subjects responded favorably to nine of the items on the questionnaire/instrument. The kinds of ratings ranged from -2 (unfavorable attitude toward science teaching) to +2 (very favorable attitude toward science teaching). A rating of 0 indicated a position of neutrality.

2. HYPOTHESIS 1: Does exposure to the art of science teaching during nondegree professional training positively influence attitudes toward science teaching?

A biserial correlation coefficient of 0.32 was obtained between the scores of the subjects on the attitudinal instrument (independent variable) and the status of the subject with regard to being exposed to science education (dependent variable). The research found the results to support the hypothesis.

3. HYPOTHESIS 2: Is there any difference between sexes and their attitudes toward science teaching?

A point-biserial correlation coefficient of 0.40 was found when gender was used as the dependent variable. The researcher concluded that male subjects have more positive attitudes toward science teaching than do females.

4. HYPOTHESIS 3: Which variable, previous exposure to science education as a discipline or gender, is more related to the "degree of positiveness of one's attitude toward science teaching"? (p. 319).

The researcher employed a partial correlational strategy and obtained the following:

TABLE 2

Correlational Coefficients Based On the Variables of Gender and Exposure to Science Education.

| Correlation Coefficient | Variable Kept Constant | Variable Partialled Out |
|---|---|---|
| 0.40 | gender | exposure to science education |
| 0.26 | science education | gender |

A t-test was done to determine the significance of the partial correlation coefficients. The correlation between attitude and gender was significant. No significance was found in the correlation between attitude and previous exposure to science education.

The researcher concludes that one's gender is more related to a positive attitude towards science teaching than is previous exposure to science education.

## Interpretations

The conclusions reached by Taiwo include the following:

1. "Previous exposure to science education is positively correlated with the favorableness of the population's attitude toward science teaching" (p. 319).

2. "Gender appears to be an important variable in the determination of the degree of positiveness of attitudes of preservice Nigerian undergraduate science teachers towards science teaching" (p. 319). Males tend to have more positive attitudes towards science teaching than do females.

3. "... gender is more related to the degree of favorableness... toward science teaching than is previous exposure to science education" (p. 319).

The researcher suggested that exposure of students to the discipline of science education begin much earlier than at the university level. In addition, Taiwo suggested that more attention be directed towards females, with the goal being to promote more positive attitudes toward science teaching.

## ABSTRACTOR'S ANALYSIS

As stated in the rationale, this study attempted to expand on the attitudinal theoretical construct as it currently stands in the realm of science education research. By addressing the attitude held by preservice science teachers, this study could provide valuable insights for colleges of education as a means to recruit future science teachers by offering career awareness opportunities in the area of science education for high school and junior high students. In addition, this study supported other research efforts that have focused on the paucity of girls selecting science as a career because of sociological, economic, and attitudinal reasons (Kelly, 1981).

Validity and Research Design. Several questions arise regarding the procedures used in this study:

1. The first question deals with instrument construction and validation in this study. The aims of the Science Methods course were used in the development of the 10-item questionnaire. What were these aims? There was not enough information given regarding the Science Methods course. For example, was the course designed to teach the models of teaching, such as the Concept Attainment model, the Advanced Organizer model or the Inquiry model? Or did the course focus on the history of science education? Was the course based on a lab-oriented approach or did it focus more on the psychology of learning? Was it designed to prepare elementary or secondary teachers to teach science? Any of this information would have facilitated the understanding of the rationale and development of the questionnaire.

Initially the questionnaire included 20-items. It was reduced to 10-items by a "corps of three judges" (p. 316). Who were these judges? By reducing the questionnaire in half, the researcher sacrificed reliability, which was not accounted for in the report. Since there were just 10 items, I would have benefitted more by actually seeing the entire instrument. Also, Taiwo does not elaborate as to what the 10 items measure. Are they truly measuring attitudes or beliefs or feelings or actions? No definition of attitude was provided in the report.

2. The study is designed around previous exposure to science education as a discipline, yet this is never elucidated in the report. What does previous exposure to science education really mean?

3. The question of ethics can be raised since the 120 respondents were told not to sign their names so they might react candidly yet "copies of the instrument reacted to by the subjects were coded for identification purposes" (p. 317). The implication is that the respondents did not know the instruments were coded. This violates the ethical guidelines for the protection of human subjects supported by several professional organizations.

4. By examining the data analysis and results, several inconsistencies result:

a. For item #1 and 10 in the Item Analysis, 98 percent of the respondents agreed or strongly agreed with these statements; zero percent disagreed. Were these items such that it was nearly impossible to disagree with them? For example, were they like "Teaching science is important in public school"? Item #10 must be something like "I would do anything in my power to improve my teaching" because Taiwo discusses #10 in the results section as "...it (#10) underscores the fact that the would-be Nigerian science teachers would do anything in their power to improve the quality of the teaching after leaving the University with the provision that they would practice what they know to be good" (p. 317). With such high percentages (98 percent), we don't know if these items are so universal that all people would agree. In addition, how do these items discriminate the effect of sex differences and course exposure difference?

b. By selecting the use of biserial correlation coefficients, this approach will not tell if a more positive score for attitude was due to taking the course or due to gender, especially since the gender percentages of those having previous exposure to the course were not provided. Since it was found that there was a correlation between males having a positive attitude toward science education, the data analysis of the first hypothesis, (Does exposure to the art of science teaching during nondegree professional training influence attitudes towards science teaching?), is nullified because gender differences were not partialled out. Taiwo should have done a multi-correlational analysis first to determine the contribution of variance toward gender and toward having previous exposure to science education instead of doing it last.

