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ABSTRACT

This issue provides abstracts and analyses, prepared by science educators, of research reports in two areas of investigation. The first, student characteristics, includes three reports which deal with student interests, attitudes, and values. The second, teacher characteristics, also contains three reports. These studies deal with teachers' characteristics and values, and students' perceptions of teacher characteristics. Finally, there are three other studies including a study of locus of control, a study of student understanding of the nature of science, and a survey of teacher and pupil perception of the Nuffield Physical Science course. Each abstract includes bibliographic data, research design and procedure, purpose, and research rationale, along with the abstractor's analysis. (BB)

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NOTES . . .

from the Editor

This issue of INVESTIGATIONS IN SCIENCE EDUCATION contains two clusters of reports. The first, STUDENT CHARACTERISTICS, includes three reports which deal with student interests, attitudes, and values. There are also three reports included in the second cluster, TEACHER CHARACTERISTICS. The studies deal with teachers' characteristics, values, and students' perceptions of teacher characteristics. Finally, there are three studies included as INDIVIDUAL STUDIES. These include a study of locus of control, a study of student understanding of the nature of science, and a survey of teacher and pupil perception of the Nuffield Physical Science course.

Stanley L. Helgeson
Editor

Patricia E. Blosser
Associate Editor

STUDENT CHARACTERISTICS

Gardner, P. L. "Attitudes of PSSC Physics Students: Relationship with Personality and Teacher Behavior." The Australian Science Teachers' Journal, 21(1):75-85, 1975.

Descriptors--Educational Research; *Physical Sciences; *Physics; Science Education; Science Course Improvement Project; Secondary Education; *Secondary School Science; *Student Attitudes.

Expanded Abstract and Analysis Prepared Especially for I.S.E. by Rodney L. Doran, State University of New York at Buffalo.

Purpose

The study described herein "set out to investigate the relationships between pupil personality, teacher behavior and pupils' attitudes to physics."

Rationale

This study is one of an international family of investigations exploring a wide variety of factors related to low enrollments in, and negative attitudes toward, science. While many of the other studies correlated pupil or teacher variables with pupil outcomes, the predictor variables were not used simultaneously, thereby missing "the complex interactions which may exist between pupil and teacher variables." Furthermore, previous studies frequently utilized class means as the unit of analysis presenting the detection of relationships where pupil characteristics act as moderator variables. In other words, "teachers might exert varying and perhaps even opposing effects on different kinds of pupils within their classes." This study is part of a continuing research interest of the investigator.

Assessment of the pupil and teacher variables was based on the "needs—press model" of Murray (1938) and Stern (1970) which suggests that "human behavior may be understood in terms of an interaction between aspects of personality ("needs") and relevant aspects of the social environment ("press").

Research Design and Procedure

Instruments

The criterion variable, pupil attitude toward physics, was assessed by an investigator-constructed Physics Attitude Index (PAI), a 40-item Likert-type instrument, yielding scores on four attitudes: (1) towards non-authoritarian modes of learning, (2) towards physics as an open, flexible dynamic discipline, (3) towards scientists, and (4) towards personal enjoyment of physics.

The predictor variables were based on the earlier-mentioned "needs-press model." Eight needs scores from Stern's Activities Index (Achievement, Conjunctivity, Deference, Play, Understanding, Order, Nurturance, and Energy) formed the Personal Preference Index (PPI)—the pupil variable. The teacher variable was assessed by the Physics Classroom Index (PCI), developed especially for this project. It contains "eight press scales which correspond to these needs: (1) Competitiveness, (2) Organization, (3) Compliance, (4) Pleasure, (5) Intellectualization, (6) Compulsiveness, (7) Warmth, and (8) Stimulation." The author chose these variables "because it was thought that they might be related to one or more of the attitudes measured by the PAI." A description of each scale and illustrative item from the PPI and PCI were included.

Sample

The students surveyed in this research were Grade 11 students in Australia "taking the first year of a two-year course based on the PSSC materials." To minimize the extraneous effect of variables such as home background and school facilities, "the sample was restricted to pupils in co-educational state high schools situated in regions at above median socio-economic status in the Melbourne metropolitan area." Complete data sets were available on a total of 1014 students (798 boys, 216 girls) in 58 classes from 34 schools.

Data Collection and Analysis

The PAI was "employed as a pre-test and eight months later as a post-test" while the PPI and PCI "were given as mid-tests." "A 4 x 4 analysis of covariance design, with an unweighted means adjustment for unequal cell frequencies, was devised to analyze the data." Classes were assigned into quartile groups (very high, high, low, or very low) based on class mean scores on each scale at the PCI. Similarly, students were divided into four groups (very high, etc.) based on their scores on the PPI scales. The covariance design was used to make inferences about the effects of combinations of teacher and pupil variables (the PPI and PCI scales) on "pupils' post-test attitude, over and above any effects which could be ascribed to attitudes already present at the start of the course." The investigator accomplished this type of analysis "32 times in order to study the effects of eight needs-press combinations on each of the four attitude variables."

Findings

"Of the 64 possible main effects, 25 were significant beyond the .05 level, and of these 18 were significant beyond the .01 level." The author described some of the findings in the article, while further details can be found in other reports [illegible] has written. The results were discussed in terms of the teacher and pupil variables affecting each of the four components of the PAI.

Non-authoritarian learning

Teacher behavior variables (PCI scales) were found to have "little effect" on pupils' attitudes to this mode of learning. It was reported that there was a "weak inverted-U-shaped relationship between attitude scores and teacher compulsiveness." Three student personality variables were found to be significantly related with "non-authoritarian learning": Play, Understanding and Nurturance.

Openness

This attitude toward physics was significantly related with only one teacher variable (Competitiveness) and two pupil variables (Achievement and Nurturance).

Scientists

The attitudes of students toward scientists were related strongly to only two student variables (Deference and Nurturance).

Enjoyment

The PAI scale "displays the richest harvest of significant findings, and nearly all the predictor variables are involved." The author concluded that "In general, intellectually intense pupils—those who are serious, intellectual and achievement-motivated—and pupils who are warm and deferent tend to enjoy physics more; intellectually stimulating teacher—those who are intellectual, cognitively well organized (high on Conjunctivity), stimulating and achievement-pressing, and whose classrooms are physically well organized—tend to be associated with greater enjoyment."

From the analysis of the data, it was concluded that non-decline in "Enjoyment of Physics" during the school year was accomplished only with about 6 percent of the sample. This involved the most intellectually stimulating teachers with the most intellectually intense students. All other teacher-student combinations experienced a decreased enjoyment of physics as a result of the year of instruction.

Interpretations

Favorable attitudes toward "non-authoritarian modes of learning" (PAI scale) were concluded to be present more with students who were serious, intellectual, achievement-motivated, warm and outgoing. These modes of learning work best with students who are cooperative and competent, so these results were not surprising.

Views of physics as an "open" discipline were associated with students who were highly achievement-motivated, warm, and friendly. "Apparently, warmth toward other people and receptivity to new ideas are related qualities." However, "achievement-pressing teachers (high on competitiveness) tend to promote a more closed view. Apparently, teachers who place heavy stress on achievement, success, and examination performance are less likely to maintain the highly open attitudes that most of the students have on entering the course."

