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ABSTRACT

This issue of "Investigations in Science Education" (ISE) provides analytical abstracts, prepared by science educators, of research reports in the areas of teacher education, learning, and student perceptions. Each abstract includes bibliographical data, research design and procedure, purpose, research rationale, and an abstractor's analysis of the research. Abstracts are clustered by topics investigated. (CS)

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NOTES FROM THE EDITOR

This final issue of Volume 6 of INVESTIGATIONS IN SCIENCE EDUCATION contains reviews of articles grouped into three clusters: teacher education, learning, and student perceptions. The TEACHER EDUCATION cluster contains reviews of articles investigating science educators' perceptions of an ideal science teacher, the philosophical view of science held by preservice teachers, in-service teacher education via television, the effects of teachers' questions on students, and the effects of methods course activities on the performance of teacher interns. The LEARNING cluster contains reviews of two articles, one focused on cognitive development relative to a Piagetian perspective and the second, on the use of advance organizers according to Ausubel. The STUDENT PERCEPTION cluster also consists of the review of two articles merged into one review because both studies were by the same investigator and apparently employed the same procedures.

This issue concludes with four responses to analyses of articles. We have achieved a backlog of reviews and are thus able to pair the critique and its response in the same issue of ISE. We hope that the reader finds the convenience of review and response in the same issue to be of value.

Patricia E. Blosser
Editor

Victor J. Mayer
Associate Editor

TEACHER EDUCATION

1/2

Bybee, Roger W. "Science Educators' Perceptions of the Ideal Science Teacher." School Science and Mathematics, 78(1): 13-22, 1978.
Descriptors--Educational Research; Elementary School Science; Elementary Secondary Education; *Opinions; Science Education; *Science Teachers; Secondary School Science; *Surveys; *Teacher Characteristics; Teacher Education

Expanded abstract and analysis prepared especially for I.S.E. by Eugene L. Chiappetta, University of Houston.

Purpose

The purpose of this investigation was to identify the perceptions of science educators regarding those characteristics that an ideal science teacher should possess.

Rationale

Science teacher educators need a model or an image of what a science teacher should be like. An understanding of these characteristics will assist these educators in their curriculum, instruction, and supervision tasks. Although a notion of an ideal science teacher is abstract, it can be constructed from perceptual methods and result in a set of descriptions that will be both understandable and useful. Members of the Association for the Education of Teachers in Science (AETS) appear to be a valid population from which to gather perceptions relative to the ideal science teacher.

Research Design and Procedure

The data for this investigation were collected during the 1975-76 academic year from a sample of AETS members. Survey material was sent to 343 AETS members and 172 (50 percent) responded. Of the respondents 83 percent were males and 17 percent were females. They ranged in age from 26 to 74 years with a mean of 43 years. Most of the sample were teaching at the collegiate level. A substantial number of them had taught at the elementary level, at the junior high level, or at the senior high level.

A Q-sort procedure was employed to categorize perceptions of the respondents regarding the ideal science teacher. The Q technique is a method of rank ordering objects or ideas and then assigning numerals to the objects for statistical purposes. In the present study the Q-sort had 50 items concerning specific characteristics of science teachers. The respondents were asked to categorize the items into five major categories which were given the following labels: knowledge of subject matter, adequate personal relations with students, adequate planning and organization, enthusiasm in working with students, and adequate teaching methods and class procedures. Each of these five categories had 10 items.

Directions for completing the Q-sort were given in the following manner. First, the 50 items were to be separated into three groups: "most important," "neutral," and "least important." Seventeen items were required for the "most important" group, 16 items for the "neutral" group, and 17 items for the "least important" group. Second, the 17 items in the "most important" pile were to be sorted as follows: two items were to be placed into envelope 1 (representing the highest rank), six items were to be placed into envelope 2 (representing the second highest rank), and the remaining 12 items were to be placed into envelope 3 (representing the third highest rank). Third, the respondents were asked to sort the "least important" category as follows: two items into envelope 7 (representing the least important rank), six items into envelope 6, and 12 items into envelope 5. Fourth, the "neutral" pile was addressed. The respondents were asked to place the three items they most agreed with into envelope 3 and the three items they least agreed with into envelope 5. The remaining 10 items were to be placed into envelope 4.

Each sorted item was then given a number between one and seven to correspond with their respective envelope and rank order. Averages for each item were tallied and the items then keyed back to the five major categories. Averages were thus obtained for each category and a grand mean ranking of categories was computed.

Findings

Science educators perceived "Adequacy of Personal Relations with Students" and "Enthusiasm in Working with Students" as the two most important qualities of the ideal science teacher. Third was "Adequacy of Teaching Methods and Class Procedures." This was followed by "Knowledge of Subject Matter" and "Adequate Planning and Organization" in this order (see Table 1). The graded mean results are shown in the table.

Rank	Category	Grand Mean
1	Adequate Personal Relations With Students	3.75
2	Enthusiasm in Working With Students	3.80
3	Adequate Teaching Methods and Class Procedures	4.03
4	Knowledge of Subject Matter	4.14
5	Adequate Planning and Organization	4.40

When various groups within the sample were compared, there was no significant difference in the ranking, though in a few cases the actual ranking was different. The groups compared were men, women, those with pre-college teaching experience, those without pre-college teaching experience, those indicating major responsibility for elementary methods, secondary methods, foundations courses, curriculum courses and those who taught in-service courses. There was considerable overlapping in these categories. Generally, "Adequacy of Personal Relations with Students" and "Enthusiasm in Working with Students" were ranked first and second respectively. However, Elementary methods and Foundations instructions reversed this order; they placed "Enthusiasm" before "Personal Relations." Women ranked "Methods and Class Procedures" second and "Enthusiasm" third. With the exception of those with no pre-college teaching experience who ranked "Methods" fourth, and women who ranked "Methods" second, the other groups ranked "Methods" third. "Knowledge of Subject Matter" was quite consistently ranked fourth; the only exception being the group without teaching experience below the college level; this group ranked "Knowledge" third. Every group ranked "Adequate Planning and Organization" fifth.

One other comparison was completed in this study—ranking of the five major categories by those indicating interest in various science disciplines. The early results which indicate an emphasis on the personal dimensions of science teaching, i.e. "Personal Relations and Enthusiasm," were generally confirmed. The variations which did occur were aligned with smaller samples and were not significant. The important variations consisted of greater emphasis on "Methods" which was ranked second by earth scientists, environmental educators and those interested in interdisciplinary studies.

Similar studies have been completed with other groups including in-service teachers, pre-service elementary education majors, high school students (average, advantaged and disadvantaged), and elementary children. Science educators' perceptions and the perceptions of these groups were highly correlated. This observation was particularly true for the top ranking categories: "Adequacy of Personal Relations with Students" and "Enthusiasm in Working with Students." With only one exception these two categories were ranked first and second respectively by all groups and in the one exception the two categories were reversed; "Enthusiasm" was ranked first and "Personal Relations" second. While science educators and teachers rank "Adequacy of Teaching Methods" and "Class Procedures" third and "Knowledge of Subject Matter" fourth, the students generally ranked "Methods" fifth and "Knowledge" third. Science educators and teachers were consistent in ranking "Adequacy of Planning and Organization" last while the students' ranking of the category ranged from third to fifth.

Interpretations

The ideal science teacher is a person who effectively coordinates certain personal qualities with skills and knowledge in classroom teaching. This is a person who can "put it all together." The ideal science teacher has a unique ability to adapt knowledge of subject matter, personal relations, planning instruction, enthusiasm for working with students, and employing a variety of teaching methods into his/her teaching. After analyzing hundreds of studies and employing perceptual research methods over a ten-year period, the author concludes that many attributes are essential to good science teaching. Consequently, effective science teaching is a holistic notion. There is probably not a definable characteristic or set of characteristics that constitute effective teaching.

ABSTRACTOR'S ANALYSIS

This research report adds to the fund of investigations employing perceptual methods to identify skills and competencies of good science teachers. It confirms the findings of other science education researchers who have used these methods. For example, one of Bybee's major conclusions is that personal relations is an important dimension in science teaching. Personal relations with students was ranked number one in a Q-sort procedure where science educators were asked to select items relative to the ideal science teacher. Personal relations were also ranked number one by science educators who participated in a Delphi study and who were asked to identify skills important to secondary school science teaching (Chiappetta, et al., 1978). In addition, it was an area ranked number one by secondary school science teachers who were surveyed to determine their perceptions of needed science teacher skills (Chiappetta and Collette, 1978).