The data analysis of the third hypothesis refutes his techniques and analysis on the first two hypotheses. By partialling out gender and exposure to science education, Taiwo found a significant relationship between gender and one's attitude towards science teaching. Taiwo did not find a significant relationship between previous exposure to science education and a positive attitude. This refutes the findings in the first hypothesis, primarily because in analyzing the data for the first hypothesis, gender was not accounted for. Finally, after taking gender into account, there is no relationship between being exposed to science education and positive attitudes. Therefore, it is necessary to reject Taiwo's first conclusion which states that previous exposure to science education is positively correlated with attitudes towards science teaching.

Conclusion. The gender related differences found in this study provide further evidence for the need to ensure that girls are provided with ample experiences which foster positive attitudes towards science and science teaching. Kahle and Lakes (1983) suggest that there be changes in the classroom as well as in society's perception and offerings to girls before there "is equality in science classrooms for women" (p. 140).

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Descriptors--Elementary Education; *Elementary School Science; Foreign Countries; Higher Education; Inquiry; Lecture Method; *Preservice Teacher Education; Science Education; *Science Instruction; *Sex Differences; *Teacher Attitudes; *Teacher Background; Teaching Methods

Expanded abstract and analysis prepared especially for I.S.E. by Hans O. Andersen, Indiana University, Bloomington, IN.

## Purpose

The purpose established for this study was to reanalyze affective and cognitive understanding gain score data collected from a study involving two groups of elementary education majors who were taught science by lecture and by an activity-oriented approach. In a previous article, Ginns and Foster (1978) reported no significant attitude difference between the two groups. This article reports a reanalysis of the previous assessment which was completed after gender and the extent of previous science were incorporated to determine their influence.

## Rationale

The influence of various types of instruction on students' attitudes toward science and their understanding of science have been researched by numerous authors. The investigators' initial study compared the attitudes and understanding of two groups of students who were given distinctly different treatments. Significant differences in attitude or understanding between the groups were not substantiated. Differences in attitudes and understanding were not significant and, because the treatments were dramatically different, the investigators reasoned that the effects must have acted differentially or they were mediated by other characteristics. In this study the investigators explored two possibly mediating factors: gender and prior science training.

## Research Design and Procedures

The entire 1975 and 1976 classes (321 females and 150 males) of students enrolled in the preservice Diploma in Teaching course of the North Brisbane College of Advanced Education were the subjects of this study. The majority of these students had entered college directly from high school and most came from middle class backgrounds. The students who had completed at least one science course at grade 11 or 12 were defined as having a science background. Those students whose last science course was in grade 8 were defined as not having a science background.

Two treatments were used. One treatment consisted of presenting lectures in a traditional structured environment and providing students related laboratory work. In this treatment the lectures and laboratories were selected and sequenced by the instructors. The other treatment was less and to a considerable extent student structured and activity/inquiry oriented. The students completed topics/units of work that included self-directed library study, related activities, and written assignments. A large number of topic/units were developed for the earth, the physical, and the biological sciences. Students were allowed to select the topics they wished to study and decide to either work independently or in a group.

The Test on Understanding Science (TOUS - Form W) developed by Cooley and Klopfer was used to measure the students' understanding of the nature of science. The Science Teacher Attitude Scale (STAS) developed by Moore and Sutman (1970) was used to measure the students' attitudes. Both instruments have been used extensively and reported in the literature.

A three way analysis of varience, using the ANOVA subprogram of SPSS, was used to determine the effect of treatment group membership, gender, and science background on gain scores. Pre and post test scores on both instruments were compared using Pearson correlation coefficients. The correlations were 0.55 for the TOUS and 0.57 for STAS. Other correlations within gender, science background and treatment groups were all between 0.5 and 0.6. These correlations were used by the authors to justify using gain scores.

## Findings

Results of the three way analysis of variance performed on the gain scores for attitudes (STAS) and understanding (TOUS) are presented in Table I.

Table 1

Three-Way Analysis of Variance for Gain Scores on STAS and TOUS

| SOURCE | df | POST-PRE STAS F | POST-PRE STAS P | POST-PRE TOUS F | POST-PRE TOUS P |
|---|---|---|---|---|---|
| TREATMENT | 1 | 1.45 | 0.23 | 0.01 | 0.97 |
| SEX | 1 | 0.10 | 0.75 | 0.28 | 0.60 |
| SCIENCE BACKGROUND | 1 | 1.01 | 0.32 | 3.26 | 0.07 |
| TREATMENT x SEX | 1 | 3.73 | 0.05* | 0.23 | 0.64 |
| TREATMENT x SCIENCE BACKGROUND | 1 | 1.64 | 0.20 | 0.26 | 0.61 |
| SEX x SCIENCE BACKGROUND | 1 | 0.59 | 0.44 | 0.35 | 0.56 |
| TREATMENT x SEX x SCI. BACKGROUND | 1 | 0.01 | 0.97 | 1.14 | 0.29 |
| RESIDUAL | 463 | | | | |

*Significant at the 0.05 level.

