DOCUMENT RESUME

ED 091 189 SE 017 723

AUTHOR Berger, Carl F.
TITLE A Comparison of Science Teaching Behavior with a Theoretical Construct.
PUB DATE 17 Apr 74
NOTE 27p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (47th, Chicago, Illinois, April 1974)

EDRS PRICE MF-$0.75 HC-$1.85 PLUS POSTAGE
DESCRIPTORS *Educational Research; Elementary School Science; *Models; *Science Course Improvement Project; *Teacher Behavior; Teaching Styles
IDENTIFIERS Research Reports; *Science Curriculum Improvement Study; SCIS

ABSTRACT

This study was an attempt to use a model or a theoretical construct and to find if that model related to an underlying construct teachers might have as they view science teaching decisions. Nine scenes from the Science Curriculum Improvement Study (SCIS) film, "Don't Tell Me, I'll Find Out," were selected. Statements reflecting three kinds of teaching behaviors: (1) teacher oriented, (2) student-teacher cooperation oriented, and (3) student oriented, were developed, submitted to an eight-person SCIS judging panel, and refined. Six statements (two of each orientation) relating to each scene were presented in the response pamphlet. Teachers indicated their degree of agreement, using a five-cell Likert scale. The packet of materials was presented to 254 subjects: 69 preservice, elementary, science-education-methods students, 69 inservice teachers of elementary schools, 57 inservice teachers completing a Cooperative College-School Science workshop in SCIS, 45 inservice teachers completing workshops and teaching experience with SCIS, and 15 SCIS staff members. The results of the study indicated that teachers view teaching elementary science depending on the particular situation and consistent with a total philosophy (for SCIS, this is teacher as guide, not as an authority). (Author/PEB)

A COMPARISON OF SCIENCE TEACHING BEHAVIOR WITH A THEORETICAL CONSTRUCT

by

Carl F. Berger
Associate Professor of Science Education
University of Michigan

Presented at the
47th Annual Meeting
National Association for
Research in Science Teaching

Chicago
April 17, 1974

A Comparison of Science Teaching Behaviors
with a Theoretical Construct

Background

During the decade from 1960 to 1970 new elementary school science curricular sponsored in part by the National Science Foundation became available on a large scale. Major characteristics of these new curricular were the large amount of involvement of children with science materials, the utilization of classrooms as laboratories, and the function of students as primary investigators. The goals of these programs were best met by teachers exhibiting a variety of differing teaching behaviors.

For some of the lessons the teacher acts as a stimulator of diverse activities done by children, for others he may act as a source of knowledge, and for others as a guide or leader of student's investigations. These differing behaviors of the teachers may not be natural outgrowths of many teacher's classroom behaviors as reported by Watson (1965:1054)

> ". . .science teachers are quite conservative. Many hold their positions and maintain their egos by virtue of the 'inner knowledge of the subject'. They enjoy 'telling and showing' their pupils. When this behavior is made unnecessary . . . many teachers will be obliged to change in position and importance. Even for those who will recognize and welcome their new role this change will be difficult."

If the new science courses require different behaviors of the teachers, several problems present themselves. Can these differing behaviors be classified? Can teachers use the behaviors present in new science programs? Can teachers recognize that a repertoire of behaviors or strategies are necessary for these new curriculum? Would teachers respond with a single strategy when confronted by the "new science programs"? Would teachers' strategies be consistent with the strategies on the new curricula after training and experience?

During the 1960's three major new elementary school science curriculums appeared. The curricula known as the Science Curriculum Improvement Study, specifically defined a learning cycle into three major groups. (SCIS, Interaction and Systems 1970:16)

1. Exploration. Children learn through their own spontaneous behavior relative to objects and events: that is, by handling objects and by experimenting with them.

2. Invention. Spontaneous learning is limited by the child's preconceptions. After exploration, he needs new concepts to interpret his observations. Since few children can phrase new concepts by themselves, you must at times provide a definition and a term for a new concept.