Based on recent studies, what do the findings say to the profession regarding the importance of personal relations in the science classroom? At least two statements seem justifiable. First, the 1970s was a decade where individualization and humanism were stressed in education, unlike the 1960s where there was great emphasis upon subject matter. As a consequence, research which assessed the perceptions of educators in this period would most likely report that interpersonal relationships are important in the teaching process. Personalization and openness was a theme of education during the 1970s. Second, personal relations, regardless of the times, are important to teaching science. It is an essential element of teaching and, along with other skills, should be promoted in science teacher training.

There is another major conclusion put forth by Bybee that merits reiteration. The conclusion is that good science teaching requires the integration of many skills, as opposed to one or a few skills. Teaching science is a complex act and it requires great expertise. It necessitates the ability to use many competencies related to areas such as knowledge of subject matter, adequate personal relations with students, adequate planning and organization, enthusiasm in working with students, and adequate teaching methods and class procedures. The notion that many competencies are necessary for good science teaching has been supported by other studies employing the perceptual methods to gain insight into the selection and training of science teachers (Simpson and Brown, 1977).

Researchers have long debated the validity of descriptive versus experimental research in identifying behaviors related to effective teaching. Each type of research has its strengths and weaknesses. The descriptive or the perceptual approach usually produces a list of skills believed to be essential to good teaching with a ranking that emphasizes certain skills, depending on the population involved. The result is a holistic picture of needed competencies. However, this picture presents teacher educators with an awesome task, since the identified skills and knowledge are usually rather extensive. Experimental research on the other hand is more empirically based and investigates links between teacher performance and pupil product, which is precisely what research on teaching must determine. Unfortunately, this approach usually focuses on too few variables, thus losing sight of the total process that is associated with the act of teaching.

The large body of descriptive studies that exists can provide direction for experimental research on science teacher effectiveness. It can be analyzed to identify several teaching skills that have been perceived to be important to science teaching and that need verification in experimental research. It appears that a new era of experimental research is in order. The research should assess the effects of several observable behaviors that should be exhibited by science teachers. These behaviors should be selected from the areas of personal relations, enthusiasm for teaching, teaching methods, planning instruction, and knowledge of subject matter.

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Lamb, William G. "Validation of a Questionnaire Used to Determine a Philosophical View of Science Held by Preservice Elementary Teachers." Journal of Research in Science Teaching, 14: 301-304, 1977.

Descriptors--Educational Research; Elementary Education; *Elementary School Science; *Philosophy; Physical Sciences; *Questionnaires; Science Education; *Teaching Experience; Tests; *Test Validity

Expanded abstract and analysis prepared especially for I.S.E. by William M. Frase, Parkland College.

Purpose

This study was designed to measure the validity of the Views of Science (VOS) questionnaire (Hillis, 1975) for use with preservice elementary education majors.

Rationale

The major assumption identified by the author for this study was that elementary science education students should hold a philosophical view of science consistent with the tentative nature of scientific knowledge.

Research Design and Procedure

Experiment #1

The VOS was administered to a sample of elementary science methods students (N=19) and elementary education graduate students enrolled in a graduate level science education survey course (N=43). Correlation coefficients between VOS score and the number of semester hours of physical science hours taken were consequently computed.

Experiment #2

The VOS was administered to nine separate study groups; biology faculty members (N=6), M.Ed. students (N=15), M.S. in biology students (N=12), senior undergraduate biology majors (N=18), freshman and sophomore undergraduate students enrolled in a general biology course for non-science majors (N=42), high school biology teachers (N=8), junior high school life science teachers (N=6), high school biology students (N=74), and seventh and eighth grade life science students (N=114). An ANOVA was then calculated to compare for significant differences among groups, and t-tests were used for two group comparisons.

Findings

Experiment #1

Neither correlation was significant; preservice = 0.13; graduate = -0.17.

Experiment #2

University faculty members scored significantly higher than all other groups (p=0.01). M.S. students scored higher than all groups (p=0.10 to p=0.01) except undergraduate biology majors (p=0.22). Differences among other groups were not significant.

Interpretations

Lamb infers that the VOS has construct validity as a measure of how tentatively individuals view scientific knowledge, but admits that the questionnaire is more applicable to the individual's knowledge of physical science than of life science.

ABSTRACTOR'S ANALYSIS

The basic premise upon which this research has been based is very sound and is in the forefront of the educational research today. However, the basic problem with the study is that an instrument designed to measure attitudes towards a physical science was used to measure the attitudes and views of individuals in the life sciences. It might have been more appropriate for the researcher to either find a more suitable instrument or reconstruct the VOS by means of an item analysis to meet the needs of individuals in the life and biological sciences.

The idea that elementary teachers are fearful of science and, due to negative (teacher) attitudes, science instruction at the elementary level is of questionable quality is one that has been investigated quite thoroughly in recent years. Unfortunately, efforts are being directed more towards the measurement of attitude as opposed to the modification of negative attitudes.

One possible suggestion for future research might be the validation of other instruments and, in turn, the compilation of either an instrument measuring the attitudes of individuals to all science and/or the compilation of one more suited to the life sciences.

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Piper, Martha K. and David P. Butts. "The Development and Evaluation of a Televised Science In-service Program." Journal of Research in Science Teaching, 13(2): 177-183, 1976.

Descriptors--College Science; Educational Research; Elementary School Teachers; Higher Education; *Inservice Teacher Education; *Methods Courses; *Science Education; *Teacher Education; *Television Curriculum

Expanded abstract and analysis prepared especially for I.S.E. by John E. Lutz, National Technical Institute for the Deaf and Rochester Institute of Technology.

Purpose

According to the writers, the intent of this study was to investigate a televised in-service program as a motivator for teaching science in elementary school classrooms. The research questions posed for the study were:

1. Can a televised in-service program provide the means to adequately prepare teachers to teach science?
2. Following televised in-service instruction, will attitudes toward science and science teaching be changed in a positive direction?
3. If science teaching competencies are acquired and attitudes move in a positive direction, will there be a corresponding increase in science activities being taught in the classroom?

Rationale

The writers cited evidence that science in the elementary school is incidentally or rarely taught. Three areas were identified from the literature as significant influences on the teaching of elementary school science: 1) a teacher's competency to teach science, 2) a teacher's attitude toward science and the teaching of science, and 3) a teacher's past experience. This investigation was an attempt to study these influences on the incidence of elementary science teaching.

Research Design and Procedure

The report described an evaluation of a 14-lesson televised science in-service program developed to train and motivate elementary school teachers to implement Science—A Process Approach (SAPA). The subjects included 76 elementary teachers (K-6) who selected SAPA for their classrooms, but had no previous experience in any elementary science programs. Fifty participants worked in their own schools with color cable TV, while 26 participants worked in their schools with black and white videotape and videotape equipment. Fifteen weekly meetings lasting from 30 to 40 minutes were held during the first school semester. A teacher assistant in each school building distributed needed materials and checked TV equipment for each meeting.

A semantic differential to determine attitudes toward science and science teaching and a science competency post-measure patterned after SAPA's Science Process Measure for Teachers—Form A, were developed, by the writers, for the study. In addition, each participant was asked to submit a weekly record of science teaching activities, and certain demographic information was obtained from them.

Findings

The competency assessment identified 66 teachers who successfully performed 29 or more tasks out of 33 listed on the science competency post-measure. Teachers who attended all of the in-service sessions achieved a higher competency on the post-measure than those who missed one or more meetings. An analysis of the pre- and post-measure of attitudes indicated many positive changes. In addition, as the in-service program progressed, there was an overall increase in the number of science activities in the classrooms. Neither prior science courses taken, years taught, nor grade level taught were related to achievement in science competency and change in attitudes.

Interpretations

The writers' discussion of the findings was brief. They concluded that a science in-service program via television was one method to efficiently make use of educational resources.

ABSTRACTOR'S ANALYSIS

Much is being studied about growth and development during early childhood and the behavioral patterns and attitudinal sets established during those early years. The major assumption for this paper seems to be that interests in science can and should be nurtured during the early years in school. The writers' concern was that science instruction is not readily available during these formative years, and thus children are not given the opportunity to develop early knowledge, attitudes, and skills needed for continued understanding and appreciation of science in the contemporary world. Four supporting articles from the literature provided some evidence to substantiate this assumption. These articles included survey research and authority judgments and represented only a limited sampling of the broader information base available on elementary school science teaching.

Analysis of the report led to the identification of some general concerns about the evaluation study. The first concern was one regarding the adequacy of the study's theory base. A theory base is useful as it attempts to describe the current state of affairs in an area of knowledge, and as it provides the means for predicting future behaviors. Its most useful function, however, is to account for and give meaning to facts and observations. The meaningfulness of research and evaluation is directly proportional to its relationship to what is known as represented by the functioning of theory.