Pupils who are "warm and friendly, and who are more likely to be submissive and conforming are more likely to regard scientists with affection and tolerance."

"Enjoyment" of physics was related to many variables with some complex interaction patterns. For instance, "highly achievement-pressing teachers exert a beneficial influence on the achievement of highly achievement-motivated pupils, but a relatively deleterious effect on the enjoyment of pupils who are very low in achievement motivation."

Further interactive effect was noted for teacher "Pleasure" and pupil "Play" on "Enjoyment of Physics." Generally, "playful" pupils enjoy physics less than do "serious" pupils (low preference of play). "Teachers in the top three quartiles on Pleasure have no influence on enjoyment, but teachers in the lowest quartile (very serious teachers) exert dramatically opposing effects upon the enjoyment of serious and playful pupils." Specifically, "very serious" pupils with "very serious" teachers indicate great "enjoyment of physics," while "playful" pupils with "very serious" teachers expressed very little enjoyment of physics. The author used these findings to support the earlier claim that "studies of curricular outcomes which fail to consider pupil personality variables and which employ class means as the units of analysis may well miss finding lawful relationships between teacher characteristics and pupil attitudes. Had only class means been considered, no relationship between teacher Pleasure and Enjoyment would have been found: the correlation between the class means was near zero."

The author found that the magnitudes of the teacher behavior and pupil personality effects found in this study were "much larger than the effects associated with different curricula." Admitting that teacher behaviors are difficult to change, the author suggested that attempts to improve pupils' enjoyment of science courses should concentrate more heavily on teacher education than upon instructional materials.

ABSTRACTOR'S ANALYSIS

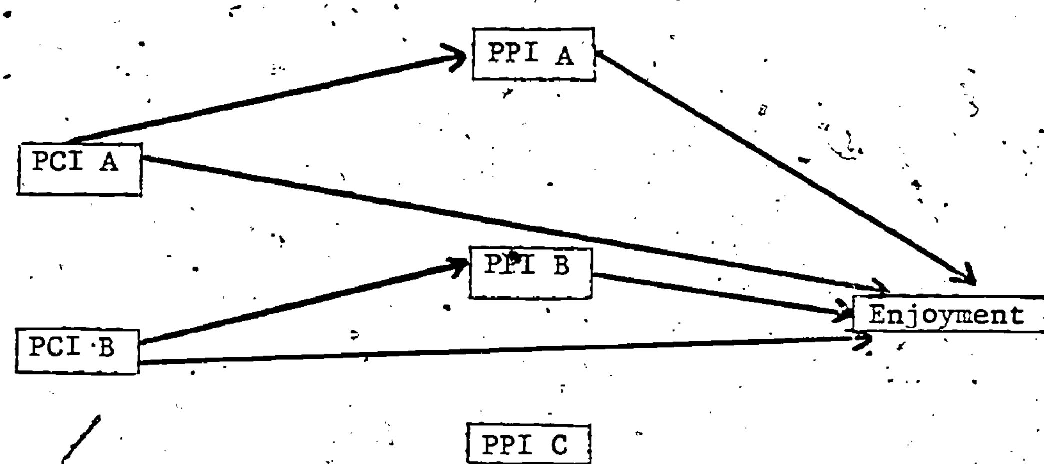
Concern by educators about students' interest in and attitude toward science, scientists, and school science courses is laudable. Investigating human behavior is indeed a complex, multi-dimensional problem and must be explored in that manner. The author reviewed a wide variety of literature which related many variables to the science enrollment/attitude phenomenon. Choosing a theoretical framework to guide the conceptualization of key variables is a move widely suggested by educational researchers. The extensive sample also distinguishes this study from many others which have been conducted. However, one must be simultaneously aware of the danger that such large samples allow relatively small effects to be determined as statistically significant. No statistics were presented in this article so the reader is unsure of the possible functional and educational significance of the findings.

Analyses which are sensitive to individual student's performance and preferences is appropriate for much of educational research. Such a design carries with it the commitment to plan educational experiences so that these idiosyncratic traits are addressed meaningfully in the classroom.

A major problem in all educational research relates to the instrumentation which we utilize to test hypotheses, formulate conclusions, and suggest implications. The criterion variable (PAI) in this study is an investigator-developed 40-item attitude scale, used in the analyses as four separate scales (apparently 10 items each). These scales were described in an earlier article by the investigator and no information was included here as to their validity or reliability. Nor were illustrative items provided. As the earlier article was in this same journal, it can be assumed such was provided there. While it's hard to know much about the PAI from its description, it seems to be missing the idea of science as a way of solving problems and as a major effect on modern societies and personal lives.

One of the predictor variables, the PPI, contains eight needs scales taken from Stern's Activities Index. The reader is not sure if validity and reliability are retained when portions of assumedly valid and reliable measures are used in isolation. The other predictor variable, the PCI, was devised by the investigator to assess "eight press scales which correspond to the needs..." Sample items from each of the PPI and PCI scales were included with a definition for each scale. No mention was made of the reliability or validity of either scale or of Stern's index. The number of items per scale was not mentioned, but one can infer that there were ten items per scale as one of the sample PPI items was No. 76.

Even with the sample size obtained, it seems questionable to use parametric analyses with attitude scales as both the predictor and the criterion variables. Multiple classification with a X^2 statistic would likely allow the same kinds of comparisons with much fewer waived assumptions. Another approach would be to use factor scores from factor analysis of the PAI, PPI, and PCI separately. The investigator apparently used this technique as he reported that "factor analysis reveals that these personality variables (Achievement, Ploy, Understanding) all lie on one factor." Such consolidation would simplify both the analysis and resulting conclusions. Relationships among fewer predictor and criterion variables may also help and connect this research to other studies. One parsimonious way of representing and testing such relationships would be by using the Path Analysis technique. A model could be constructed with the PCI variables as influencing the PPI variables and the criterion variable and the PPI variables influencing only the criterion variables. The following sketch might be an example for the hypothesized relationships among two PCI and three PPI variables and the PAI "Enjoyment" scale.



With the extensive sample, one could use one random half of the data to help empirically develop the model (substantiated with theory and past research findings) and use the other half to test the validity of the model.

Such a conceptualization could accommodate other variables as deemed appropriate and could be used as a point of reference for subsequent investigations. Many other variables have potentially some relevance to this domain of behavior. For instance, the investigator reported some sex-linked findings. Similarly, he admitted that there were some "potentially influential variables such as school facilities and home background" which were eliminated from consideration in this particular study.

Because of the 16 interrelated predictor and four criterion variables, the discussion section was complex and not conducive to clear cut implications for classroom application. As a matter of fact, the major implication was to concentrate on teacher education to improve pupils' enjoyment of physics.

The investigator claimed that the teacher behavior and pupil personality efforts detected in this study "are much larger than the effects associated with different curricula." Not knowing which curricula these are, it seems appropriate to suggest some areas to pursue with further research. As this study was with students in the first year of a two-year curriculum, it seems obvious to pursue the second year group with similar assessments and also with students that may have only completed the first year. Comparisons could also be made with data from students who are of the same age in the same school but who choose not to enroll in physics. If physics is considered an "advanced" course, comparisons could be extended with data from students in other "advanced" classes.