3. Discovery. We use the word discovery for those activities in which a child discerns a new application for a concept.

Within the description of the learning cycle, classroom emphasis was decribed such as ". . . children explore the materials with minimal guidance . . . ", " . . . encourage them to look for examples that illustrate their new idea" and "You may plan a variety of situations . . . or you may depend on the child's own experiences . . ." (op. cit.:17) Using these descriptions it was thought possible to observe teaching behaviors to see if the teachers were consistent with the learning cycle in actual classroom situations. However, actual classroom observation of the total teacher group was ruled out for several reasons. Among these were those highlighted by Medley and Metzel (1963:247)

> Research workers point out that observations are expensive in terms of time, money, and professional skill demanded of observers; that observations constitute an evasion of privacy; that teachers and administrators resent and resist; that the presence of an observer in a classroom is so disturbing that the behavior seen cannot be regarded as typical of the behavior which goes on when the observer is not present; and above all, that most studies in the past which have employed classroom visitation have not been successful in increasing our knowledge about teaching.

A secondary method of observing teaching behavior was considered and a predicted teaching behavior device was developed and entitled, "Decisions in Teaching".

Device

The "Decisions in Teaching" packet consisted of a film, response pamphlets and scoring sheets and was developed in the following fashion.

From the SCIS film, "Don't Tell Me, I'll Find Out", nine scenes were selected reflecting the SCIS teaching strategy - exploration, invention and discovery. These scenes showed teachers: asking questions, answering questions, responding to students' comments, preparing for experiments, handling intellectual disagreements, handling organisms, distributing equipment and introducing concepts. Statements reflecting three kinds of teaching behaviors were submitted to an eight person SCIS judging panel. The behaviors were:

1) Teacher oriented - teacher decides next action or uses an immediate authority such as a book;
2) Student-teacher cooperation oriented - students and teacher jointly decide next action; and
3) Student oriented - teacher allows student to decide next action in class.

Statements were altered or eliminated until the judges had a Kendall Coefficient of concordance of .90 or better.

Six statements relating to each scene, two of each orientation, were presented in a response pamphlet. Teachers predicted on an answer sheet their degree of agreement using a 5 cell Likert scale. Three primary scores were generated using the sums of degrees of agreement for each of the three kinds of behaviors. The three scores corresponded with three behaviors, teacher oriented, student-teacher cooperation oriented and student oriented. Primary scores were generated for each scene and totals for all scenes combined (see appendix). Traditional test analyses were performed which indicated that "Decisions in Teaching" had a split halves reliability of 0.84 and a predicted to observed behavior validity correlation of 0.74.

Data Sources

The packet of materials (film, response pamphlets and scoring sheet) was administered and responses gathered from 254 subjects, made up of the following groups:

69 Preservice elementary science education methods students

69 Inservice teachers of four complete faculties, 13 and 17 from two California elementary schools, 21 from a Massachusetts elementary school and 13 from a Michigan elementary school

57 Inservice teachers completing Cooperative College School Science (CCSS), Science Curriculum Improvement Study (SCIS workshops, 13 from a two week CCSS/SCIS workshop in Carolina, 44 from a 4 week CCSS/SCIS workshop in California.

45 Inservice teachers completing workshops and teaching experience with the SCIS materials. 26 California teachers who had one year's experience and 19 California teachers who had two year's experience.

15 Staff members of the Science Curriculum Improvement Study

Methods and Procedures

From the questions stated in the background section, three major objectives which could be resolved by the Decisions in Teaching device were investigated: 1) to find if elementary school teachers of science predict science teaching behaviors based on a particular situation or from one behavioral viewpoint, 2) to find if elementary school teachers' predictions of science teaching behaviors can be classified into categories of behaviors, and 3) to find if the categories of behaviors are consistent with those of the curriculum designers.