This study limited its references to theory to the three areas identified from the literature as significant influences on the teaching of elementary school science. They seemed to function as assumptions, and the study was shaped by them. Discussion of them, however, as they influenced the study and elementary school teacher motivation to teach science was omitted, thus limiting the report's meaningfulness. The value and power of a theoretical model is to provide a basis for description, prediction, and explanation of events around us. Perhaps more value could have been realized from the study if it had evaluated the validity of these assumptions upon which it was based. The contributions of theory can provide a powerful potential for the remediation of motivational problems toward science teaching.

A second concern was related to the lack of an expressed evaluation design. Both evaluator and decision-maker should be interested in controlling, or at least accounting for, possible threats to the quality of information collected. The investigators did not address this function of evaluation design in their report. It appears, however, that the study represented a one-group pretest-posttest design; thus, reported gains cannot be attributed to the televised inservice lessons. Some kind of control group against which to compare the effects of the televised lessons on the dependent variables is necessary.

Measurement was a third concern. The three questions which framed the purpose for the study were not fully answered because of questions about measurement procedures. Measures used to assess science competency and teacher attitude were designed specifically for the project and required especially careful determination of the worth of the measures. Although it is recognized that measurement of more subjective qualities, such as attitudes, is difficult to obtain, more technical information is needed about the adequacy of the measures used to assess teacher attitudes toward science and science teaching. More complete descriptions of operational definitions for the dependent variables would help clarify measurement activities.

The final general concern was about the discussion section of the report. This section was disappointingly brief and did not address the meaning of the results in terms of the original questions, an explanation of what influences or assumptions could or could not be supported by the study, limitations of procedures and restrictions in generalizability, or suggestions for implementing its findings. It would have been interesting, too, to know more about possible differences in results obtained through the presentations on color cable TV and black and white videotapes, and whether or not motivation to teach science was dependent upon competence and positive attitudes, as suggested.

A recent report by DeRose, Lockard, and Paldy (1979) stated that elementary school science represents a significant problem area. It has low priority in the elementary schools presumably because the relationship between science and other curriculum areas is not apparent to elementary school teachers and their administrators. Perhaps a greater impact can be made upon increasing the incidence of science teaching in elementary schools if science education research, program development, and evaluation could focus on improving the perceptions of elementary school professionals toward the importance and usefulness of science as part of a basic education. In doing this, careful consideration must be given to the design, execution, and interpretation of our research and development efforts.

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Santiesteban, A. Joseph. "Teacher Questioning Performance and Student Affective Outcomes." Journal of Research in Science Teaching, 13 (6): 553-557, 1976.

Descriptors--Attitudes; *Educational Research; Elementary Education; *Elementary School Science; *Instruction; *Questioning Techniques; Science Education; *Student Attitudes; Teaching Techniques

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

Purpose

This attitude study was conducted to determine the effect of different levels of teacher observation and classification questioning performance on student affective outcomes. It was hypothesized that a videotape model would be superior to an audio-tape model, and that both models would be superior to a no-model treatment in the frequency of questions generated.

Rationale

Santiesteban's study examined the effectiveness of two observational learning modalities on the acquisition of observation and classification questioning performance by preservice teachers. This report concerning attitudes toward science instruction is part of the large study.

Several studies were cited that examined the impact of different instructional presentations on the attitudes of students. A report by Rowe concerning wait time and student behavior change was examined. The investigator presented the generalization that if the teacher requires observation and classification of events and objects, the students will acquire these skills and later transfer the skills to other situations. Perhaps students perceive a high frequency of questions by the teacher negatively and perform required behaviors with little or no interest. It was assumed that teachers trained to ask more questions would produce different types of student attitudes toward a lesson. It was also assumed that observational learning or modeling via audio-tape did produce teachers who would adopt the behavior of others.

Research Design and Procedure

The independent variable was the type of teacher questioning model used. Models were audio (A), video (V), and control no-model. Forty-eight preservice elementary teachers were trained to ask observation and classification questions by means of one of these models. Each teacher prepared and taught a 15-minute micro-teaching lesson to three randomly assigned third or fourth grade students. Science—A Process Approach (SAPA) materials were used. The lessons were audio-taped and later analyzed by trained raters. Mean rater reliabilities ranged from .83 to .93.

An attitude measure was the dependent variable. This set of eleven summative-scale items was administered to the 144 children at the conclusion of the micro-teaching lessons. Reliability estimates ranged from .52 to .77.

The overall design of the study be summarized as:

$$
\begin{array}{llll}
R & \_\_\_\_ & X_A & O \\
R & \_\_\_\_ & X_V & O \\
R & \_\_\_\_ & \_\_\_\_ & O
\end{array}
$$

The attitude measure was factor-analyzed to determine if subsets of co-varying variables could be identified. Four factors were extracted and rotated. The factors were (1) lesson enjoyment, (2) naming things, (3) frustration, and (4) learning in small groups. Multivariate analysis of variance (MANOVA) was performed using the factors as dependent variables and the treatment groups as independent variables. Scheffé's test for comparisons of the means was used to determine treatment-group differences.

Findings

Teachers assigned to both the V and A model treatments asked significantly more questions than the control group. Students exposed to the V and A model-trained teachers responded more frequently than children assigned to control teachers.

An $F_{8,276} = 1.37$ was calculated for MANOVA. This was not significant. A univariate analysis of variance indicated that only the frustration factor exhibited significant differences. Subjects that had been taught by the V model teachers scored significantly higher than the control groups. No differences were found between the A and V model treatments or between the A and the control groups. Students perceived the test and micro-teaching task as being difficult.

V-model teachers asked more observation and classification questions and they required the students to manipulate materials more than the control teachers. There were no differences between V and A treatments on the frequencies of observation and classification questions asked.

Interpretation

The investigator stated that levels of teacher observation and classification questioning performance affect student attitude outcomes. The reader is cautioned of a possible Type I error for the significant differences found in factor III.

It is suggested that the asking of high frequencies of questions may yield negative attitudes on the part of some students. Excessive demands for the manipulation of science materials could also produce negative affective responses.

ABSTRACTOR'S ANALYSIS

Several studies were cited that were related to the current investigation. It would be desirable to review the numerous studies compiled by Balzer et al. (1973) in order to further develop a base for the interaction of modeling, micro-teaching, and student attitudes.

The major conceptual contribution of this study may be the thesis that an optimum range of questions and manipulations should be completed within a given time period. Since several elementary science programs encourage questioning and manipulation, the identification of this "range" may be a helpful teaching strategy.

Rigorous analysis was performed on the collected data. Although reliability indices were given for the attitude measure, no indication of validity was cited. Without this information, the credibility of the study is greatly reduced.

What was the sample size? An N = 144 elementary children was given. Since the study was dependent on the teaching-modeling behaviors of 48 preservice teachers, perhaps it would be more appropriate to use "classes" as the sample size which is actually 48.

The A and V model treatments were not explained. What happened in these training sessions? How long were they? How were the models related? Were the models inservice teachers, or preservice teachers? Even with the space limitations imposed by the Journal, it would be helpful to know more about the model treatments.

It was reported that each teacher prepared and taught a 15-minute lesson based on SAPA materials. Were the lessons all the same? If the lessons did differ, how was control maintained concerning the observation and classification type questions? If different groups of children received "different" lessons, the procedure can be questioned.

Each "class" consisted of three children. How realistic is a group of three in extrapolating to classrooms of 30? Since frequency of questions generated was a component of the independent variable, it could be argued that more questions can be generated in a small group than in a larger group within 15 minutes. It would be interesting to try this treatment with a "full size" class to see if the generalization for groups of three apply to a larger group.

A final comment concerning this study relates to the issue of measuring attitude immediately after a treatment. What might be the attitudes of subjects ten days after a treatment when other "strategies" have intervened? How well does a question such as "the teacher was nice" relate to the factor of learning in small groups?

The results of this study tend to support the general contention that levels of teacher observation and classification questioning performance affect student attitudes. Of even greater educational significance is the thesis that asking of high frequencies of questions may yield negative attitudes on the part of some students. This thesis certainly warrants investigation.

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Descriptors--*Educational Research; *Elementary School Science; Elementary School Teachers; *Evaluation; Higher Education; Methods Courses; *Preservice Education; Science Education; *Student Teachers; *Teacher Education

Expanded abstract and analysis prepared especially for I.S.E. by William Capie, The University of Georgia.