As educators, we must explore which key variables relate to major outcomes of the school science programs, including those from the affective domain. It is hoped that this study is viewed as a stepping stone to broader knowledge and understanding.

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Descriptors--Educational Research; *Interests; *Secondary School Students; *Science Education; Secondary Education; Secondary School Science; *Student Characteristics

Expanded Abstract and Analysis Prepared Especially for I.S.E. by Ronald D. Simpson, North Carolina State University.

Purpose

The purpose of this study was to determine the influence of selected variables on the development of student interest in science. The variables included instruction, student, home and social factors.

Rationale

The investigator of this study presents two concerns relevant to the interests of students toward science education. First, he states that science is a basic component of the general education of all individuals in today's world. Second, he states that the manpower demands of science and technology are such that many people are needed to fill vital positions in these fields. In both cases, effective science teaching should be geared to stimulate interest among students toward science. Science educators should be aware of important variables that influence the development of science interest.

The author cites research that permits one to conclude that interest in science seems to be related to sex, science achievement, attitudes toward science, mechanical and abstract reasoning abilities, and practical hobbies (Bingham 1967-68; Meyer, 1970; and Neujahr and Hansen, 1970). He also cites research that suggests that student interest in science is more strongly influenced by teachers' personalities and value systems than by their training, teaching experience, and science background (Rothman, et al., 1969). Finally, the investigator indicates that student interest in science can be fostered through instruction, although less is known about the interaction among instructional, cultural and motivational variables (Ramsey and Howe, 1969).

This study was designed to test the following null hypotheses:

Hypothesis 1. There is no over-all difference between students with high interest in science and students with low interest in science on the following instructional variables: motivation of science teachers, motivation of school science textbooks, and participation in extra-curricular science activities.

Hypothesis 2. There is no over-all difference between students with high interest in science and students with low interest in science on the following cultural variables: father's level of education, mother's level of education, and number of science hobbies practiced by families from which students come.

Hypothesis 3. There is no over-all difference between students with high interest in science and students with low interest in science on the following outer motivational variables: career the father desires for the student, attitude of parents towards science and science careers, and social desirability of science and science careers.

Hypothesis 4. There is no over-all difference between students with high interest in science and students with low interest on the following inner motivational variables: student's evaluation of his science abilities and future career desired by the student.

Research Design and Procedure

A total of 340 eleventh grade science students was randomly selected from four major high schools in Jordan for this study. Ages of the students ranged from 16-19 years. There were 166 boys and 174 girls in the sample.

Instruments measuring science interest and the other variables under study were administered at the beginning of the 1971-72 scholastic year. Based on scores on the science interest scale, male and female students were each divided into three groups: high, medium, and low. The highest and lowest 27 percent-scoring students on the interest scale were studied as subjects with high and low interest in science, respectively.

The science interest scale consisted of 40 triad statements. (In the report the word "traid" was found but the abstractor assumes this was meant to be "triad.") The scale measured student preference for science topics, school science lessons and activities, and leisure-time science activities. The validity of this scale was obtained by selecting items that discriminated between science and literary students in the eleventh grade. [In Jordan students, upon completion of the tenth grade, are branched into two courses of study, science and literature (arts).] Split-half reliability estimates for the scale ranged from .88 to .98.

In addition to measuring science interest, the investigator also collected data on the other variables mentioned in the hypotheses by means of questionnaires, checklists, and rating scales. The questionnaire consisted of personal and family questions. The rating scales measured students' standings on the following variables: 1) motivation of science teachers, 2) motivation of school science textbooks, 3) motivation of parents, 4) social desirability of science, and 5) ability to succeed in science. With eleventh grade students, reliability estimates using the Kuder-Richardson 20 ranged from .50 to .83.

The science teacher motivation rating scale consisted of 14 items designed to measure students' perceptions of their science teachers' interest and concern toward their (students') learning of science.

The school science textbook motivation rating scale consisted of nine items designed to measure students' evaluations of a science textbook on characteristics such as readability, clarity of presentation, logical organization, and the degree it provoked questioning and inquiry.

The parent motivation rating scale was comprised of four items measuring students' perceptions of parental encouragement for their (students') studying science.

The social desirability rating scale consisted of eight items measuring students' perceptions of the importance of science to individuals and society.

Finally, the student science ability scale consisted of six items that attempted to measure students' perceptions of their own abilities to understand science, solve science problems and conduct science activities.

The checklists were designed to include lists of activities and hobbies frequently enjoyed by middle-class secondary school students in Jordan.

The research design of this study was constructed in order to determine whether there were significant differences between students with high and low interest in science on each of the four groupings of variables stated in the four hypotheses. Mean vectors of scores for high and low interest groups were compared using Hotelling's T^2 test of significance (Anderson, 1966). Mean scores of both groups on every variable in that grouping were compared using the t-test. Differences between groups were said to be significant when they were at the .05 level of confidence or lower.

Findings

For the male science students in this study, null Hypotheses 1, 3 and 4 were rejected. In the case of the female science students, null Hypotheses 3 and 4 were rejected. Acceptance or rejection in this case was based on results of the multivariate t-test-Hotelling's T^2 test.

The groupings of variables, <u>instruction</u>, <u>outer motivation</u> and <u>inner motivation</u> differentiated significantly between high interest and low interest male groups. The <u>outer motivation</u> and <u>inner motivation</u> groupings, on the other hand, differentiated significantly between high and low interest groups in females.

A subsequent table (IV) in this report revealed a summary of scores of the two interest groups obtained by male students on the variables of each of the three groupings found to differentiate significantly different between the high and low interest groups. In order to help the readers of this paper understand more clearly the results of this section, Table IV is reproduced at the end of this analysis.

Two of the three variables of <u>instruction</u>, motivation of science teachers and student participation in extra-curricular science activities, were found to differ significantly between students with high and low interest in science. Only one variable from the <u>outer motivation</u> grouping produced a difference. Both variables under <u>inner motivation</u>, career desired by the student and the student's ability in science, were significantly different between high and low interest groups.

Table V shows means, standard deviations, differences and significance levels relative to the high interest and low interest female groups and is included, likewise, so that readers of this analysis can view more clearly the results. Career desired by parents, social desirability of science, career desired by student, and perception of science abilities differentiated significantly between the high interest and low interest groups.

Interpretations

Stated in the null form, it was hypothesized in this study that students with high interest in science did not differ significantly from students with low interest on several variables related to four groupings: instruction, culture, outer motivation and inner motivation. As can be seen, some of the variables were significantly different between the two interest groups and some were not.

Male students with high interest in science 1) participated in more science activities, 2) had a better image of their science ability, 3) rated their science teachers as better motivators, 4) had more desire to follow a career in science, and 5) had parents who exhibited more desire to see them follow a career in science than did students with low interest in science.

Female students with high interest in science, moreso than females with low interest, 1) had parents who exhibited a desire to see them follow a science career, 2) perceived science and scientists as socially desirable, 3) possessed a good image of their science capabilities, and 4) had a desire to follow a career in science.

None of the cultural variables examined in this study differentiated significantly between high and low science interest students. One can conclude from this that among these students in Jordan, both males and females with high interest in science came from families whose educational levels did not differ from those of families from which students with low interest in science came.