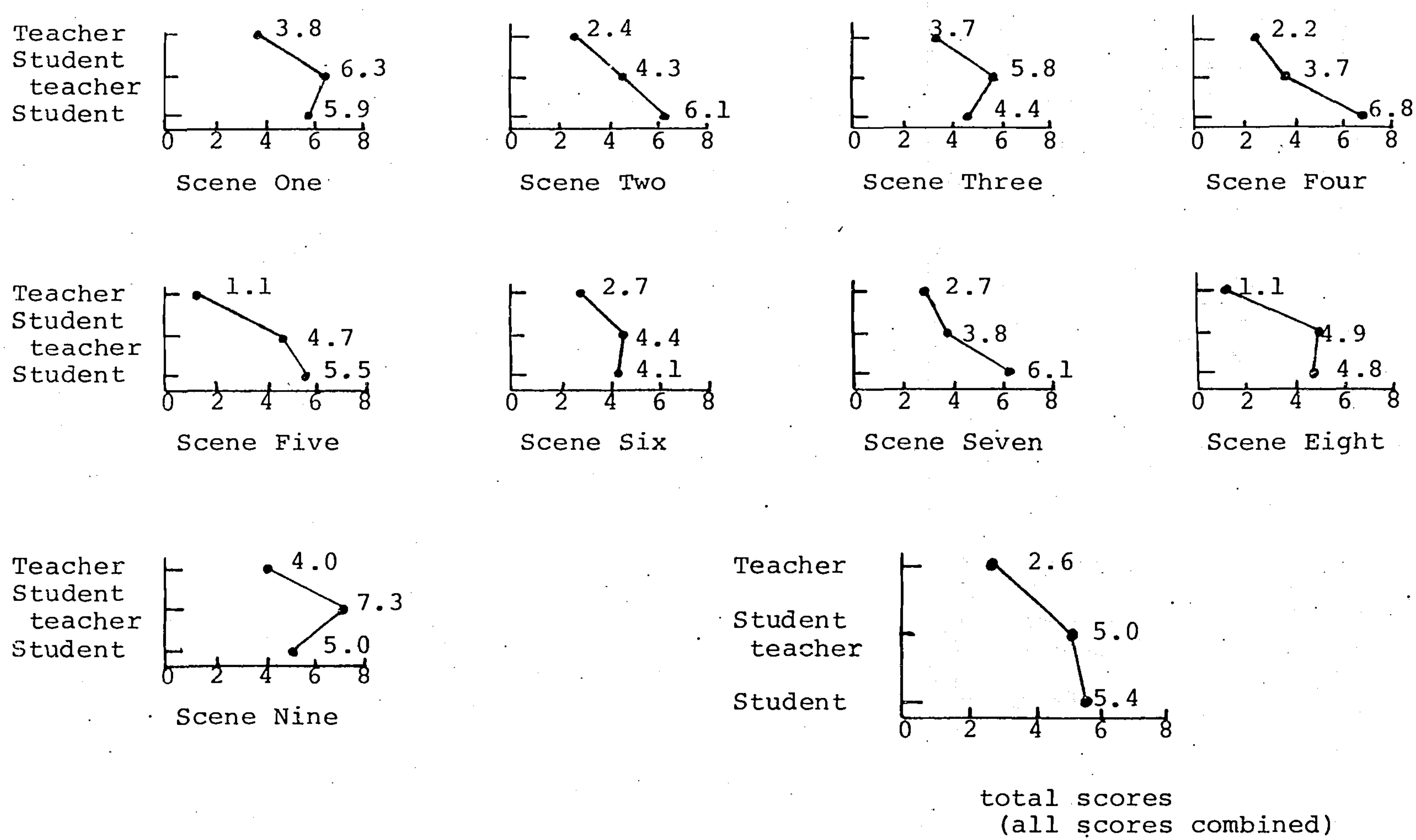
To find if elementary school teachers of science predict science teaching behaviors based on a particular stituation or from a single behavioral viewpoint, a profile analysis was carried out. First, profiles for the total group of teachers (n = 240) were generated from the means of the three scores in each scene. The profiles are shown in Table 1. As can be observed from Table 1 teacher oriented scores were lowest in all scenes but the profiles differed in preference for student-teacher cooperation oriented scores or student oriented scores.