None of the main effects or interactions for understanding gain scores was significant. The treatment by gender interaction was the only significant attitude effect. This interaction is illustrated in Figure 1.

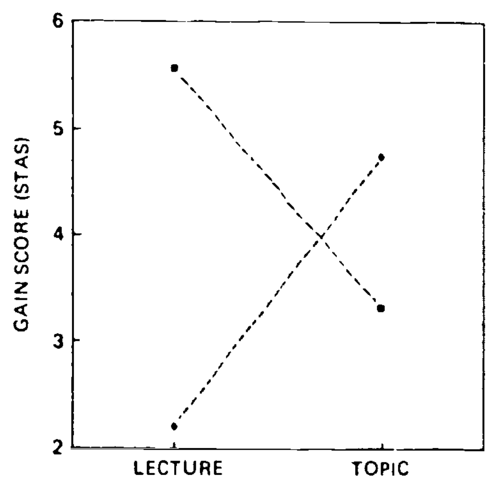


Figure 1. Interaction between lecture approach and topic approach and gain in STAS score for (F) females and (M) males.

Treatments affected males and females in the following differential ways: Males' attitude gains were significantly higher under the lecture approach while females achieved a greater positive change in attitude under the topic approach.

Interpretations

The authors concluded that the lack of significant gain scores on the TOUS indicated that attitudes toward science could be made more positive without changing the students' understanding of the nature of science. Based on the fact that most preservice elementary teachers are female and that they achieved higher scores under the topic approach the authors concluded that the topic approach should be the teaching approach of choice for these classes.

## ABSTRACTOR'S ANALYSIS

Preservice elementary teacher education majors have been subjects of many attitudinal studies because it is a well established fact that these individuals prefer other subjects and prefer to teach most other subjects in the curriculum. Motivation for these studies stems from the belief that persons with a more favorable attitude toward science will not only learn more science but they will teach more science, once they become practicing science teachers.

Ginns and Foster taught each of two groups of students using different teaching treatments. One treatment could essentially be labeled a traditional structured lecture approach. The other treatment was much more open and flexible. It was a "warmer" method that allowed students a choice of what they would study, who they would study with and it had an activity orientation. It is reasonable to predict (at least if you have my bias) that students given the "warmer" treatment would develop a more favorable attitude toward science.

It is, therefore, surprising to note that the treatment groups' scores did not differ significantly on the attitude toward science dimension. In this continuation of an earlier study, the investigators report their findings on the influence of gender and previous science background on attitude and discovered that there was a differential interaction effect. Male attitudes were more positively influenced by the more "traditional" treatment and female attitudes were more positively influenced by the "warmer" treatment. The authors suggest that "the effects of science courses with high levels of student involvement are mediated by sex-related cognitive style differences or preferred learning styles." If this is true, does it not also suggest that there should have been significant TOUS score differences?

The investigators also reported that there were not any significant TOUS score differences that could be attributed to previous science instruction. This may be the most important finding of the study. Most of us are probably willing to assume that more science instruction will inevitably lead the student to a better understanding of the nature of science. Do students gain an understanding of science from studying "about" science? An understanding of science includes understanding how various parts of science relate and interact. It appears obvious that many students successfully complete science courses by memorizing the parts and pieces without ever thinking about how these parts and pieces relate or interact. The obvious conclusion is that TOUS gain scores did not result from taking more science courses. Or, an understanding of the nature of science was not gained from studying science. It must be remembered that this is what was! A problem has been clearly identified and it can be addressed. An important point to remember is that no results or negative results are often as important as significant results.

In their discussion, Ginns and Foster state that they can be indicative but not prescriptive. Based on the fact that the females in the study who were given the "warm" treatment developed more favorable attitudes toward science, and because most of the preservice elementary population is female-they indicated that the "warm" approach should be preferred. Since neither approach produced higher TOUS gain scores, this writer would conclude that neither treatment produced the desired effects. Hence, neither treatment should be used. This is, of course, assuming that the TOUS is a valid instrument.

The most important finding of this study, that more science courses do not confer a greater understanding of science upon students deserved serious deliberation. I suspect that similar findings could be reported for more students from everywhere. This finding directs us to ask, Why don't students who take more science courses understand science better? Is it because students have learned that memorizing pieces and parts is all they have to do to get a good course grade? Is it because science teachers emphasize pieces and parts at the expense of connections and relationships?

It is, of course, important to design science experiences that develop (among students) better attitudes toward science. However, a better attitude without a better understanding is not enough. Co rses and experiences that improve both the attitude toward and understanding of science are needed and this is what these investigators should have concluded.

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Descriptors--*Attitudes; Conservation Education; *Educational Research; Elementary Secondary Education; *Environmental Education; Interdisciplinary Approach; *Teacher Attitudes

Expanded abstract and analysis prepared especially for I.S.E. by Avi Hofstein, The Weizmann Institute of Science.