While the variables, student's career desired by parents, career desired by student, and student's perception of science ability, operated on both male and female students, other variables appeared sex-dependent. Motivation of science teachers and student participation in science activities were different only among male students. Conversely, the social desirability of science variable was different only among female students.

The author of this study concluded that if the development of science interest is desirable, then one can, on the basis of this study, pinpoint the most suitable characteristics of the secondary school science program. The author continued by saying that this program is one in which science teachers are concerned with students' questions, science readings and activities, vocational choices, and a program in which they show personal interest in the science learning of their students. In addition, it is a program that includes a component on the social importance of science, encourages students to participate in appropriate science activities, and also helps students develop confidence in their abilities to study science.

ABSTRACTOR'S ANALYSIS

This study adds additional information to a rapidly growing area of research in science education. There is increasing evidence that affective characteristics of students influence what and how they learn science, as well as other subjects in the curriculum.

While attitude studies have burgeoned, surprisingly few investigations have been reported specifically on student interest in science. In this study, student behaviors that appear to be influenced by student interest in science have been analyzed. In addition, selected demographic variables such as parents' educational level and career of father have been correlated with student interest in science. The results of this study, then, shed light on student interest and several relevant variables thought to be related to interest.

The author of this report chose to study student interest in science by first grouping both males and females into "high" and "low" interest groups. This was accomplished by administering a science interest scale consisting of 40 "triad" statements. While the format of the scale is not clear from the report, the instrument had successfully discriminated between science and literary students in Jordan, hence a case for validity was claimed. Reliability estimates ranged from .88 to .98 suggesting that the responses of the eleventh grade students from Jordan in this study to this scale were inconsistent.

The other variables were classified into four groups: instructional, cultural, outer motivational and inner motivational. The author did not refer to any of the variables in this study as being independent or dependent in function. In attempting to examine the nature of these variables it appears that they can be categorized in such a manner. When <u>interest in science</u> is considered as an <u>independent variable</u>, something students already have that influences how they behave, some of the remaining variables appear as <u>dependent variables</u>—the subsequent <u>outcomes</u>. The variables in this study delineated as instructional and inner motivational variables fall into this latter category. They are the behavioral and perceptual outcomes that were measured in this study and are potentially influenced by interest in science.

The variables grouped as cultural and outer motivational do not fit as dependent variables. They are, for the most part, phenomena already present. When one considers interest in science as a dependent variable, an outcome instead of an influence, then the cultural and outer motivational variables function as independent variables. They are the background characteristics, the influences, that appear to affect a student's interest in science.

In studies where relationships are sought between variables, it is helpful to build research models that allow one to speculate toward possible cause and effect relationships. In studying <u>student interest in science</u> we should be concerned with two questions. First, how does interest in science affect the cognitive and affective behavior of students enrolled in science? The other question is: How do background variables—the attitudes, values and knowledge that students and their families already possess—affect student interest in science? Interest in science, then, is both an independent and a dependent variable. It is potentially both a cause and an effect.

I found this study well organized and clearly written. While I would have preferred reading more information about the contents of the various instruments used, the rationale, procedures and results of the investigation were communicated in an excellent manner and the major ideas could be assimilated with ease. Before studies like this one can be synthesized and the results woven into the work of others, it is necessary to construct models that allow us to speculate about cause and effect relationships. The investigator, by failing to include independent and dependent relationships, did not develop a context into which these variables and findings can be placed. Multiple regression analyses and other correlational techniques would have produced more information about certain of the relationships studied here and would have made it possible to estimate the amount of variance accounted for between the different groups of variables.

While the author's findings were not cast in terms of dependent or independent variables or in terms of correlations allowing for speculation of cause and effect relationships, he states in the final paragraph: "If the development of science interest is desired, then one can, on the basis of this study, pinpoint the most suitable characteristics of the secondary school science program." The author continues:

> It is a program in which science teachers are concerned with students' questions, science readings and activities, and vocational choice, and in which they show personal interest in the science learning of their students. In addition, it is a program that includes a component on the social importance or science, encourages students to participate in appropriate science activities, and also helps students develop confidence in their abilities to study science.

I do not feel that, on the basis of this study, such a conclusion is justified. These statements imply that these <u>characteristics</u> of a school science program have been found to be <u>independent variables</u> affecting student interest. In other words, the implication is that in this study "Teachers concerned with students' questions, science readings and activities" and the other instructional variables found to differentiate significantly between high and low interest students actually <u>caused</u> the differences in interest. While data from this study offer evidence that selected variables correlate highly with interest, the design of the study and the statistical procedures used do not allow one to say these variables produce high interest in science.

This study is a valuable contribution to the research in this field. The study contains an identification and grouping of several variables relevant to the potential development of science interest in students. The investigator cautioned against generalizing the findings of this study to North

America due to potential cultural biases. I would agree, but, at the same time, suspect that many of the relationships found here would be similar in other countries, including the United States. This represents a ripe area for investigation. By building models whereby the variance of selected independent variables can be studied in light of relationships with relevant dependent variables, researchers will be able to get closer to the question of cause and effect. Multiple regression techniques and path analyses are among the promising analytical tools for studying these relationships.

TABLE IV

Comparison of Scores Obtained by Male Science Students with High and Low Interest in Science on the Variables Indicated

Variable	High $\bar{x}$	High SD	Low $\bar{x}$	Low SD	Diff	P.
Instruction:						
Motivation of teacher	5.73	3.81	3.04	2.81	2.69	.002
Motivation of science textbook	3.53	1.77	3.20	2.07	.33	NS
Participation in extra-curricular science activities	2.71	1.58	1.42	1.34	1.29	.002
Outer Motivation:						
Motivation of parents	2.58	.69	2.25	.98	0.33	NS
Career desired by parents	.86	.35	.46	.50	0.40	.002
Social desirability of science	4.31	2.05	3.55	2.12	.76	NS
Inner Motivation:						
Career desired by student	.73	.45	.40	.49	0.33	.002
Perception of science abilities	3.22	1.49	2.02	1.56	1.20	.002

TABLE V

Comparison of Scores Obtained by Female Science Students with High and Low Interest in Science on the Variables Indicated

Variable	High $\bar{X}$	High SD	Low $\bar{X}$	Low SD	Diff.	P.
Outer Motivation:						
Motivation of parents	2.36	.70	2.38	.69	.02	NS
Career desired by parents	.93	.42	.22	.26	.71	.002
Social desirability of science	2.75	2.32	2.60	1.92	1.15	.02
Inner Motivation:						
Career desired by student	.62	.49	.11	.32	.51	.002
Perception of science abilities	3.06	1.74	1.62	1.53	1.44	.002

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Descriptors--Attitudes; Educational Research; Elementary School Students; *Elementary School Science; Science Education; *Self Concept; *Student Attitudes; *Teacher Behavior; Teacher Role

Expanded Abstract and Analysis Prepared Especially for I.S.E. by Chester E. Raun, Temple University.

Purpose

The investigators identify the purpose of this study as an effort to explore student self-concept in relationship to two specific strategies for teaching elementary school science. Two hypotheses, related to instrumentation used, are referred to in the body of the report. These are, as synthesized by the abstractor:

1. That students exposed to the TSLS teaching strategy would select outside help when confronted with a problem situation.