Paired T tests (MIDAS 1973:80) were initiated to find if significant differences existed between the three scores in each scene. In every scene the teacher oriented score was significantly different and lower than either the student-teacher cooperation oriented score or the student oriented score at the .01 level.

In scenes (one) asking questions, (three) reacting to responses, and (nine) using concepts just introduced, the student-teacher cooperation oriented scores were significantly higher than the student oriented scores. In scenes (two) answering questions, (four) designing experiments, (five) handling disagreements, and (seven) answering questions, student oriented scores were

Table 1

Profiles of Means of Teacher Oriented, Student-Teacher Cooperation Oriented, and Student Oriented Scores for 240 Teachers



significantly higher than student-teacher cooperation oriented scores. Responses in scene (six) distribution of materials, and (eight) handling of organisms indicated no significant preference between student-teacher cooperation oriented scores and student oriented scores. Thus, it was concluded that teachers viewing the film predict that they will use few teacher oriented responses but choose from the particular situation the behavior(student-teacher cooperation oriented, or student oriented) they believe appropriate. A multivariate analysis of variance (Morrison 1967:159, MIDAS 1973:72) was conducted to find if significant differences occurred between the groups particularly as compared to the SCIS staff. The results of the multivariate analysis for the total profile is shown in Table 2. As can be seen there were significant differences among the groups. Pairwise multiple contrasts indicated significant differences between preservice and the SCIS staff, significant differences between random inservice faculties and the SCIS staff but no significant difference between teachers who had completed a CCSS/SCIS workshop and/or taught SCIS for a year or more and the SCIS staff. Thus, the third objective was answered, categories of behaviors are in agreement between teachers trained in the use of SCIS materials and/or teaching the program for one or two years and the designers of the SCIS staff. Examination of the multivariate analysis for each scene confirmed that no significant differences occurred between the predicted behaviors of the teachers completing CCSS/SCIS workshops and/or taught SCIS for a year or more compared to the SCIS staff. To answer the third objective, to find if the categories of behaviors are consistent with those of the curriculum designers, the total scores of the 240 teacher participants were analyzed using principal component analysis. Principal component analysis was chosen over cluster analysis and

Table 2

Multivariate Analysis of Variance and Multiple Contrasts
for Total Scores of the Decisions in Teaching Measure

Equality of Group Means	degrees of freedom	F	Sig
	12,653	7.54	.0000

Alternate test (Roy's union intersection) maximum root = .348 .0000

Means	preservice	inservice faculties	inservice +workshop	inservice +workshop +experience	SCIS staff
Teacher oriented	26.1	28.1	19.9	18.3	13.0
Student-teacher oriented	47.1	46.0	43.4	44.3	39.0
Student oriented	47.3	47.7	50.3	51.8	46.7

Multiple Scheffe Contrasts

compared to	preservice	inservice	inservice +workshop	inservice +workshop +experience
Inservice faculties	-1.2 ± 12.4			
Inservice +workshop	6.9 ± 13.1	8.1 ± 13.1		
Inservice +workshop +experience	6.2 ± 14.0	7.4 ± 14.6	$-.7 \pm 14.6$	
SCIS staff	21.9 ± 21.4*	23.1 ± 21.4*	15.0 ± 21.8	15.7 ± 22.4

*Sig at p .01

various forms of factor analysis for the reasons quoted by Schuessler (1971:108):

> Thurstone (1947:178) himself, who was generally regarded as the leading exponent of the centroid method, recognized the statistical advantages of the method of principal factors and commented: 'The centroid method of factoring and the centroid solution for the location of the reference axes are to be regarded as a computational compromise, in that they have been found to involve much less labor than the principal-axes solution.' Some authorities maintain a stricter attitude. For example, Kendall (1957:27-28) writes: "Psychological workers have developed numerous methods of component analysis which avoid the arithmetic required by the solution of the characteristic equation. My personal opinion is that they are objectionable and should not be used when they can be avoided. Perhaps they can be justified to some extent as giving approximations to the principal component method, but any discussion of their sampling properties seems almost beyond the range of reasonable possibility."