Purpose

This paper reports on a study to:

1. determine to what extent teachers are currently using the environment to teach both by study trips and school site study;
2. find out what is taught outside schools;
3. determine where study trips are taken;
4. determine a teacher's priorities regarding environmental education activities;
5. find out what factors inhibit teachers from conducting environmental education activities; and
6. determine the willingness of teachers to obtain inservice training in the use of the environment for teaching.

The questions were formalized using results obtained in a research study conducted by Ploutz and Mirka (1983).

Rationale

The researcher claims that little is known and little research has been conducted on factors that influence teachers' use of the outdoors. The author summarized several research studies in which it was found that:

1. The school principal plays a major role in curriculum within the school.
2. There is a need for good administration in the elementary school to support the environmental education effort.

3. Ninety-three percent of Missouri teachers responding to a questionnaire were convinced that field trips are an effective teaching tool (Mirka, 1970).

## Research Design and Procedure

The study involved a stratified population of 4513 Columbus, Ohio, teachers of all grade levels and subject areas. A questionnaire was mailed to a random sample of 224 teachers.

The questionnaire requested information about teacher's gender, age, teaching experience, grade taught and class size. Teachers were asked to rank environmental education in relation to other parts of the school curriculum. The questionnaire requested information on:

1. How environment is used for teaching
2. What is taught outdoors
3. How often were study trips conducted
4. If teachers were interested in attending inservice training in the use of the environment for teaching.

## Findings

1. No significant differences were found between teachers at the more affluent suburban schools and all the others.
2. Principals of different schools held the same attitudes towards the teachers' use of environment for teaching.
3. It was difficult to determine whether males and females differed concerning the attitude to environmental studies because females usually taught in primary schools and males in senior schools.
4. Elementary teachers reported teaching outside of the school building much more often than did secondary school teachers.

5. Elementary teachers teach several subjects and they often teach them outside the schools. They do so significantly more than do secondary school teachers.
6. The researcher found that principals relatively encouraged primary school teachers to teach outdoors but they were ambivalent in the secondary school setting.
7. In general, primary school teachers took more study trips with their students than did secondary school teachers.
8. Many teachers claimed that the major reasons for not conducting field trips were financial constraints.
9. Twenty five percent of the secondary school teachers claim that they had logistic problems organizing environmental outdoors activities.

Interpretations/Implications/Conclusions

The author concluded that:

1. In general, outdoor activities are conducted in the primary school educational phase rather than in the secondary school one.
2. Secondary school teachers encounter more problems organizing such trips.
3. The inservice component of an environmental education program will likely be attended mostly by elementary school teachers.
4. To attract teachers' attention, environmental education programs should relate as much as possible to consumer and vocational education.

## ABSTRACTOR'S ANALYSIS

The study reported here is a survey and not experimental research. As such, it is very difficult to use the findings for the purpose of generalization. In my mind, one of the limitations of such a survey is that it gives the potential curriculum developer a more or less objective picture of the state of the art but very little beyond it.

In his summary, the author wrote: "Financial and other support for environmental education programs will come only if such groups are shown that these programs are relevant to all facets of the curriculum and can enhance teaching of the basics."

Unfortunately, there is no evidence (based on this survey) for such a claim. I believe that such a survey should eventually help future curriculum developers, principals, and other decision makers. However, on the basis of the findings reported on this article, there is very little one could do to improve the situation.

In the future, such reports should accompany information concerning students' perceptions and cognitive achievement based on the outdoor experiences. Surveys of research conducted in the area of science teaching in recent years have shown that studies which are based on one single questionnaire are rare because it is clear that the amount of information, as well as the ability to generalize, from a single questionnaire is limited.

I would like to make another comment concerning the planning of outdoor trips in the secondary school. It is clear (Nae, Hofstein and Mandler, 1983) that with more mature students, these trips should be carefully organized. The older the students are, the more sophisticated they become. Thus, their level of expectation is much higher.

This article provides the reader with a set of data gathered from teachers. The author, however, failed to provide the reader with clear ideas and suggestions of what one could do with this information. He also failed to provide an explanation about reasons for certain phenomena. My own feeling is that this report could be more valuable if it had been anchored in the curriculum in existence, and if the author had provided some suggestions for future developments and activities.

In order to fulfill students' expectations concerning a particular field trip, there is a need to prepare a detailed scheme of the activity and to train teachers in the method and content of such trips.

In summary, such surveys are important provided they can be useful for future planning and developments. It is suggested that it is fairly easy to convince principals to support teaching outdoors, provided the request for such support is accompanied with clear evidence that such activities are effective and sound. Unfortunately this report does not provide us with such evidence.

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Descriptors--*Anxiety; *Attitude Change; Biology; Earth Science; Elementary Education; *Elementary School Science; Elementary School Teachers; Higher Education; Physical Sciences; *Preservice Teacher Education; Science Education; *Science Instruction; *Teacher Attitudes; Teacher Characteristics

Expanded abstract and analysis prepared especially for I.S.E. by William R. Brown, Old Dominion University.

## Purpose

The two descriptive studies were conducted to determine the effects of a sequence of two science content courses on the attitude toward teaching science and on anxiety about teaching science in a sample of preservice elementary teachers.

Research question:

Major Questions

1 and 2. Was attitude toward/anxiety about teaching science changed in a positive direction?