2. That students exposed to the SSLS teaching strategy would select active independent investigation in a problem situation.

Rationale

The study is identified as one facet of a comprehensive research project at Florida State University. The overall objective of the larger project was to study the effects of two contrasting teaching strategies on certain aspects of student behavior. Previous and related research studies, identified by the investigators, include one by Stains (1956) and one by Brookover, et al. (1965). Assumptions, based on the previous research, are:

1. That a positive self-concept is related to higher achievement and improved performance among children.

2. (If) The classroom teacher is the principal "significant other" in molding the student's self-concept as related to a particular

subject area or school setting (then) it seems to be of vital importance that the classroom teacher become aware of those behaviors and strategies which will create a positive self-concept in students.

Research Design and Procedure

The investigators indicate that the contrasting teaching strategies used in the study consisted of controlled classroom facilities, available materials, and quantitatively defined teacher behaviors. The two contrasting teaching strategies are referred to as teacher-structured learning in science (TSLS) and student-structured learning in science (SSLS). Under SSLS the teaching strategy is to "allow" the student to engage in science activities consistent with the individual cognitive and affective characteristics of each student. The TSLS strategy utilized the characteristics of a specific set of science materials to guide and direct the activity of each student. There is no clear indication by the investigators of what constitutes controlled classroom facilities nor of what materials were available. Further, it is not clear as to what "allow" encompasses ~~under~~ SSLS.

To identify teacher behaviors associated with the SSLS or TSLS conditions, the investigators refer to an instrument developed by Mathews, Phillips, and Good and denoted as SCAS. The instrument consists of classroom interaction categories but the acronym is not spelled out nor is any reliability or validity information provided. This instrument was used with and by a group of eight teachers from the Florida State University Developmental Research School during a six-week workshop in the summer of 1972. This workshop was designed to train the teachers to exhibit SSLS and TSLS teaching strategies.

The study, using "approximately" 250 students (10 classes with 25 students per class) in grades 1-5, was conducted during the 1972-73 school year with an eight-month treatment period. At each grade level students were randomly assigned to one of the teaching strategies and remained in either the SSLS or TSLS ~~class~~ for the entire school year. Teams of two teachers were used in grades 1-3 exchanging responsibilities weekly. In grades 4 and 5 the individual teacher assumed the responsibility of teaching both strategies.

Students were pre- and post-tested with two instruments developed by the investigators. An 11-item instrument, "Self-Perception in Science: Part I" (SPS-I) was considered a measure of the child's "science self-concept." It was based on the child's responses to questions which were intended to reveal how the child perceives himself in the science situation with respect to the teacher, peers, and the general activity associated with science. A 12-item instrument, "Self-Perceptions in Science: Part II" (SPS-II) was designed to answer specific questions concerning the way in which students' perceive the problem solving processes of science. The child responds to two different situations: one in which he is personally involved; and one in which a scientist might find himself. In addition, the child is asked in each situation to select one of two modes of operation. In one mode the child or scientist may seek directions from some source for the solution while in the other mode the child or scientist may choose to operate independently to solve a problem. The second mode is further divided into two parts which are called a passive solution (preference to use outside written sources of information) and an active solution (preference to direct manipulation of materials for information).

Content validity of the SPS-I and SPS-II was judged acceptable by the investigators because of the specific nature of the information sought. Internal consistency was determined by means of the Kuder-Richardson formula (KR-20) and, using only pretreatment data from the sample of this study, produced coefficients of 0.85 for SPS-I and 0.79 for SPS-II.

Data were tabled as frequency responses for each item of each instrument with a Chi-square analysis of each item.

Findings

Comparing the combined responses of all students exposed to the TSLS teaching strategy to the combined responses of those exposed to the SSLS teaching strategy there were no group differences in student self-perception at the end of the treatment period as measured by SPS-I.

With regard to SPS-II, items 1-7 called for personal involvement on the student's part (What would you do?) while items 8-12 required the student to respond to someone else's role (What do you think a scientist would do?). The data indicated that students exposed to the SSLS treatment were skewed toward an active independent mode on items 1-7 while the TSLS treatment group were skewed to a seeking outside help mode. In items 8-12 both treatment groups held to the active independent mode.

Interpretations

No inferences are drawn concerning the effect of teacher behavior on the self-perceptions of students enrolled in the elementary sciences programs presented by the study; i.e., SSLS and TSLS strategies. The investigators do propose that the global nature of self-concept defies accurate measure of just one facet of self-image such as that measured by the SSP-I instrument and associated with experience in a science classroom.

Conversely, the investigators felt that the patterns of student responses to the problem solving situations of SPS-II clearly established that certain aspects of teacher behavior can be established to produce predictable changes in student performance.

ABSTRACTOR'S ANALYSIS

If one reviewed the literature concerning self-concept it is possible to find a multitude of articles, many of which are research based, spanning the early sixties and seventies. There are few directly related to instructional strategies. What is of interest is that self-concept studies lack a focus that would result from an agreed-upon definition of self-concept (Shavelson, 1976). This study is no exception, and in fact does not attempt to define self-concept either in terms set forth by the investigators or in terms described in the literature.

The investigators describe the focus of the study early in the report and, at a much later point, describe two hypotheses which the abstractor has attempted to synthesize. The contrasting teaching strategies are described as consisting of three major components: controlled classroom facilities, available materials, and quantitatively defined teacher behaviors. The terms

TSLS and SSLS are then used to refer to the contrasting strategies. It is left to the reader to infer what constitutes controlled classroom facilities and available materials. As far as quantitatively defined teacher behaviors are concerned, these are specified as classroom interaction categories drawn from an instrument identified only as SCAS. No reliability or validity coefficients are reported for this instrument.

Vagueness is also introduced by the investigators indicating a student sample of "approximately" 250 (10 classes of 25) students. What was the actual number of students in each class and in each grade from one to five? Students were randomly assigned to one of the teaching strategies but "how" is not indicated. Fluctuations in the student population are not addressed. The reader is left to infer that this population remained constant over an eight-month treatment period including the pre- and post-testing. In the SSLS strategy how did the investigators arrive at science activities consistent with the cognitive and affective characteristics of each student? Similarly, what are the characteristics of a specific set of science materials in the TSLS strategy?

The control difficulties associated with the variable of one group of teachers (grades 1-3 and presumably six teachers) teaching one strategy, either TSLS or SSLS for the entire period and one group (grades 4-5 and two teachers) using both teaching strategies is not addressed at all. How did the investigators assure themselves that over the treatment period the teachers maintained faithful allegiance to a particular teaching strategy?

A major deficiency arises concerning the content validity of the instrumentation. Notwithstanding the absence of quality standards of measure in the area of self-concept, why wasn't a panel of judges selected from among the investigators' peers in the field of science education?

Data analysis was made with the non-parametric technique of Chi-square. There is nothing which says an investigator must use parametric techniques except the desire to use the most powerful technique consistent with the design of the study and the data produced. Even though nominal data were produced, parametric techniques of analysis of variance and/or covariance could have been used. Indeed, as this abstractor discovered, the investigators have published another report (3) which closely parallels the one reviewed here and which is based on the same population and design. In that report the parametric techniques suggested above were used.