The principal components of the three total scores (teacher oriented, student-teacher cooperation oriented and student oriented) of the 240 teachers are shown in Table 3. Computations were performed on the correlation matrix using MIDAS, Michigan Interactive Data Analysis System, (1973:84). This program generated a Barlett's test of independence as reported in Morrison (1967:113). As can be seen the test of independent correlations indicated that the variables were significantly correlated and thus were amenable to principle component analysis. In addition to a test for equicorrelation was also generated (Morrison 1967:252). From that statistic it was concluded that a single axes for the three major scores was not tenable.

An examination of the component indices on Table 3 (such indices have a simple linear relation to component correlations) indicated three principal components. The first accounted for 45 percent of the variables and was correlated positively with all variables. The second brought the cumulative variance to 84 percent

Table 3

Independence, Equicorrelation and Principal Components of the Total Scores for the Decisions in Teaching

Test of Independence of Variables

n = 240 $X^2 = 66.097$ df = 3 Sig at p .01

Test of Equicorrelation of Variables

n = 240 $X^2 = 43.28$ df = 2 Sig at p .01

Principal Components

component number	1	2	3
component variance	1.36	1.16	0.48
cumulative percent	45	84	100

Component Indices

variable			
teacher orientation	.513	.510	.843
student-teacher cooperation	.648	-.137	-.995
student orientation	.226	-.765	.727

and had strong positive correlation with the teacher oriented score and had negative corelation with the student oriented score. The third component brought the cumulative total to 100 percent and indicated strong negative correlation with the student-teacher cooperation oriented score and positive correlation with the teacher oriented score.

The analsyis of the components answered the second objective of the study as the three components did indicate a classification of behaviors. The second component was called the proteacher - antistudent student orientation component and the third was called the antistudent-teacher cooperation component. But what of the first? Because of the positive correlation of all scores this unsuspected component was called the degree of agreement component. Did this indicate that a mean total score could be a definite contributing variable? To test this conjecture and also to find if other hidden components might have been lurking in the correlation matrix, a mean total score was generated. This mean total score was the sum of each participants scores for teacher oriented, student-teacher cooperation oriented and student oriented scores.

Once this was completed a new principal component analysis was carried out, the results shown in Table 4.

As Table 4 indicates possible hypotheses of independence and equicorrelation were again rejected (even at a higher level, for x^2 with 5 degrees of freedom at .01 is only 20.52).

As was suspected the mean score correlated highly with the first principal component and accounted for 58 percent of the variance. The other two components remained the same and the fourth component was so small (3×10^{-16}) that it accounted for 8×10^{-15} percent of the variance. It was finally concluded that the three principal components had been identified. The principal

Table 4

Independence, Equicorrelation and Principal Components of the Total Scores for the Decisions in Teaching and the Mean Scores

Test of Independence of Variables

n = 240 X^2 = 8388. df = 6 Sig at p .01

Test of Equicorrelation of Variables

n = 240 X^2 = 237. df = 5 Sig at p .01

Principal Components

component number	1	2	3	4
component variance	2.34	1.17	0.50	$3x10^{-16}$
cumulative percent	58	88	100	100

Component Indices

variable				
teacher orientation	.267	.602	.698	2.36x10
student-teacher orientation	.362	.004	-1.071	1.99x10
student orientation	.211	-.704	.581	2.21x10
mean score	.426	-.031	.186	-4.27x10

components were in general agreement with the curriculum designers with an extra variable, the degree to which teachers predict they might use many behaviors in a class rather than one single variable (the mean score).