3. Does a relationship exist between attitude toward teaching science and anxiety about teaching science?

Other Questions

4 and 5. What relationship exists among attitude towards/anxiety about teaching science and selected demographic variables?

6 and 7. What is the relationship between academic achievement and attitude toward/anxiety about teaching science?

8. Did factors such as previous experience and/or individuals influence attitude toward science?

9 and 10. Does change in attitude toward/anxiety about teaching science continue to change in a positive direction in subsequent courses?

## Rationale

The investigator identified two major variables that are related to reluctance of elementary teachers to teach science: (1) inadequate science background including both content and attitudes toward science and (2) high anxiety levels that accompany poor academic performance and the avoidance of science study. Several studies are cited related to these variables. However, the investigator was unable to locate any research studies that directly measured anxiety about science or science teaching in preservice or inservice elementary teachers.

## Research Design and Procedure

The two studies involved 78 and 71 preservice elementary teachers enrolled in two science content courses respectively, specifically designed for this audience.

Three instruments were used including a demographic questionnaire (DQ). The Modified Bratt Attitude Test (M-BAT) was administered to determine attitude toward teaching science. Coefficient alpha was calculated for three samples. The mean value was .65 (N=176). Content validity was determined by a panel.

The State-Trait Anxiety Inventory (STAI) had a computed coefficient alpha measure of internal consistency ranging from .83 to .92.

The instruments were administered in the following order: STAI, M-BAT, DQ. The basic design of the study was $O_1\ X_1\ O_2\ X_2\ O_3\ X_3\ O_4$

$O_1 = O_2 = O_3 = O_4$ = administration of three instruments

$X_1$ = first science class

$X_2$ = second science class

$X_3$ = student teaching

The same procedure was used for two academic years.

## Findings

Questions 1 and 2, Attitude toward/anxiety about teaching science:

Analysis of variance and Tukey's HSD multiple comparison technique were used. A significant change in attitude toward/anxiety about teaching science took place in a positive direction.

Question 3, Relationship attitude-anxiety:

Correlation coefficients were computed. The general finding was that students with positive attitudes toward teaching science tended to have less anxiety about teaching science.

Questions 4 and 5, Selected demographic variables:

Eight variables were selected related to numbers of high school and college science and math courses and level of enjoyment of these courses. None of the variables were significantly related to either attitude toward teaching science or anxiety about teaching science. M-BAT and STAI scores were dichotomized at the mean and chi square values were computed.

Questions 6 and 7, Academic achievement:

Achievement was measured by final grades in the two science courses. Correlation coefficients were computed. Achievement appears to be related to both attitude toward teaching science and anxiety about teaching science in the earth science and biology course but not consistently related to these variables in the physical science course.

Question 8, Background experiences:

Anecdotal analysis indicated that the teacher was the most important single influence on attitude toward science.

Questions 9 and 10, Change in subsequent courses:

Both attitude toward teaching science and anxiety about teaching science continued to change in a positive direction during subsequent courses including student teaching. ANOVA was used for four successive administrations of the M-BAT and STAI.

## Interpretations

In both studies, attitude toward teaching science and anxiety about teaching science were changed in a positive direction during the two science courses and continued in a positive direction through student teaching. Students with positive attitudes toward teaching science tended to have less anxiety about teaching science.

## ABSTRACTOR'S ANALYSIS

The reported relationships between attitude and anxiety are interesting in that they support a position taken by many science educators who work with elementary teachers. Besides being competent in content one also needs to understand how the discipline works -- what really makes science a unique field of inquiry? In these studies the preservice teachers were enrolled in science content classes specifically designed for teachers. A significant research and development problem that evolves from these studies is: how can science educators help research-oriented scientist-professors teach teachers? How can we "break" the attitude that a dictionary of terms is the prerequisite for effective teaching of children and youth?

The anecdotal information analyzed to answer question eight cited the teacher as the most important single influence on attitude toward science. Perhaps the various school divisions, and colleges, should recognize and reward this significant factor. Research-oriented universities rarely recognize and/or reward outstanding teaching. Merit pay for teachers at all levels may eventually speak to the issue of rewarding teachers as teachers.

An interesting extension of these studies would be to assess attitude/anxiety one-three-five years after college graduation. What factors contribute to change in attitude/anxiety on-the-job? I suspect numerous teachers will change their attitude toward science once they enter the "real school" world. It might be desirable to know what happens to anxiety levels on the job.

A potential major contribution of these studies may be the identification of the State-Trait Anxiety Inventory. This instrument has been used in hundreds of studies in the field of psychology. Science educators may benefit by using this instrument in additional studies. State anxiety is defined as a transitory emotional state which can be influenced by training. A potential area of research and development is related to the question: can we devise training situations (both preservice and inservice) to reduce state anxiety levels for teachers, administrators, students, and even parents?

The content validity of the M-BAT was determined by a panel of three science educators. The comments by Hugh Munby (Munby, 1982) are especially relevant to this report. It might be desirable for science educators to temporarily halt the creation of "new" instruments that could be used in numerous areas.

The abstract in JRST is a case of too much, too quick, too confusing! An abstract should not require the reader to become an expert in shorthand (ATTS, M-BAT, ANX-TS, STAI, A-State, Science 5, Science 6, Science 6-5)! An abstract should include the variables in the study, the sample used, a brief, simple outline of the design (Campbell and Stanley nomenclature), and key findings. An abstract should encourage a person to read an article!