The investigators interpreted the results of the study to support the assertion that certain aspects of teacher behavior can be established to produce predictable changes in student performance. Few of us would quarrel with this statement but we may ask what are these certain aspects of teacher behavior?

One might infer from the written report of a study the conduct of the study itself; e.g., a clear, precise, substantive report would lead one to infer a tight, well organized, specific research study. That is not the case in the study reviewed here.

There has been continued investigation of the self-concept area with most studies examining intercorrelations between self-concept and other constructs, or differences in mean self-concept scores between different populations of students, or changes in self-concept due to some treatment. As suggested by Shavelson (1976), self-concept studies lack the focus that would result from an agreed-upon definition of self-concept, lack adequate validation of interpretations of self-concept measures, and lack empirical data on the equivalence of many self-concept measures currently in use.

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TEACHER CHARACTERISTICS

Moore, Richard W. "A Two-Year Study of a CCSS Group's Attitudes Toward Science and Science Teaching." School Science and Mathematics, 75(3): 288-290, 1975.

Descriptors--*Attitudes; *Elementary School Science; Elementary School Teachers; Higher Education; *Inservice Education; Research; Science Education; *Teacher Education; *Teacher Attitudes; Workshops

Expanded Abstract and Analysis Prepared Especially for I.S.E. by David R. Stronck, Washington State University.

Purpose

The purpose of this investigation was to determine the impact of a four-week summer workshop on the attitudes of the 31 participants toward science and science teaching. The researcher hypothesized that this summer workshop would have a positive effect upon both the science attitudes and the science teaching attitudes of these teachers. Moreover, it was anticipated that these elementary teachers would maintain or possibly even strengthen their attitudes during the two years following the workshop.

Rationale

Especially during the early 1970s, the National Science Foundation (NSF) funded many Cooperative College School Science (CCSS) projects. These projects were designed to help teachers with the implementation of specific new curricula. Because these projects met the obvious, immediate, and practical needs of the teachers, they were very popular with teachers and administrators. Unfortunately, political pressures terminated the funding of such projects after 1975. This investigation considers the impact of a CCSS project on a group of participants seeking preparation as resource persons in the use of one of the "new" elementary school science curricula which had been adopted in their respective schools. The underlying assumption of this investigation was that the conclusions derived from this typical CCSS project would provide some generalizations about most CCSS projects. Hopefully these conclusions would support the funding of new CCSS projects or similar workshops.

The researcher used the Science Teaching Attitude Scales, the only instrument available which is designed to assess elementary-school teachers' attitudes toward science and science teaching. He also observed: "There are no reports of longitudinal studies of these teacher characteristics in the literature." Because this investigation involves the use of the instrument repeatedly over a two-year period, it attempts to make a unique contribution to the literature.

Research Design and Procedure

The research design used in this investigation was the "Time-Series Experiment," a quasi-experimental design. The time-series design requires the presence of a periodic measurement process on some group (or individual) with the introduction of an experimental change into the time series of measurements. The periodic measurement process of this study was the administration of the Science Teaching Attitude Scales five times. The experimental change was the four-week workshop in the summer of 1971, a CCSS project in Butler County, Ohio. Two of the administrations of the Science Teaching Attitude Scales were done before the experimental change: (1) during the Spring of 1971, when the participants were recruited for the workshop; and (2) on June 14, 1971, at the beginning of the workshop. Three administrations were done after the experimental change: (1) on July 9, 1971, at the end of the workshop; (2) during the Spring of 1972; and (3) during the Spring of 1973.

Although the primary experimental change was the summer workshop of 1971, an additional experimental change was the series of twelve meetings held during the academic year of 1971-72. These meetings provided additional support to the 31 teachers who had participated in the summer workshop. Hopefully these meetings would continue the impact of the summer workshop through the following year and would remedy any deficiencies of the workshop. All necessary materials for science instruction were provided for each of the participants through their schools. Only the 31 teachers selected as participants were the subjects of this study.

This investigation describes the teachers as using the "new" elementary-school science curricula. However, neither the title of these curricula nor the specific grade levels are mentioned. The reader might assume that grades one through six were involved. Some of the typical "new" elementary-school science curricula of 1971 were the Elementary Science Study, Science--A Process Approach, and the Science Curriculum Improvement Study.

Findings

The Science Teaching Attitude Scales contains 70 Likert-type items. Forty of these items assess the teachers' attitudes toward science. The remaining thirty items assess the teachers' attitudes toward science teaching. The two parts of the Attitudes Scales are treated as two separate instruments. Analysis of variance among the data showed some significant F ratios at the 0.01 level.

There were no significant differences in the attitudes of these teachers toward science when the following comparisons between scores were made: (1) between the Spring of 1971 and the beginning of the workshop; (2) between the Spring of 1971 and the Spring of 1973. Nevertheless, attitudes toward science significantly improved between the beginning of the workshop and the end of the workshop. These improved attitudes continued between the end of the workshop and the Spring of 1972 without any significant differences. During the year of 1971-72, there were twelve meetings to support the work of the participants. During the following year of 1972-73, there were no meetings; there was a significant decline in the attitudes toward science during that year.

There was no significant difference in the attitudes of these teachers toward science teaching between the Spring of 1971 and the beginning of the summer workshop. There was a significant improvement in scores between the beginning of the workshop and the end of the workshop. Unfortunately, the scores on the attitudes toward science teaching significantly decreased between the end of the workshop and the Spring of 1972. Nevertheless, the scores in the Spring of 1972 were significantly higher than those of the Spring of 1971.

Interpretations

The researcher observed that the significant improvement in teachers' attitudes toward both science and science teaching during the summer of 1971 demonstrated the success of the workshop. On the other hand, the significant decreases in scores on attitudes toward both science and science teaching revealed that the desired changes were unstable. The only definitely observable long-range affect of the workshop on attitudes was some improvement toward science teaching.

The researcher clearly acknowledges that his sample of 31 teachers from a population of 600 teachers is "quite biased." The participants were selected on the basis of their interest and enthusiasm. Since this selection process is typical of many in-service projects, the results of this study "may be generalizable."

ABSTRACTOR'S ANALYSIS

The researcher has attempted to study the difficult topic of attitudes. Because the only instrument used to measure attitudes is the Science Teaching Attitude Scales completed by the participants, the topic is limited to the self-analysis done by the participants. The abstractor has used a similar instrument in a similar way and agrees that this technique can provide valuable information. The abstractor's research considered a single instrument used in six different workshops involving a total of 306 participants; the results were published in 1977 in the article "The Comparative Effects of Institutes for Changing the Philosophy of Teaching Elementary School Science Among Teachers and Administrators" (Strouck, 1977). The abstractor claimed only to measure expressed philosophies of teaching science. He also discovered significant improvements at the end of each institute.

The abstractor's research cited above distinguishes among various new elementary school science curricula. Both teachers and administrators demonstrated significantly different changes in philosophies depending upon the orientation of the curricula. Recognizing these distinctions, the abstractor presumes that the researcher's study on attitudes toward science and science teaching is difficult to interpret because the science curricula are never defined. Many studies have demonstrated that groups of teachers have different attitudes toward different curricula. Without detailed information about the curricula considered within the study, the abstractor cannot relate this study to most other studies which deal with this topic of attitudes.