Discussion

The development of a model or a theoretical construct and the verification of that construct have in the past been greatly ignored at the teaching level. Rynaus, saw the development of models as a direction in future research. (1963:416)

> There also has been a significant trend -- not yet of great magnitude but certainly gaining momentum -- toward concern with the theory of instructions and with models of teacher behavior that may provide organizing principles for research. This theoretical orientation should exert an important influence on future research concerning teaching behavior.

This study was an attempt to use a model and to find if that model relates to an underlying construct teachers might have as they view science teaching decisions.

The results of the study, within the confines of the method, indicated that teachers view teaching elementary science depending on the particular situation and consistant with a total philosophy (which in SCIS is the teacher as guide rather an authority).

Three principal components emerged from the teachers responses, two of which were consistent with the SCIS teaching strategy and the third which indicated a new component may help explain teacher behavior. That component, "degree of agreement" may lead to further research to answer such questions as "Do teachers as they become involved in teaching a program perceive more or less agreement with all possible teaching behaviors?" From recent research (Berger 1971) teacher groups involved in activity science programs did exhibit different predicted behaviors when compared to teacher involvement in reading science programs. Would such groups show differences in "degree of agreement" scores?

The major significance of this study was that it was possible to develop a secondary device to measure teacher behavior, that could support other interaction analysis techniques. Such a device was validated against theoretical constructs. Because teachers predicted differing behaviors, curriculum developers can expect and utilize differing behaviors for teachers in their curriculum designs. Most importantly, it may be possible to use such a device to test whether teachers change their predicted behavior based upon education and/or experiences with a new curriculum.

References

Berger, Carl F., "Predictions of Teaching Behaviors by Teachers of Elementary School Science", University Microfilms, Ann Arbor, MI, :72-6459.

Fox, F. and Guire, K., MIDAS, Michigan Interactive Data Analysis System, The Statistical Research Laboratory, University of Michigan, Ann Arbor, MI, 1973.

Medley, D. and Metzel, H., "Measuring Classroom Behaviors by Systematic Observation" Handbook of Research on Teaching, Rand McNally and Co., Chicago, 1963.

Morrison, D., Multivariate Statistical Methods, McGraw-Hill, New York, 1967.

Rynaus, D., "Assessment of Teacher Behavior and Instruction", Review of Education Research, 33, 416-441, 1963.

Scheussler, K., Analyzing Social Data: A Statistical Orientation, Houghton Mifflin, Boston, 1971.

Science Curriculum Improvement Study, Interaction and Systems, Teachers Guide, Rand McNally and Co., Chicago, 1970.

Watson, F., "Research on Teaching Science", Handbook of Research on Teaching, Edited by N.L. Gage, Rand McNally and Co., Chicago, 1965.

DECISIONS IN TEACHING

The film you will watch involves teachers making decisions during the teaching of science. At the end of certain scenes, the film will be stopped and you will be asked about possible decisions that could be made in the scene you just observed.

We would like to know your degree of agreement with each of six possible decisions for each scene. Mark a number in the box on the Answer Sheet which corresponds to your decision.

4 - agree completely
3 - agree somewhat
2 - neither agree no disagree
1 - disagree somewhat
0 - disagree completely

SAMPLE

As an example, a scene might be shown of a chameleon eating a cricket in a classroom terrarium. The question might be:

SCENE 0

How would you justify the chameleon-eating-cricket activity in the classroom?

	ANSWER SHEET SCENE 0
The cricket is not an important animal.	0
This event would normally happen in nature.	
This situation should be avoided; transmit information verbally instead.	
This type of event is important because it stresses the predator-prey relationship on children.	
The activity cannot be justified.	

SCENE 1

The teacher asked the question, "Are <u>all</u> the fish goldfish?" For what reasons would you ask this question in this situation?

To have the children discuss with one another whether or not all the fish are goldfish. ....

To have the children review their observations on the kinds of fish they saw. ....

To elicit from the children the answer that all the fish are not goldfish. ....

To help the children refine and apply their abilities to classify fish. ....

To encourage divergent responses from the children about the many kinds of organisms. ....

To determine the children's knowledge of the types of fish. ....