Purpose

The study was designed to address two questions: (1) which of five activities used to evaluate interns was most highly related to their standing in the science methods class?, and (2) is there a relation between the classroom teacher's rating of a science lesson and the rating of the campus activities made by the university instructor?

Rationale

Classroom performance is the ultimate goal of methods course instruction. However, in many contexts following students into schools to observe and evaluate student lessons is not possible for university faculty members. It is desirable, therefore, to determine if performance in the classroom is predictable by more convenient on-campus measures and if the in-the-school activities can be adequately assessed by the supervising classroom teacher, a more accessible source of data.

Research Design and Procedures

Forty-six post-graduate interns enrolled in an elective science methods course were subjects for the study. Seven performance measures were used. Four of these related to on-campus components of a methods course: an introductory assignment, construction of teaching aids, preparation of a science resource unit, and teaching a minilesson to peers. A fifth component of the course was the supervising teacher's assessment of a lesson taught to pupils in local schools. The final course standing was used as the sixth variable. The university instructor analyzed the data generated by the supervising teacher to create a seventh variable.

The teacher used the Lesson Evaluation Form (LEF) adapted from Uhlhorn (1968) in assessing the lesson. Twelve general competence items were rated on a 1-5 scale and summed to compute a general competence measure. No validity or reliability data are reported from the original study and no reliability data were included from this work. It is not clear how the university instructor's interpretation of the supervising teacher's rating differed from the teacher's summation data.

Product moment correlations were computed between each variable and all others. In addition, correlations were reported between each variable on the LEF and the total LEF, the university instructor's interpretation of the LEF, and the final course standing.

Findings

All of the variables were significantly correlated with the final course standing. Few correlated with each other, however. Complete data are shown in Table I.

Eleven of twelve LEF scale ratings correlated with the total score and the instructor's interpretation ($r \approx .5 - .7$). Only one of the scales correlated with the final course grade as high as $r = .4$, however.

Table I

Correlation Matrix of Course Activities Used to Evaluate the Science Methods Course

Variables		Science Methods Course						
Name	Number	10	11	12	15	29	35	32
Introductory Assignment	10	1	.206	.076	.062	.038	.026	.288*
Construction of Teaching Aids	11		1	.369	.153	-.056	.078	.554*
Science Resource Unit	12			1	.307*	.247	.122	.888*
University Minilesson	15				1	.164	.272	.496*
University Instructor's Interpretation	29					1	.812*	.447*
Classroom Teachers' Evaluation of 12 items	35						1	.429*
Final in Science Course	32							1

*$p < 0.05$.

Interpretation

Wolfe claims that campus activities are related to the final grade, but that "...connections cannot be drawn" between performance in the classroom and in the university setting. Justifiable concern is expressed for the validity and reliability of the instruments used to assess interns. In conclusion, Wolfe claims, "The university instructor should continue to evaluate the methods class activities and the assisting teacher, the act of teaching in the classroom."

ABSTRACTOR'S ANALYSIS

The role of school activities in preservice methods instruction is an area of grave concern in many campuses. These activities are time-consuming, difficult, and they make great demands of the personnel and material resources of school and university. But field experiences do have the ultimate relevance.

Given the obvious pertinence of the teaching activity, it is difficult to imagine why emphasis in this study was directed toward correlations with the final course grade. It seems that the question is "Do campus performances predict field performances?" Either way, the answer is "probably not," given the measures used in this study.

Wolfe points out a major problem in interpreting the correlation matrix. The final course evaluation was computed from five of the other variables. Therefore, when one of these five was compared to the final evaluation it was being correlated with itself! The problem may be confounded further in that these types of measures are frequently weighted unequally in a course context. If this is so in this case, more heavily weighted subscores would correlate more highly with the total. (Note that a resource unit did correlate highly ($r = .88$) with the final.)

A better procedure in situations like this one is to correlate one variable with the sum of the others. I suspect that the high correlations would be lost if this were done.

The instrument reliability problem is critical. The low reliability of individual items from the LEF may account for their inability to predict the course grade, while their sum does a somewhat more adequate job.

Interrater agreement is another dimension in using the rating scale. Often raters will produce results with satisfactory measures of internal consistency, but with low levels of agreement. (For example, I have done work where groups rated a videotaped lesson using a series of 1-5 scales and found Cronbach Alpha to be in excess of .8 but interrater agreement below 40 percent.) A problem with the procedure in this study is that no training of teacher raters was done. Although university instructor and teacher agreed on the interpretation of the ratings ($r = .81$), there is no testimony to their accuracy.

Perhaps, most puzzling is Wolfe's claim that the professor should evaluate on campus and the supervising teacher in the classroom. I see little justifiable basis for that position in this research. A system whereby supervising classroom teachers assess intern competence for the university professor has a strong appeal, but adequate instrumentation and training in its use are a long way off.

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LEARNING

Boulanger, F. D. "The Effects of Training in the Proportional Reasoning Associated with the Concept of Speed." Journal of Research in Science Teaching, 13: 145-154, 1976.

Descriptors--*Concept Formation; *Educational Research; Elementary Education; *Elementary School Science; General Science; Instruction; *Ratios (Mathematics): Science Education

Expanded abstract and analysis prepared especially for I.S.E. by Anton E. Lawson, Arizona State University.

Purpose

Applying "mediation" theory (Flavell and Wohlwill, 1969) to the development of proportional reasoning, the present study asked whether instruction of concrete operational children in the proportional reasoning associated with the concept of speed would enhance reciprocally the development of proportional reasoning in a more general set of tasks characteristic of the formal operational stage.

Rationale

The study is one of the increasing numbers of studies attempting to determine effective ways of increasing students' understanding and use of key components of formal operational reasoning as so designated by Piaget's theory of intellectual development. It is not only assumed that proportional reasoning is a key aspect of scientific reasoning and necessary for understanding concepts such as speed, but that effective teaching of such reasoning to elementary school students is difficult, if not impossible, due to its dependence on the prior acquisition of less complex reasoning skills and its intimate relationship to a whole host of reasoning skills acquired during the latter formal operational stage.

It is further assumed that, if effective ways of teaching such reasoning can be identified, we will not only have acquired procedures for the teaching of certain scientific concepts but that we will have identified important ways of advancing scientific reasoning in a more general sense. Mediation theory was proposed as a possible guide for the development of such effective teaching procedures.

Research Design and Procedure

One hundred five third-grade children enrolled in three middle-class Seattle elementary schools were administered a screening test to identify concrete operational subjects. Fifty-one of the 74 concrete operational subjects thus identified were randomly assigned to three groups of 17 subjects each ($\bar{x}$ age = 8 years, 10 months). Assignments were stratified by classroom.

The first treatment group designated the Training and Comparison Group was trained in the proportional reasoning associated with converting a distance and elapsed time into a statement of speed followed by a set of speed-comparison problems which appeared in subject workbooks.

The second treatment group, designated the Comparison-Only Group, received no direct training in proportional reasoning. Distances traveled and elapsed times were demonstrated and related to the illustrations in the workbooks but the distance-time pairs were not related to the concept of speed. Subjects were then given speed-comparison tasks identical to those in the Training and Comparison Group. No assistance was given in solving the problems.

The training and comparison treatment required 55-60 minutes of individual instruction given on three successive days. The comparison-only treatment required 45-50 minutes of individual instruction given on two successive days.

The same physical apparatus was used in both treatment groups to demonstrate speed comparisons. Subjects were tutored from a script. The third group served as a non-instructional control group.

Immediate and delayed posttests which each included 12 multiple-choice retention items were administered to all three groups. The delayed posttest was administered three weeks following instruction. All items required comparison of ratios where both distances and times were different followed by this question: Which object moved faster or did they both move at the same speed?

Immediate and delayed transfer items were also administered during the posttesting. Content varied, but the numbers and operations needed for problem solution remained the same. Two remote transfer tasks based upon Piagetian tasks were also administered. The tasks involved a comparison of speeds and distances traveled by a bicycle and car and by rolling spheres.

Findings

Analysis of variance was used to determine significant group differences followed by Scheffé's Test where appropriate. The Training and Comparison Group and the Comparison-Only Group showed similar group means on all posttest tasks. In general these were slightly higher than the Control Group's means. However, on the Piagetian remote transfer tasks the Control Group's means were similar or slightly higher. In only two cases group differences reached statistical significance ($p < .05$). The Training and Comparison Group scored significantly higher than the Control Group on the immediate retention items while the Control Group scored significantly higher than the Training and Comparison Group on the immediate administration of the second remote transfer task.