The study makes an important conceptual contribution to the literature by showing the impact of a summer workshop after two years. Because of limited funds for evaluation, most workshops are evaluated only within the year of funding. Frequently the evaluation is done only at the end of the workshop. This study confirms the existence of a typical pattern which is recognized by many teachers and administrators; i.e., although participants generally reach high levels of enthusiasm for science and science teaching at the end of the workshops, within two years this enthusiasm has disappeared.

The high levels of enthusiasm for the implementation of the Science Curriculum Improvement Study are well described in the recent doctoral dissertation by Geraldine R. Koller: "The Effectiveness of an Implementation of an Elementary School Science Program with a Science Resource Center" (Koller, 1978). This dissertation considers the implementation of a new science curriculum into the 35 elementary schools of Spokane, Washington, during the year 1975-76. The attitudes of these teachers were measured by self-inventories, questionnaires, interviews, and the use of the science resource supply center. Recently the administrators in this same district have observed a significant decrease in the teaching of this elementary school science curriculum. Because they wish to restore the attitudes which prevailed two years ago, these administrators have now ranked another workshop in science teaching as the highest priority of the district.

The importance of this study is its documentation of the difficulty of maintaining improved levels of science instruction in the elementary schools. Officials of the NSF have recognized this problem for many years. This study and the research completed by Geraldine Koller in Spokane show the value of supervision throughout the academic year following a summer workshop. Certainly many school districts are ignoring the consistent findings of such research when they eliminate the functions of science supervisors for the sake of budgetary savings. The research argues that elementary school science supervision is necessary in order to maintain the advantages gained through workshops.

This study makes interesting use of the instrument, the Science Teaching Attitude Scales. Certainly the longitudinal nature of the study through the repeated use of the same instrument is a valuable methodological contribution.

The validity of the study depends upon the appropriate interpretation of this instrument. The abstractor prefers to describe the data as simply the expressed opinions of the participants. The abstractor presumes that the instrument can provide only a weak indication of the actual attitudes of the participants. Probably the observation of behavior is needed to identify correctly the attitudes of the subjects. Koller's study in Spokane measures the use of science materials and therefore directly identifies the behavior of the teachers toward using the new science curriculum.

This study used a quasi-experimental design; i.e., the "Time-Series Experiment." Without the use of control groups, the study lacks the data needed for fully logical conclusions. Because the same instrument was used five times by each participant, there may be a factor of fatigue in the attitude of the participants toward this instrument. Probably each participant at the time of finishing the summer workshop was conscious of any changes made in any response to the instrument. There may have been some deliberate efforts to conform to the changes desired by the director of the institute. The study could have been improved by using equivalent but different versions of the same instrument.

The written report is only three pages in length and omits any details about the activities of the four-week workshop in the summer of 1971 and the twelve meetings held during the academic year of 1971-72. The reader does not know how well the teachers were trained in any new elementary science curricula or even which curricula were considered. The variable quality of different workshops is well explained by D. C. Orlich and J. R. Ezell in their article "Evaluating the Efficacy of an Elementary Science Inservice Education Program" (Orlich and Ezell, 1975). Without knowing details about the workshop and subsequent meetings, the reader is unable to relate this study to other workshops in science education.

This study should encourage others to make longitudinal investigations on the impact of inservice projects. There is a critical shortage of such studies. The abstractor recommends that these future studies should consider more than the expressed opinions of the participants. There should be studies of the type completed by G. Koller who directly observed the use of science materials by the teachers. The knowledge of scientific concepts and processes derived from the workshops can certainly be measured by valid and reliable instruments. Such examinations may demonstrate that workshops do provide a long-term impact on the knowledge and skills of the teachers. The abstractor suspects that the primary reason for the abandoning of science instruction by elementary teachers is the logistical problem of maintaining the materials. An increased use of science resource supply centers by school districts may greatly improve the promotion of science instruction in the elementary schools. Certainly this study suggests that researchers should continue to seek the identifying of appropriate means to maintain the enthusiasm for science and science teaching which usually result from workshops.

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Butzow, J. W. and C. W. Ryan. "Career Choice and Philosophical Values of Student Teachers." Science Education, 59(1):73-81, 1975.
Descriptors--*Career Choice; Educational Research; *Educational Philosophy; Learning Theories; *Student Attitudes; *Student Teachers; Teacher Behavior; *Teacher Education

Expanded Abstract and Analysis Prepared Especially for I.S.E. by Vincent N. Lunetta, The University of Iowa.

Purpose

The measured philosophical value orientation of student teachers was compared with their actual classroom practice. In addition, role preference and personality type were discussed as variables in teacher training and selection. Hypotheses investigated were:

1. If there is a relationship between philosophical position and teaching style, measured philosophical position should be consistent with the philosophical position manifested in an actual sample of classroom teaching;

2. If there is a relationship between philosophical position and student teacher attitudes toward the purpose and method of teaching, questionnaire responses to teaching procedure and the role of the school should be consistent with measured philosophical position;

3. If a student teacher sample is restricted to a narrow range of personality types as defined in Holland's theory and subsequently to a narrow range of vocational choice, there should be a narrow range of philosophical positions measured and operating in such a sample.

Rationale

A major question the authors hoped to examine in the study was whether or not the philosophical belief system of student teachers was related to teaching practice. If no relationships were to be found, they argued that "the philosophical course work of a teacher trainee becomes a vital focus in his professional education." The investigators postulated that "if teachers have a well articulated philosophical position, they will select a learning theory which is consistent with their basic philosophy." The authors cite and briefly discuss "recent research" that supports the work of Holland (Making Vocational Choices: A Theory of Careers, Prentice-Hall, 1973) presenting evidence that individuals select occupations consistent with their perceptions of self and values.

Research Design and Procedure

Data in the study were received for 18 student teachers at the University of Maine (12 females and 6 males) from a total of 40 who had been randomly invited to participate. Data on these subjects were gathered from the following sources:

The Ames Philosophical Belief Inventory (Counselor Education and Supervision, 7:335-339, 1968);

An audio-tape of a teaching lesson of the student's choice made at the mid-point of student teaching;

A questionnaire assessing the student's prior educational background and vocational choice and his view of "purposes and procedures inherent in teaching methods and schools";

A questionnaire administered during the final week of student teaching assessing career choice and educational belief.

A ten-minute segment from each audio-tape was selected at random and rated for "teaching style." Each investigator "judged the segment on manifested teaching behavior, the curricular pattern and the predominant teaching method. A single philosophical descriptor was assigned by each investigator. No differences in overall judgment were found for any student teacher when independent judgments were compared." These ratings of teaching style were then compared with scores on the Ames Philosophical Belief Inventory. A listing of previous vocational choices by each student was examined to determine if the predominant psychological orientation would be of the "social-type" and to observe whether those choices would fall in the same category as the student's "personality orientation." Career choices were classified according to the scheme developed by Holland and then compared with philosophical position. Student responses to questions assessing attitudes toward teaching and schools were rated by each investigator independently according to a scheme they had devised enabling them to classify these responses in a particular philosophical position. Differences in ratings between the two investigators "were discussed and a single philosophical position for each response was agreed upon."