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RESPONSES

IN RESPONSE TO THE ANALYSIS OF

Westerback, Mary. "Studies on Attitude Toward Teaching Science and Anxiety About Teaching Science in Preservice Elementary Teachers." by William Brown. Investigations in Science Education 12 (2): 42-46, 1986.

Mary Westerback
Long Island University

William Brown of Old Dominion University did an excellent job of preparing an expanded abstract and analysis of my Journal of Research in Science Teaching article.

The teacher from the primary grades to the university level has the opportunity to reduce anxiety about subject areas in the classroom. My recent investigations have focused on the identification of specific content areas and tasks (i.e. the identificaiton of minerals and rocks) which provoke anxiety and the development of teaching practices which reduce anxiety about these tasks.

The suggestion that assessment of attitude/anxiety be done some years after graduation is excellent and is being considered.

IN RESPONSE TO THE ANALYSIS OF

McNaught, Carmel. "Relationship Between Cognitive Preferences and Achievement in Chemistry," by Glen S. Aikenhead. Investigations in Science Education 11 (2): 31-36, 1985.

Carmel McNaught
University of Natal

Tha abstract and analysis prepared by Glen S. Aikenhead are clear and present interesting points for discussion. I particularly agree with his comment that educational significance of the research could have been explored in more detail.

The f '' surrounding this piece of reseai ch are not unusual ones - it was done for my M. Ed. degree and, as soon as it was completed, I left Australia seeking permanent employment overseas. My field of research here in Africa is, not surprisingly, quite different from the sophisticated work on cognitive preferences presented in the JRST article.

The vast amount of research which is underutilized because it is done as a 'one-off' piece of work is something which has been recognized for some time by most educational institutions but, in times of increasing cut-backs in educational spending, the seriousness of this wastage becomes more critical.

I have two suggestions to help remedy this problem which ISE readers might like to con

1) encourage (by financial grant policies, etc.) institutions which build up properly co-ordinated networks of research. I feel the work of Master s students, who are usually embarking on their first serious piece of educational research, should wherever possible contribute to the understanding of some central theme or problem selected by the Education Faculty. The size of and expertise in the Faculty will, of course, determine the number of suc themes or problems.

   This does not mean that the highly motivated and capable student who presents an alternative idea for research should not be allowed to argue his/her case but that the majority of higher degree students in any Faculty (especially at the Master's level) should make a contribution to a co-ordinated network of research.

   Of course, many institutions have adopted this policy but there is, I'm sure, scope for much greater co-ordination in educational research.

2) Examiners of educational theses should direct their attention much more to the educational implications of the work being presented. As Aikenhead comments: "The criteria for educational significance are not nearly so well developed as the criteria for statistical significance." However, the real test of the value of a piece of research is whether it can be utilized, and higher degree students should be encouraged to present firm suggestions as to the educational significance of their work.

Since I wrote that article in the late 1970s, my sense of frustration at unusable research has increased enormously. I now want usable ideas from my literature reading. I may disagree with these ideas but I want a starting point for considerations of how to use the work.

My thanks to Glen Aikenhead for opening what I hope might be a more serious consideration of how to make educational research more relevant and useful.

IN RESPONSE TO THE ANALYSIS OF

Otto, Paul B. and Robert F. Schuck. "The Effect of a Teacher Questioning Strategy Training Program on Teaching Behavior, Student Achievement, and Retention" by Gerald Krockover. Investigations in Science Education, 12 (1): 16-20, 1986.

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Critical analysis is a fine art based upon substantive analysis in opposition to speculation. The reviewer has raised questions regarding the content of the units of instruction, the granting of in-service credit, the appropriateness of using elementary teachers as raters and the use of volunteer populations. These are questions of generalizability of the study. As such they are both interesting and important, but in the absence of substantive rationale regarding the influence of these factors upon the results, we, like the reviewer, can only speculate as to their effects. Although the BSCS Blue Version units were used, it was not reported since the units taught were common across the study and the focus was on questioning technique rather than biological content or curricular construct. However, a replicative study using another biological curriculum, unit of study or another area of science certainly would add to the general knowledge base. Again, the reviewer's concern about using elementary teachers as observers would be more relevant if the study dealt with biology content rather than pedagogical technique. The use of volunteers in psychological, medical and educational research is routine, often with monetary remuneration. Regulations at both of the principal investigators' home institutions demand voluntary participation of human subjects.

The details relative to the test and measurement features of the study were deleted by editorial rather than scholarship requirements, and we concur should have been included. A simple inquiry to the authors can easily clear the matter. The experimental/control group statement is an obvious editorial error.

The essence of the work resides in the randomized design employed, the training program devised and the method of evaluation of the results of implementation.

A serious concern of the principal investigators is the reviewer's final comment "Where's the beef?" Although this commercial catch-phrase has demonstrated success in the fast-food market and adaptation in the political arena, it does not add scholarly credibility to a review in Investigations in Science Education. We trust future I.S.E. reviews will espouse scholarly analysis without resorting to popular cliche.