Interpretations

The Training and Comparison Group's superior performance on the immediate retention items indicates that training was successful, yet the three groups' similar performances on the delayed test indicates that the positive effects of training were almost completely lost within three weeks. The finding that the Comparison-Only Group performed slightly worse than the Training and Comparison Group on the retention items but slightly better on the transfer items suggests that the conflict experienced by the latter in not being given a solution strategy had a stronger residual effect. Since group differences failed to reach significance, this differential effect must remain a hypothesis. The relatively poor performance of the training groups on remote transfer task one showed that training had not resulted in the acquisition of any generalized ability to use proportions. This was interpreted to be consistent with Piaget's view that such a general acquisition normally does not appear until formal operations at around 11-12 years of age.

The Control Group's significantly better performance on remote transfer task two which required compensation operations was interpreted as an indication that direct training on proportions can interfere with the concrete operational child's normal use of compensatory operations at least within the same conceptual area.

ABSTRACTOR'S ANALYSIS

The experimental design and statistical procedures employed were appropriate. Sufficient care seems to have been taken to insure the validity of the results in terms of potentially confounding variables such as experimenter bias and non-equivalence of treatment groups. It should be cautioned, however, that group sizes of 17 are certainly at or near the lower limit one would want to go in trusting the laws of random assortment. The results appear to have been interpreted satisfactorily within the Piagetian framework and reveal interesting and important, yet not novel, conclusions. Aside from this, the report leaves considerable ambiguity concerning the application of mediation theory to the experimental treatments involved. This, I believe, makes a thoughtful interpretation of the study's importance extremely difficult. I would like to raise the question as to whether cognitive mediation was really involved at all. Allow me to expand upon this by first providing some needed background information about Flavell and Wohlwill's "implicative and nonimplicative mediation patterns" of the acquisition of cognitive abilities referred to by Boulanger as their "mediation theory." This background information was not provided in Boulanger's report.

Flavell and Wohlwill (1969) considered the acquisition of two cognitive abilities designated as A and B. Four patterns of acquisition of these abilities were discussed. First A and B may be unrelated such that the order of their acquisition varies from individual to individual, e.g., although a child's initial coherent image of the president may coincide in time with his acquisition of number conservation, no cognitive relationship exists between the two.

Second the relationship between A and B may be one of substitution where A emerges first and functions to guide behavior. Then B emerges and preempts A's function. A and B may be cognitively unrelated except that they function in the same task domain, e.g., the preoperational child's perceptual mode to conservation tasks is preempted by the concrete-operational child's inferential approach.

Third A and B may be related by "implicative mediation" such that A develops first, then B develops with A forming a cognitive subset of B. The use of B always and necessarily implies the exercise of A, e.g., the concrete operations of classification and seriation are necessary prerequisites (subsets) to the identification of proportional relationships among the variables so identified. In fact concrete operations, in general, are necessary prerequisites for formal operations.

Fourth A and B may be related by "nonimplicative mediation" whereby the advent of A helps mediate the subsequent acquisition of B yet this mediative role is not assumed as in the previous case, e.g., the ability to multiply or coordinate height and width relations may play an important, yet not necessary, mediation function in the child's conservation of liquid quantity. The function is not a necessary one since other paths to conservation may exist. Nonimplicative mediation further opens up the possibility that B may develop first and mediate the development of A. As Flavell and Wohlwill point out, nonimplicative mediation implies that there can be alternative developmental paths to a given cognitive product and all children may not acquire the same things in the same ways.

Which of these mediation patterns, implicative or nonimplicative, did Boulanger attempt to apply? Although he did not specify, it is probably safe to assume that he was attempting to apply the nonimplicative pattern since he mentioned reciprocal stimulation of cognitive acquisitions and he cited Bearison's study (1969) in which the nonimplicative pattern was hypothesized to be functioning to produce the observed experimental group gains in conservation. But did one or the other of Boulanger's treatments really involve nonimplicative mediation? I do not think so. First, what two cognitive acquisitions was he studying? I can only identify one, and that was the ability to apply the schema of proportions. As Boulanger put it, the study asked whether or not instruction in the proportional reasoning associated with the concept of speed (presumably one cognitive acquisition) would reciprocally enhance the development of proportional reasoning in a more general set of tasks (another cognitive acquisition?). But why should it? How does mediation theory apply?

The issue, as I see it, is not one of some other cognitive acquisition either mediating or being mediated by the proportional reasoning associated with the concept of speed, but the facilitation of the generalizability of this reasoning from one context (e.g., the comparison of ratios of distance/time) to many contexts. This is a problem of abstraction, not one of acquisition. Thus no mediation, implicative or nonimplicative, may have been involved. In effect Boulanger's major treatment amounted to teaching students how to set up ratios, to reduce them to some common standard (lowest terms?) and to compare resulting numbers. These abilities are no doubt necessary to successfully employ a general proportions schema but it is by no means clear that they are sufficient to mediate its development. And why did Boulanger have two different treatments? How do they relate to the theory? The report did not say.

Boulanger's treatment did draw attention to some quantity or indicator property that would permit a reliable comparison. In this sense it is related to the idea of a measurement strategy used by Bearison (1969) in which nonimplicative mediation presumably was operating. But that is where the similarity stops. In Bearison's study the subjects were not initially facile at quantitative measurements. They did not have a "quantitative set" as they were all preoperational at the experiment's outset. Presumably they did have a quantitative set in Boulanger's study as his subjects were all concrete operational. The crucial aspect of Bearison's training was that it strengthened subjects' use of the quantitative set and thereby provided them with a viable and powerful cognitive acquisition that would preempt their earlier perceptual set. In other words they could begin to imagine transformations in terms of discrete countable units of volume, area, length, etc. rather than rely solely on perceptions, e.g., it looks bigger so it is bigger.

Bearison reasoned that the acquisition of this quantitative set (acquisition A) reciprocally mediated the acquisition of the logical operations associated with the conservation (acquisition B), the logical operations being evidenced by statements such as: it's taller but wider so it's the same; or, you have not added any clay or taken any away so it's still the same. But again how does this relate to Boulanger's treatments? If in fact the reduction and comparison of ratios was the new cognitive acquisition then practice at this may in fact facilitate the development of proportional reasoning. As Inhelder and Piaget (1958, p. 310) claim, the capacity to organize the schemata can become manifest when required by the nature of the problems to be solved. But research indicates that this is a lengthy and difficult process, one which we would not expect to happen in the course of a few short treatments--especially for third grade children.

Now, of course, it is possible that Boulanger's experimental treatment did involve some implicative or nonimplicative mediation as just described. If they did, however, the written report did not make this clear. In short, Boulanger's written report would have been strengthened considerably by a careful exposition of its theoretical rationale and how the treatments did or did not follow that rationale. Only then can an adequate assessment be made of the study's relationship to other studies in the area and to future research questions.

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Kahle, Jane B. and John J. Rastovac. "The Effects of a Series of Advance Organizers in Increasing Meaningful Learning." Science Education, 60(3): 365-371, 1976.

Descriptors--Academic Achievement; Biology; *Biology Instruction; *Educational Research; *Instruction; Learning; *Science Education; *Secondary School Science

Expanded abstract and analysis prepared especially for I.S.E. by Jerie Robertson and Marcia C. Linn, Lawrence Hall of Science.

Purpose

Kahle and Rastovac investigated the effect of a series of advance organizers on learning of materials in biology.

Rationale

The concept of advance organizers comes from the work of Ausubel (1968) who viewed organizers as a set of "generalizable, encompassing ideas which may be introduced to the learner prior to a learning sequence." Although Ausubel (1968) and Kuhn and Novak (1970) have reported that advance organizers have increased learning on a short term basis, it is unclear whether instruction using advance organizers will continue to foster learning from subsequent instruction in the same content area. The authors also suggest that research has not clarified the long term effects of advance organizers (e.g. Kahle and Nordland, 1975; Ausubel and Fitzgerald, 1969). The present study examines learning when a series of advance organizers and biology lessons are presented but does not examine the long term effects of advance organizers when no instruction intervenes.

Research Design and Procedure

Subjects. One hundred sixteen ninth and tenth graders enrolled in six introductory high school biology classes were individually randomly assigned to either an experimental or control group.

Materials. Subjects were presented three sequentially-arranged lessons in genetics. Presentation was by audiotape accompanied by printed study guides. Each lesson included behavioral objects and quizzes. No details of these lessons are reported. These lessons were preceded by an organizer or historical narrative, neither of which contained any information covered in the actual instructional unit. Achievement was measured by a summative final examination which was a 30 item, four-alternative, multiple choice test. All materials including the organizers, narratives, lessons and examinations were developed by the authors.