SCENE 2

The boy asked, "What's the black stuff?" You would:

Have him present his question to the class. ....

List a few experiments he could try in order to find out what the "black stuff" is. ....

Tell him of an experiment in which he could find out what the "black stuff" is. ....

Let him select an experiment from a few he found he found in the book or student manual. ....

Have him ask the other children who were with him at the time of the observation. ....

Tell him the "black stuff" is detritus. ....

SCENE 3

In addition to listening to responses about where the children think the "black stuff" comes from, you would:

Repeat the responses so all the children can hear. ....

Have the children react to each other's responses. ....

Have the children correct each other's responses. ....

Reward all the responses. ....

Use responses to encourage more responses. ....

Correct inaccurate responses. ....

SCENE 4

The children are ready to do an experiment. You would:

Decide on the experiment after the children have presented their ideas for determining the source of the "black stuff." ....

List the children's ideas and let the children decide which to do. ....

Have the children read the experimental design in their books. ....

List a number of experiments and let the children decide from your list of experiments. ....

Tell the children the design of the experiment they are to do. ....

Allow the children to experiment freely to determine the source of the "black stuff." ....

SCENE 5

The children do not agree on the number of containers. You would:

Question the children until a number evolves from the class. ....

Tell the children how many containers they will need. ....

Show the children the number of containers listed in the book or student manual. ....

Allow the children to discuss the problem among themselves and decide. ....

Allow each child to decide on the number of containers he would like to use. ....

List the possible numbers of containers and let the children vote. ....

SCENE 6

The teacher is distributing soil individually to each child. What distribution technique would you use?

Have the children go to stations to get the soil.

Have the children go one at a time to the science kit to get the soil.

Have each child come to you to get the soil.

Walk around the room giving out the soil.

Have monitors go to stations around the class to get enough soil for their groups.

Give monitors the soil for each group.

When the boy asks the teacher what would happen when the vial gets full of fruit flies, you would:

Have him present this question to the class.

List a few experiments he could try in order to find the answer.

Tell him to leave the cap on to discover the answer.

Let him select from a few experiments he found in the book or student manual.

Have him ask the other children around him.

Tell him what would happen.

SCENE 8

The chameleon is being transferred to a terrarium. You would:

Select a child to handle the chameleon. ....

Allow all the children to handle the chameleon. ....

Transfer the chameleon yourself. ....

Ask for a volunteer to transfer the chameleon. ....

Make the chameleon available for any child who wishes to transfer or handle it. ....

Wear plastic gloves and then transfer the chameleon. ....

SCENE 9

After introducing the terms "predator" and "prey", you would:

Have the children question each other on their understanding of the predator-prey relationship. ....

Have the children read textbooks that give examples of the predator-prey relationship. ....

Have the children search for examples of predators and prey from their experiments. ....

Describe examples of the predator-prey relationship. ....

Have the children give examples of predators and prey from their past experiences. ....

Have the children discuss the predator-prey relationships with each other in small groups. ....

TOTALS

☐ A ☐ B ☐ C

ANSWER SHEET

NAME: ____________________

TEST TAKEN AT (CITY): ____________________

DATE: ____________________

SEX Male ☐ Female ☐

AGE 19 - 30 ☐
31 - 40 ☐
41 - 50 ☐
51 - 60 ☐
61 Over ☐

NUMBER OF YEARS TEACHING ☐

PRIMARY (K-3) ☐
INTERMEDIATE (4-8) ☐
SECONDARY (9-12) ☐
COLLEGE ☐

ARE YOU PRESENTLY TEACHING IN

AN OPEN CLASSROOM ☐
A SELF-CONTAINED CLASSROOM ☐

At any time in your career have you returned to teaching after being away for several years?

YES ☐
NO ☐

How long an absence ________ years.

SCENE 9	SCENE 8	SCENE 7	SCENE 6	SCENE 5	SCENE 4	SCENE 3	SCENE 2	SCENE 1
☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