IN RESPONSE TO THE ANALYSIS OF

Maloney, D. P. "Proportional Reasoning and Rule-Governed Behavior With the Balance Beam." by Linda Cronin and Elisabeth Charron. Investigations in Science Education 11 (4): 66-71, 1985.

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There are several points raised by the abstractors which I feel merit further attention. I appreciate the opportunity to respond to these points and to the abstractors' questions. I think the abstractors did a very good job; I believe I can answer most of their questions because our investigations have been ongoing since the original article was published.

First, on the matter of the rule-assessment technique being a better predictor of problem solving behavior than Piagetian classification, there never was any intention of examining this in the study. As stated in the article, the primary purpose of the study was to determine if college age subjects would use definite strategies. The answer in that study, and all subsequent studies, was "yes."

The method used to generate "ideal" response patterns was simply to apply the selected strategy to the items in the task set. For example, to determine the answers for the "mass only" rule, one simply chose, as the answer for each of the 24 items, the side with the greater mass. The resulting 24 letter sequence, where each letter was either L (left), R (right), or B (balance), was the "ideal" pattern for the "mass only" rule.

The "Not Consistent" category was the default category for all response sequences that could not be matched to one of the six rules. These response patterns differed by at least five answers from the sequences associated with the six rules. In other words, the closest match between such a student response sequence and the ideal sequence was 19 of 24. Since only matches having at least 20 of 24 letters the same were considered acceptable, these student sequences did not fit any of the rules, so they were put into the "Not Consistent" category.

The reliability data for the Lawson test (Lawson, 1978) have been reported elsewhere. With regard to the RA measures the traditional reliability measures, other than test-retest perhaps, really do not apply. The reason for this is that the responses for all of the items are used to identify one rule, rather than taking some average level of performance or using a correct-incorrect dichotomy on each item.

The conclusion about more sophisticated rule use in more advanced classes has been supported by subsequent research. Eight general physics classes have been tested (Maloney, in press), and the average percentage using Rule 6 in those classes is 48 percent (s = 9.0). This is clearly better than the performance of either the Natural Science class or the Physics 187 class in the original study. In addition, the "Not Consistent" percentages for the eight general physics classes averaged 13 percent (s = 9.7), much better than found for the one class reported originally.

On the question of whether the RA technique can be applied to other tasks, the answer is very definitely yes. The author has already conducted other studies with such physics topics as: Newton's Third Law (Maloney, 1984a), conservation of mechanical energy (Maloney, 1985), flowing liquids, pendulums, and Newton's Second Law (Maloney, in press), electric charge-magnetic field interactions (Maloney, in press), and simple DC circuits (Maloney, 1984b). In all of these studies the majority of the subjects were found to be using identifiable rules. In addition, the number of rules used was limited, and there were patterns in the rules employed by different classes.

On a final point, we now have some pre-postinstruction data available. For a task set involving carts going up inclines under the action of gravity, we have found that approximately 40 percent of the students use the same rule after instruction as before. The majority, on the order of 78 percent, were using a rule which was contradicted by what they were being taught. On a task set involving a simple three bulb series circuit we also found about 40 percent staying with their initial strategy. The majority (80 percent) of these students were also using rules contradicted by instruction. These data indicate that not only are alternate concepts resistant to change, but in a reasonable percentage of the cases the specific strategy derived from the alternate conception is also resistant.

Our investigations into students' strategies continue.

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IN RESPONSE TO THE ANALYSIS OF

Haladyna, T., R. Olsen, and J. Shaughnessy. "Relations of Student, Teacher, and Learning Environment Variables to Attitudes Toward Science" by Marcia Lakes Matyas. Investigations in Science Education 10 (3): 46-55, 1984.

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Matyas (1984) has written an expanded abstract and analysis of our paper "Relations of Student, Teacher, and Learning Environment Variables to Attitude Toward Science" (Haladyna, Olsen, and Shaughnessy, 1982). This brief paper is intended to respond to several comments made by Matyas.

Our research, funded by the National Science Foundation, addressed the mathematics, science, and social studies attitudes of fourth, seventh, and ninth grade students. Our studies have been reported in a variety of journals (Haladyna and Thomas; 1979a, 1979b; Haladyna and Shaughnessy, 1982a; Haladyna, Shaughnessy, and Redsun, 1982a, 1982b; Haladyna, Olsen, and Shaughnessy, 1982, 1983; Haladyna, Shaughnessy, and Shaughnessy, 1983a, 1983b); and a manual has been widely distributed without cost to those requesting it (Haladyna and Shaughnessy, 1982b).

The research has been programmatic in the sense that (1) a theoretical model was formulated to both define attitude and to explain how the teacher and the learning environment established by the teacher are probably the two most influential factors in shaping attitude toward a subject matter, (2) measures were created, adopted, or adapted to represent both variables believed to influence attitude as well as variables NOT believed to influence attitude, (3) data were collected on these measures in an effort to test hypotheses generated via this model, and (4) the analyses of data drew attention and support to the validity of the model as useful in the study and influence of each of the three types of attitudes toward school.