Procedures. The study was conducted during a three week period in which experimental group subjects received an advance organizer immediately preceding each lesson while the control group received a historical narrative immediately before each lesson. Each group received behavioral objectives, quizzes and the summative evaluation measure. The timing of these events was not described.

Findings

1. Several analyses were conducted to determine whether there was an effect for the class during which subjects received biology instruction. No effects for classes were found, so subsequent analyses were conducted comparing all experimental subjects to all control subjects.
2. Statistically significant differences ($p < .05$) between the experimental and control group on the summative evaluation measure were found.

Interpretations

The following conclusions were drawn:

1. Meaningful learning was greater for the group receiving the advance organizers and the genetics units than for the group receiving the historical narrative and the genetic units.
2. The organizers provided an overview to which the sequentially presented factual information contained in each unit could be related.
3. An inference was that the organizers provide a cognitive structure which facilitates the assimilation of new material.

ABSTRACTORS' ANALYSIS

The research reported in this study is focused on an important aspect of instruction. This is a preliminary study, it reveals general effects of advance organizers but does not document specific effects. For example, no attempt is made to demonstrate why advance organizers are effective or which students benefit from advance organizers. The authors cite a number of previous research studies using advance organizers in conjunction with learner characteristics which suggests that they will investigate learner characteristics in the reported research. In addition, the reviewed research suggests that long-term effects of advance organizers may differ from immediate effects but long-term effects are not investigated (e.g. no delayed posttest is used). Perhaps the authors will report the data on the relationship between learner characteristics and advance organizers collected in this study in another publication.

We have four major questions about the study:

1. *Why was a historical narrative chosen as a critical competitor to the advance organizer?* In what way is the historical narrative a control for the advance organizer? The authors did not describe the differences between the advance organizers and historical narratives and therefore it is not known what characteristics of the advance organizers lead to the improved performance on the summative evaluation. From the reported

results we do not know what makes an advance organizer work or how to design another advance organizer with the same characteristics.

2. *Why were the materials used in the study not described?* We cannot determine the validity of the materials because insufficient information is given. The authors report that validity was established by submitting materials to experts. Few details of the procedures for selecting the experts were reported; the reactions of the experts and the criteria utilized to evaluate the materials were not given. Since many readers of this type of article are also "experts," examples of the advance organizers, teaching materials and test items would give the reader an opportunity to participate in establishing validity. Much of the reported tabular material could be summarized in a few sentences, thereby providing space for describing materials without lengthening the manuscript.

3. The rationale of the study was to determine the effects of a series of advance organizers interspersed in three lessons on retention of learned material. *We question the design employed in this study.* This hypothesis could have been tested either by comparing each lesson or by comparing performance on summative items for the first lesson with performance on summative items for the third lesson. Increases for the single posttest employed in the study could be due only to increases on the third lesson taught, not to all three lessons as the authors infer.

4. According to the authors, response to advance organizers is frequently mediated by learner characteristics, *why was available data on age, sex, and achievement not used to predict performance?* Analysis of the relationship between learner characteristics and performance would be useful for indicating the generalizability of the results and for grading subsequent research into detailed effects of advance organizers.

5. While we consider collapsing on classes a reasonable strategy in this research, *why were the reported data and statistical procedures used to justify the decision?* For example, why did the authors use two one-way analyses of variance to investigate the effect of the class variable on performance? A two-way analysis would have given the same information, plus indicating whether or not the class variable interacted with treatments.

Conclusions

Research on learning from instructional procedures such as were used in this study is very important for educators. This study offers some directions for future researchers. More detailed and comprehensive studies must now be done. It is not known how other advance organizers could be constructed which would foster learning now it is known what type of learning occurred as a result of the advance organizer. From a theoretical standpoint, the authors hypothesized that the organizers would provide a more efficient cognitive organization of the information in the instruction than the historical narrative, but it is not clear how this took place. Thus, the theory cannot be elaborated from the results of this study.

In order to enhance the effectiveness of this type of research for educators, future studies should employ more specific designs. Answers to questions such as, "What aspect of the organizer resulted in what specific gains on the evaluation measure?" would guide design of advance organizers. In addition, possible interactions between the organizer and the sequence, content, and presentation of the instruction need to be investigated. Possible interactions between instruction and learner characteristics need scrutiny. Studies designed to elaborate this kind of understanding would be of great benefit to science education.

(Discussion with Steven Pulos, Cathy Clement, Christine Bradford, and Elizabeth Stage is appreciated.)

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STUDENT PERCEPTIONS

45/46

Lawrenz, Frances. "Student Perception of the Classroom Learning Environment in Biology, Chemistry, and Physics Courses." Journal of Research in Science Teaching, 13(4): 315-323, 1976.

Descriptors--Biology; Chemistry; *Classroom Environment; Educational Research; *Perception; Physics; *Science Education; *Secondary Grades; Social Environment; *Secondary School Science

Lawrenz, Frances. "The Prediction of Student Attitude Toward Science From Student Perception of the Classroom Learning Environment." Journal of Research in Science Teaching, 13(6): 509-515, 1976.

Descriptors--Attitudes; *Classroom Environment; *Educational Research; *Prediction; Science Education; *Scientific Attitudes; *Secondary Education; Secondary School Science; Student Attitudes

Expanded abstract and analysis prepared especially for I.S.E. by Thomas P. Evans, Oregon State University.

These two investigations are reviewed together because of the similarity in their procedure. The data in both reports apparently came from a set of data collected as part of a National Science Foundation evaluation project (grant GW-6800).

Purpose

The purposes of these investigations were as follows: (1) t examine student perception of classroom learning environments in secondary school biology, chemistry, and physics classes in light of student interest and (2) to examine how well biology, chemistry, and physics students' attitude toward science can be predicted from student perception of the classroom learning environment.

Rationale

The investigations were predicated on a notion that the perceived classroom environment might influence affective outcomes. Earlier researchers had reported finding relationships between the perceived classroom environment and cognitive outcomes. Robinson (1969) had pointed out the possibility that differences in perception existed betweem physical and biological science classes. The need to examine the extent and effect of these differences had been previously noted by Shulman and Tamir (Travers, 1973). Ahlgren (1969), Kaphingst (1971), Mackay (1970), and Pella and Sherman (1969) had reported declines in student interest in science resulting from participation in science classes with the losses being more pronounced in physical than in biological science classes. The investigator felt that if differences in student perception of the classroom learning environment did exist, they might possibly be related to student interest in science.

Procedure

The investigations were conducted using a large-scale experimental design described by Gullickson and Welch (1971). Secondary schools within strata of urban-rural were selected from three midwestern regions that included Mississippi, Alabama, South Dakota, North Dakota, Nebraska, Minnesota, Iowa, Wyoming, Colorado, Utah, Idaho, and Montana. The participating schools represented 60 percent of those contacted. The principal in each school used a table of random numbers and selected one biology, chemistry, or physics teacher. The teacher, in turn, randomly selected one of his/her classes and administered the following criterion instruments: Learning Environment Inventory (LEI) (Anderson, 1971, 1971a), Test of Achievement (TAS) (Lawrenz, 1971), and Science Attitude Inventory (SAI) (Moore and Sutman, 1970). The instruments had been randomly ordered before being mailed to the teacher, who simply followed directions resulting in the random assignment of instruments within the class. Thus, students within each class completed different instruments simultaneously, and administration of instruments was completed within one class period. The final sample in both investigations consisted of 238 science classes. This included 83 biology, 113 chemistry, and 42 physics classes in the first investigation and 84 biology, 113 chemistry, and 41 physics classes in the second investigation. Whether this difference reflected a real difference in data collection or an error in reporting could not be determined from the reports or references.

The LEI had 10 scales and was purported to measure student perception of the classroom learning environment. The scales included Diversity, Formality, Friction, Goal Direction, Favoritism, Difficulty, Democratic, Cliqueness, Satisfaction, and Disorganization. The research reports made no mention of the number of items making up each scale, but references (Anderson, 1970, 1971), cited by the investigator pointed out that each scale contained seven statements. Each statement was scored on a four-point basis from strongly agree to strongly disagree.

Student attitude toward science was measured with the SAI. It consisted of 60 Likert-type items scored as agree strongly, agree mildly, disagree mildly, or disagree strongly. The items related to 12 position statements emphasizing intellectual and emotional attitudes toward science (Moore and Sutman, 1970).

The TAS was used to measure student achievement in science. It contained 45 multiple-choice items compiled from the National Assessment Test for science.

Student scores on the 10 LEI scales served as dependent variables, and achievement, as measured by the TAS, served as independent factors in the investigation that examined student perception of the social learning environment. It was stated that achievement measures were included because they helped to insure group comparability, increased the power to identify differences, and allowed for an examination of interactions. In the second investigation, student scores on the LEI scales served as independent variables, while student attitude toward science served as dependent variables.

Overall differences in student perception of the classroom learning environment were tested using F-statistics from a multivariate analysis of variance. Differences among the science courses for each LEI scale were examined using univariate F-statistics. Newman-Keuls multiple comparisons were made on the combined means of those scales that revealed a significant difference among the science courses. A discriminant function analysis was completed to determine the best discriminating scales for course effect. The predictability of student attitude toward science from student scores on the LEI scales was ascertained through the use of stepwise multiple-regression analysis.

Findings

The findings reported by the investigator were as follows:

1. students' perception of their learning environment was significantly different ($p < .01$) in the three science courses;
2. achievement level and type of science course did not significantly interact ($p < .26$);
3. significant differences among the courses were found for Diversity ($p < .01$), Formality ($p < .01$), Friction ($p < .01$), Favoritism ($p < .01$), Difficulty ($p < .01$), Democratic ($p < .01$), Cliqueness ($p < .01$), Satisfaction ($p < .02$), and Disorganization ($p < .05$);
4. the combined mean scores for biology rated highest followed by chemistry and then physics on the Diversity, Formality, Friction, Favoritism, and Cliqueness scales;
5. the combined mean scores for physics rated highest followed by chemistry and then biology on the Democratic and Satisfaction scales;
6. the combined mean scores for chemistry rated highest followed by physics and then biology on the Difficulty scale and lowest on the Disorganization scale;
7. the best discriminating scales for course effects were Difficulty, Friction, and Formality;
8. the Friction and Cliqueness scales successfully discriminated among all three classes;
9. the 10 LEI scales successfully predicted 29-39 percent of the variance in student attitude toward science;

10. the Favoritism scale was shown to be the best predictor of biology students' attitude toward science;

11. the Friction scale was found to be the best predictor of chemistry students' attitude toward science; and

12. none of the scales were shown to be good predictors of physics students' attitude toward science.

Interpretations

In the first research report, the investigator concluded that the perceived classroom learning environments in biology, chemistry, and physics classes were different, and that the best discriminators were student perception of classroom difficulty and friction. These discriminators were cautiously suggested as having had some influence on student interest in science. The investigator pointed out, however, that the perceived differences in classroom learning environments may not have been the result of course effects. They could be attributed to other sources such as sampling, maturation, selection, and comparability.

In the second report, it was concluded that a relationship appeared to exist between student perception of the classroom learning environment and student attitude toward science. The relationship between student perception of the learning environment and student attitude in chemistry and biology classes was more highly correlated than student perception of the classroom learning environment and student attitude in physics classes. Students in classes perceived as having little internal conflict were more likely to have positive attitudes toward science. Students in challenging chemistry classes tended to be more positive in their attitude toward science while the reverse was true in biology classes.

ABSTRACTOR'S ANALYSIS

The investigations, or investigation as the case may be, were well-conceived and carried out in a fairly unique manner. The large-scale experimental design was particularly interesting and has a great deal of potential for use by other researchers in the field. The outcomes were extremely thought provoking, especially finding differences between student perception of the learning environment among the different types of science classes. The fact that the investigator recognized and reported the possibility of alternative explanations for these differences was commendable and revealed her understanding of the research design. Nevertheless, the differences did exist, and their causes provide an area in need of further research. Such a finding brings into question, as indicated by the investigator, the common practice in research of combining chemistry, biology, and physics classes and treating them collectively as science classes.

An equally thought-provoking outcome of the investigations was the suggestion that differences in students' perception of classroom difficulty provided the most logical explanation of students' loss of interest in science after participating in science classes. Chemistry and physics classes were perceived as being more difficult than biology classes and, according to other researchers, had the greatest loss of student interest in science. Generating such a hypothesis by combining the results found in the investigation to a body of existing research was laudable. This is something that is not done frequently enough in research reports. The fact that these two sets of findings occurred did not prove a cause and effect relationship, but the possibility of such a relationship certainly seems possible on *a priori* grounds. The procedure illustrates a model of reporting outcomes for other researchers to follow, and the hypothesis should provide impetus for an array of additional investigations.

Although the investigations were well-conceived and the outcomes thought-provoking, the research reports left something to be desired for several reasons. First, it could not be ascertained with any certainty whether or not the investigations were part of one larger investigation or were two separate investigations. The reports would have been greatly improved if this information had been given and cross-referenced. In all fairness, Lawrenz did refer to the first investigation in the second article, but only to mention that student perception of the learning environment varied with the science taught. She did not mention whether or not it was part of a larger investigation. This is not a criticism concerning the separation of larger investigations, involving more than one problem, into smaller units for reporting. Such a practice is actually desirable in many cases, because separating the problems should allow more details of the overall investigation to be presented, especially if, for example, one report places emphasis on the procedure while the second concentrates on instrumentation. The reports by Lawrenz were confusing, because they were not properly cross-referenced, and both provided similar and partial descriptions of the procedures and instrumentation.

Second, the large-scale design, including the methodology for obtaining the sample of schools and randomized data, was not readily discernible from the research reports. The design represented one of the outstanding features of the investigations and would have provided a useful guide for other researchers. It is true that references to the design were given, but one of the major references describing the selection of the schools was a mimeographed paper. The paper was apparently later published as a university research report. No doubt a copy of one of these documents could be obtained, but it would require considerable time as many university libraries would not have copies on file. The research reports would have made a greater contribution had they included a more complete description of the design and accompanying methodology. If a lack of space prevented a more complete description, it could have been provided by possibly eliminating in one of the reports one of the identical tables of the LEI scales and cross-referencing the reports.

Third, the research reports did not contain an adequate description of the LEI, and descriptions of the instrument in the available references were not consistent with the descriptions provided in the research reports. Lawrenz referred to two publications by Anderson (1970, 1971) in the first research report and one by Anderson (1971) in the second research report. The 1970 reference was not to the LEI *per se*. It was concerned with the relationship between cognitive outcomes and student scores on the LEI. In this publication, the LEI consisted of 14 rather than 10 scales. Intimacy, Speed, Environment, and Apathy were the scales not included in the investigations by Lawrenz. The 1971 reference described the LEI as having 15 scales; the additional scales being Cohesiveness, Speed, Environment, Apathy, and Competitiveness. Actually the scales in the two references were different by three scales, i.e., Intimacy, Cohesiveness, and Competitiveness. The 1971 publication also referred the reader to the 1970 publication for evidence of the LEI's validity, even though the two forms of the instrument were different. This is a very questionable research practice and caused the reviewer to wonder about the validity of the 10 scale LEI used by Lawrenz. Was an earlier form of the instrument evidence for its validity? In addition, some of the scales used by Lawrenz had slightly different definitions from similar scales used in the earlier publications. These inconsistencies in the available references, coupled with the extremely brief descriptions of the LEI provided by Lawrenz, were confusing and detracted from the research reports.

Some of the confusion concerning the LEI could possibly have been resolved had the reference by the investigator Anderson (1971a) been available and had the investigator listed the references as 1971a in both reports. This latter point was undoubtedly a typographical error as both reports contained two 1971 publications by Anderson. Apart from the confusion, however, the reports should have devoted more attention to the LEI as an instrument was not widely known in the field, and the manual was a Canadian publication and not readily accessible.

In conclusion, the investigations were well done and thought-provoking, with the large-scale design being particularly noteworthy. The research reports, however, were not as skillfully done. Several deficiences of the reports were pointed out along with suggestions for improvement. The investigations evoked a large number of questions in need of further study. The following are suggested as areas for future research.

1. Is there a cause and effect relationship between student perception of the classroom learning environment and student attitude toward science?

2. What causes students to have different perceptions of their classroom learning environment?

3. How does student perception of the classroom learning environment compare to the teacher's and/or various learning psychologists' perception of the classroom learning environment?

4. Do similar types of students perceive the same classroom learning environment in the same way?

5. How does student perception of the classroom learning environment compare to systematic observation of classroom learning environments?

6. What is the relationship between student perception of classroom difficulty and students' interest in science?

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RESPONSES TO ANALYSES

A RESPONSE TO THE ANALYSIS OF

Boulanger, F. David. "The Effects of Training in the Proportional Reasoning Associated with the Concept of Speed," by Anton E. Lawson. Investigations in Science Education, 6(4): 31-38, 1980.

by

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Lawson's criticism that the report did not sufficiently explain Flavell and Wohlwill's (1969) mediation theory and the theory's relationship to the study treatments is fair and accepted. However, sufficient information was provided that the knowledgeable reader could consult the references provided and accurately fill in the details. Lawson did just that and correctly inferred that the study was an attempt to apply Flavell and Wohlwill's nonimplicative mediation theory cited by Bearison (1969). The doctoral dissertation (Boulanger, 1973) on which the published article was based considers in detail the Bearison study and the mediation theory, both of which have been adequately summarized in Lawson's abstract and analysis. I disagree, however, with Lawson's claim that nonimplicative mediation theory applied to Bearison's treatment but not to the treatment employed in this (speed) study. My defense of this position follows.