The underlying assumption of our research is that attitudes toward various subject matters are important outcomes of schooling. While not nearly as important as achievement, attitudes are clearly important for reasons of motivation to achieve cognitive school outcomes. As educators, we ought to promote positive attitudes as part of the educational process. Some, like Mager (1968), would take a stronger stance on this issue, arguing that without positive attitudes, students will hardly want to learn. We have essentially agreed with that position.

Matyas (1984) has stated that our model is simple and that it is in need of expansion in future research. Models stand or fail based on their validity as supported by evidence. Models should never be judged by their simplicity or complexity, but simply by their logic and the research which either supports or refutes hypotheses generated via the model. If given a choice, parsimony is desirable in model building. In fact, it is an objective in describing behavior and measuring constructs. Fortunately, despite the simplicity of our model, the data reported in our studies support the model. Thus, we would agrue that a parsimonious model is a desired end point and not a beginning point.

In much of our research, we made a distinction between exogenous and endogenous variables. The former refers to variables outside the realm of influence of the phenomenon we were studying. Some examples of exogenous variables are socioeconomic status, gender, and education levels of parents. Endogenous variables are more likely to influence that which is of interest. We hypothesized two classes of endogenous variables, teacher quality and learning environment, to be causally related to school subject attitudes and exogenous variables to be most least influential. The further study of exogenous variables or the expansion of the model to include new and remotely associated exogenous variables appears pointless, particularly when the reported research already supports the model and the two classes of endogenous variables. Another point to be made releva to this issue is that many exogenous variables such as gender and socioeconomic status are beyond the control of researchers and other educators, while most endogenous variables are under the direct control of teachers who potentially have the greatest influence over students with respect to developing attitudes toward these subject matters.

Criticism was made by Matyas of single-item variables. Such variables are often demographic in nature or involve a rating scale. In a classical sense, reliability may appear to be low. Operationally, some of these variables have a high relationship with more reliable counterparts. This should not come as any surprise because many one-item variables are sufficiently clear enough to students to provide dependable indicators of simple unidimensional traits.

There was criticism by Matyas of the reliability of many subscales. This criticism was very valid. Sufficient reliability studies have not been done. But this brings up an important point. Because such studies have not been done does not invalidate any research. If no relationships had been reported when expected, one might conclude that the various scales that we used were unreliable. However, most of our research indicates high relationships, which statistically implies high reliability, because reliability forms a ceiling for correlation. Therefore, we would conclude that reliability should be estimated more systematically if one uses our scales, but one can have some confidence in these measures because they have been successfully used. In short, the lack of a reliability study does not mean that measures are unreliable.

There was also criticism by Matyas for a lack of validity studies. Any time research is conducted with measures where a theory is presented, measures are used to explicate elements or constructs of the theory, and the data support the hypotheses generated from the theory; we have a strong case for construct validity. Evidence for content validity of our attitude measures was reported earlier (Haladyna and Thomas, 1979a). All other studies, in various ways, provide for construct valid interpretations of many variables we used. Perhaps the strongest evidence was a causal analysis conducted with mathematics attitude (Haladyna, Shaughnessy, and Shaughnessy, 1983a). The study offered support for the model and for construct valid interpretations of the mathematics attitude scale.

Matyas also commented on an apparent lack of definition of attitude. A more comprehensive discussion of attitude can be found in Haladyna and Shaughnessy (1982a, 548-551) where we reviewed various studies employing the term "attitude" and attempted to differentiate among these many diverse approaches. Our position was that the attitude of concern in our study was simply an emotional disposition toward an object: the school subject of science. No attempt was made to study scientific attitudes, attitude toward scientists, attitude toward a specific method of teaching science, scientific interests, or attitudes toward various parts of the science curriculum. This is not to say that these other attitudes are unimportant but simply to say that this was not the concern in our studies.

A final comment has to do with the inadequacy of any research report, including ours. Most journal articles are by necessity brief. One cannot provide all detail necessary in a journal article. Instead, one must make reference to prior research in an effort to round out that which is missing from the research report. Our critic has used sound principles of research to criticize our study, attacking every area that we discussed in our review paper (Haladyna and Shaughnessy, 1982a). While the research paper receiving this criticism does not provide all information the critic wanted, we believe that a review of the references in that paper provides further background and information needed to complete one's understanding of the sum of our efforts toward studying science attitude.

Hopefully this response to Matyas' comments will correct any lack of clarity in our research paper.

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IN RESPONSE TO THE ANALYSIS OF

Jungwirth, Ehud. "Consistency Across Methods of Observation - An in Depth Study of the Cognitive Preference Test." by Frances Lawrenz. Investigations in Science Education 11 (3): 51-55, 1985.

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Since the reviewer agrees with me, I have no quarrel with her, except that she seems to have misread two points:

On page 3, lines 11-13, it says that: "76 percent of the respondents had attended to both formats..." This should be amended to read: "76 percent of the respondents stated that they had attended to both formats in the same manner, i.e., using the same thought-processes." (in fact all the respondents had attended to both formats!). And to continue - "Subjects were evenly divided as to the suitability of the traditional versus the associative approach in CP testing."

Further on page 3, line 21, it says that: "Third - it appears that reasons-for-choice are not based on CP modes..." This would better read: "Third - it is doubtful that reasons-for-choice are indeed based on..."

These changes will, I believe, better portray the intentions of the original paper.