Nonimplicative mediation means there is a plausible but not a necessary role to be played by one cognitive acquisition (in this case training in the concept of speed which involves proportions) in support of the acquisition of another cognitive acquisition (rates of change in novel situations). Implicative mediation means one acquisition is prerequisite to another. Implicative mediation is not involved in this study, since the transfer tasks did not require as prerequisites knowledge or skills taught in either version of the instructional treatment.

As in the Bearison study, this (speed) study involved nonimplicative mediation between a quantitative set and logical structure. Bearison's quantitative set was induced counting of subunits to show invariance of quantity when perceptible dimensions might suggest otherwise to the preoperational subject. The quantitative set in the speed study was induced counting of length or distance subunits per unit of time to show invariance of a second order or derived quantity (speed) when perceptible dimensions, distance or time in this case, might suggest otherwise to the concrete operational subject. In both studies, the attempt was made to use quantitative analysis to overcome perceptually induced errors of judgment during quantitative comparisons. Both experiments prompted the subjects to begin to acquire the elements of a new schema which required the subject, in the simpler case, to be aware of the relative number of subunits in two perceptually different arrangements; and, in the more complex case, to be aware of the relative ratios of two subunits in two perceptually different situations. This later schema is very similar to Lawson's (1978) "for every" schema, which is closely related to the schema of proportions.

Lawson's conclusion that, in fact, no mediation, implicative or non-implicative, may have been involved is empirically supported by the results of the study. The hypothesized mediation did not occur in that the cognitive acquisitions which could have provided evidence of mediation were not observed as a consequence of the primary Training and Comparison Treatment. Training in the quantitative concept of speed through this treatment was effective only on an immediate retention basis. Non-implicative mediation was apparent, however, through the Comparison Only Treatment where direct training in the quantitative speed ratio was not present.

The Comparison Only Treatment showed weak but measurable effectiveness in mediating the acquisition of other rate comparison skills. The mediation was nonimplicative in that the learning involved in the Comparison Only Treatment was not prerequisite to the novel tasks but was related to the tasks through the quantitative set required for solution. This quantitative set was not directly taught as in the primary treatment but was induced through repeated exposure to speed comparison problems requiring the set for correct solution, followed by immediate, very graphic demonstrations of each speed comparison outcome. The child had to "discover" the set in this version of the treatment.

In summary, I agree with Lawson's criticism that the mediation theory was inadequately presented in the published article. I disagree with his criticism that the nonimplicative mediation hypothesis as applied in Bearison's study is less applicable to the speed study. The difference, I believe, is one of level of application in the Piagetian stage sequence: Bearison's being at the preoperational-concrete operational transition whereas the speed study applied the mediation theory at the concrete-formal operational transition. The other difference, of course, is that Bearison's study showed a substantial effect in support of the hypothesis, whereas the speed study resulted in a weak effect by the secondary treatment. Potential reasons for this later difference are many. Among them are age and stage position of the subjects, length of the treatment, instrument precision, and low statistical power due to the small sample size.

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IN RESPONSE TO THE ANALYSIS OF

Hall, John R. "A Study of the Teaching of Elementary Chemistry," by Ann C. Howe. Investigations in Science Education, 6(2): 35-39, 1980.

by

John Ruthven Hall
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I consider Ann Howe's critique of my article of 1976 in the Journal of Research in Science Teaching to be fair and certainly support her plea for more studies of the kind I reported. Indeed, I do my best to encourage my master's degree students (mostly serving teachers) in this direction. I have conducted a larger-scale investigation of the role of visual schemes in integration of ideas, which sprang from some of the observations in the earlier research. This has produced some interesting findings and, to my mind, confirms the value of the small-scale study. Results of this larger investigation are as yet unpublished, but a preliminary report to the Social Sciences Research Council (SSRC) is deposited in the British Lending Library.

With regard to Dr. Howe's resume of my article, this seems to me an excellent summary, but I note that in her second paragraph (last sentence) the impression might be gained that the Nuffield Scheme provides "very little guidance" to students in the learning of concepts, whereas my original statement, from which this derives, refers specifically and only to the introduction of the notion of chemical change. I [illegible] be sorry if it were thought that I was making some general critici[illegible] the Nuffield Scheme.

A further small point, the third paragraph on page 2 ought to begin, "The oral test of conservation . . ." so making it clear that there was only one oral test in the procedure.

IN RESPONSE TO THE ANALYSIS OF

Kahle, Jane B. and John J. Rastovac. "The Effects of a Series of Advance Organizers in Increasing Meaningful Learning," by Jerie Robertson and Marcia C. Linn. Investigations in Science Education, 6(4): 39-44, 1980.

by

Jane Butler Kahle
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Three general criticisms of the article need to be addressed: first, the lack of supplementary materials such as copies of the organizer, of the historical narrative, and of the units; second, the nature of the organizer and the type of learning it effected; and, third, lack of attention to the relationship between learner characteristics and the effect of the organizer.

As stated, the experimental period was three weeks. During that time three advance organizers and three historical reviews were presented along with three instructional units, including tape scripts and study guides. The total package of printed materials was approximately 100 pages; it was not feasible to print enough of these materials to illustrate the package. The authors have sent copies of the organizer, review, and instructional materials upon request, which is the accepted manner of facilitating an indepth study. They concur that copies of the experimental materials would strengthen most articles and hope that editors and publishers will agree also.

Concerning the second question, the authors state that "each organizer provided an overview to which the sequentially presented factual information...could be related." Furthermore, the historical review was used because it is the standard means for establishing control in studies of advance organizers.

The last analysis in the article was directed specifically toward analyzing the type of learning affected by the use of an organizer. It was demonstrated that the summative evaluation items were discriminating and assessed higher levels of learning. This analysis was considered crucial; for often any effects of advance organizers are lost due to inadequate evaluation measures.

Third, earlier, cited work dealt with research by the authors and others on the relationship between learner characteristics and the effects of an advance organizer. The purpose of this paper was to analyze "the effect of an organizer on meaningful learning with sequentially structured learning materials."

IN RESPONSE TO THE ANALYSIS OF

Wolfe, Lila F. "Correlations Among Course Activities used to Evaluate Elementary Science Teacher Interns," by William Capie. Investigations in Science Education, 6(4): 23-27, 1980.

by

Lila F. Wolfe
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Professor Capie's abstract and analysis of my study presents issues with which I would agree and to which I referred in my study. Unfortunately, he has taken a number of statements out of the context of the original report and used those as a basis for some of his arguments.

In the abstract, Professor Capie interpreted one of the claims of my study as follows: "Wolfe claims that campus activities are related to the final grade, but that...connections cannot be drawn between performance in the classroom and in the university setting." The inaccuracy lies in the manner in which these two statements have been put together. On page 159 of the study I state: "Product-moment correlations were computed (Table 1) and revealed that all the component activities of the science methods course were significantly related ($p < 0.05$) to the final science course evaluation." The emphasis has been added to indicate that I refer to all activities which include both campus experiences as well as the field performance and not just the campus activities as interpreted by Capie. Further, on page 161 of the study, my statements read: "This presumption, based on the internship program, was not borne out. The results illustrate that when examining specific performance of student teachers in the university setting and in the school classroom connections cannot be drawn." Thus, in spite of assumptions usually made about the value of internship programs, in this case, correlations could not be found between the two sets of activities.

It was further interesting to note that Professor Capie did not consider my suggestions for bridging the gap between these activities (p. 162) when he puzzled over my assertion that university professors should "continue" to evaluate the campus activities and the supervising teacher should continue to assess classroom teaching. My assertion was made in the light of the suggestions which were not considered in either the abstract or the analysis.

Professor Capie finds a problem with instrument reliability and with the correlation of the variables. Both problems are acknowledged and discussed in the study. The main issue is not to look for high correlations between variables or even the predictability of the variables, rather it is to examine whether the field experience relates with the campus activities. In this case they do not. The need to train supervising teachers in the use of the Lesson Evaluation Form remains. However, it may be time to place more professional confidence in teachers' ability to assess teaching competence rather than trying to establish related criteria between university and school teaching practice.