Findings

The teaching behaviors identified from the audio-tapes bore little resemblence to the student teachers' philosophical positions as measured by the Ames Philosophical Belief Inventory (APBI). Fifteen of 21 student teachers were classified in the Realistic category on the basis of manifested teaching behavior. (Information provided in the paper is not sufficient to allow the reader to know whether or not the six students classified in this APBI category were among the fifteen who were reported to behave this way.) Between three and five students were classified in each of four other philosophical positions according to APBI scores while an analysis of the audio-tapes placed the other six students in one of two of the remaining four categories.

There seemed to be "considerable crossing over on a direct versus indirect teaching style and a traditional versus progressive view on school policy." Summary statements developed by the authors from questionnaire responses were:

1. It appears to the student teachers that schools exist to perpetuate the culture...

2. Most of the student teachers viewed the learner as a self-disciplining person. The sample describes the learner more as a highly motivated adult than as a child or adolescent. Views on the use of punishment were mixed...

3. The predominant teaching role preference was a combination of realism and pragmatism. The sample saw the teacher as being very much in control...

4. The pragmatist view of student activity was the model (sic) attitude... (The abstractor assumes the word is supposed to be modal.)

5. The pragmatist view of evaluation was again the modal view...

Questionnaire responses on career choice indicated education as the unanimous current choice. The modal vocational choice for this group was consistently Social with less emphasis on Artistic or Realistic choices. Comparison of career type with APBI scores showed no specific trends.

Interpretations

1. "...the school may demand a more realistic type of action than the student teacher believes in."

2. "Direct interpretations of the data" comparing APBI score categories and attitudes toward teaching and schools "were not possible."

3. "It would seem that our sample has not manifested positions which question the system as it now exists."

4. Evidence gathered in the study supports "the theoretical assumption of Holland that choice of academic measure is a reflection of personality needs." Stability in major field and career choice do appear to correlate.

5. A general conclusion is that the student teacher "operationalizes a more traditional kind of teaching behavior than one would expect from APBI scores... The student teaching situation appeared to be coercive enough to prevent student teachers from modeling their behavior on their divergent philosophical beliefs."

Based on their interpretation of the results, the authors conclude the paper with six questions they claim need to be answered relating to teacher education reform.

This research study may be of interest to persons involved in teacher education, but the authors have not outlined any connections between the data they have collected and the practice of science teaching. Neither have they made connections with previous research in the science education literature. If the study is properly grounded in a body of research from areas outside of science education, that information is not presented clearly to the reader. Certainly science educators ought to have an understanding of the implication of those positions on learning and on subsequent behavior. Yet, the paper does not provide an adequate review of the relevant literature, and the rationale that is presented is very weak.

The authors do not describe the research as a pilot study or as a case study but the data reported have been gathered from an extremely small sample, i.e., complete information was gathered from only 12 female and 6 male student teachers. The authors report that the APBI was administered to a randomly selected sample of 40 students registered at the University of Maine. Yet, they make no comment on the bias introduced when only 18 of the 40 (45 percent) provided all the information that was sought. No information was reported regarding the nature of the 22 students who did not respond. It would be difficult to make inferences from a biased sample of such small size. Certainly the data are insufficient to warrant some of the broad generalizations found in the paper. There are a number of limitations in the data acquisition procedures. One of these results from the effort to classify teaching behavior on the basis of one ten-minute segment of an audio-tape.

The paper includes arguments that are poorly developed logically, and the writing lacks the precision that one hopes for in a scholarly report. To cite one example, the authors claim that "philosophical theories" are cited in Figure 1 (p. 74). Yet, the reader can only find one-word labels of "philosophical position" in the figure followed by some statements of implication for teaching and learning. An example of inference appearing in the paper that is not sufficiently cautious occurs on p. 78. The authors say that "the observed trends suggest that the school may demand a more realistic type of action than the student believes in." The paper has provided no information that would make this inference any more logical than a variety of alternative explanations. For example, it could be argued that student teachers have a very limited repertoire of teaching behaviors due to limitations in their experience. The paper provides no information whatever about the nature of the teacher education program. There is no reason to suggest that the student teachers are capable of displaying the behaviors the researchers thought they could measure. There is no reason to place all responsibility for this observation on the school environment. The authors commit the same error in concluding their paper in their final paragraph (p. 80). The authors write that "the student teaching situation appeared to be coercive enough to prevent student teachers from modeling their behavior on their divergent philosophical beliefs." The inference may be valid, but there is certainly no reason to assert that it is a conclusion as the authors do.

In discussing the data and results, there are no comments referring directly to the hypotheses that were to be investigated. Surely, these hypotheses should have been central to the discussion of results of the study. The investigators suggest a number of implications and new questions to be investigated, but it is difficult for the reader to see what has been accomplished by the study. The authors also do not comment on many of the limitations inherent in their study, and they do not suggest ways that these limitations could be overcome in future studies of this kind.

LaShier, Jr., W. S. and J. W. Nieft. "The Effects of an Individualized, Self-Paced Science Program on Selected Teacher, Classroom and Student Variables-ISCS Level One." Journal of Research in Science Teaching, 12(4):359-369, 1975.

Descriptors--*Curriculum; *Educational Research; Science Education; *Secondary Education; Secondary School Science; Science Course Improvement Project; *Student Opinion; Teacher Characteristics

Expanded Abstract and Analysis Prepared Especially for I.S.E. by Dorothy Gabel, Indiana University.

Purpose

The primary purpose of this study was to determine whether students in ISCS classes had different perceptions of activities in their classrooms and of teachers' characteristics than had students in non-ISCS classes. In addition, differences in attitude toward science, perception of classroom activities and teacher characteristics of high and low ISCS achievers were examined.

Five hypotheses were tested:

1. There is no relationship between the change in student perception of classroom activity in classrooms that implemented ISCS materials and change in classrooms that continued non-ISCS courses.

2. There is no relationship between students' cognitive achievement progress in ISCS and their perception of classroom activity.

3. There is no relationship between student perception of teacher's personality traits and the student's experience in classrooms where ISCS materials were implemented or where teachers continued teaching a non-ISCS course.

4. There is no relationship between students' cognitive achievement progress in ISCS and their perception of teacher variables of warmth, demand, and use of intrinsic motivation.

5. There is no relationship between student cognitive achievement in ISCS and student attitude.

Rationale

ISCS is a self-paced laboratory-oriented science program in which the teacher assumes a role different from that of a conventional teacher. The teacher guides students through the materials and has more personal interactions with the students. This new role and activity orientation should change students' perceptions of both the teacher and classroom activities. In addition, because the program focuses on science processes there may be differences in science attitude resulting from ISCS instruction.

Vickery (1968) reported that ISCS teachers' behaviors were different from non-ISCS teachers. This study examines students' perceptions of these differences. Gentry (1969) reported that ISCS teachers thought that the program contributed to the development of scientific attitudes. This study examines the effect on attitudes.

Research Design and Procedure

The sample consisted of 150-200 seventh grade students in Kansas whose teachers volunteered to participate in the study. (Number varies according to hypothesis tested.) The ISCS students were randomly selected from 600 students for whom data were complete and the non-ISCS, from 200 students. Non-ISCS teachers used a laboratory approach to teaching science.

The study really consists of three substudies with different means of analysis for each. Each will be considered separately below.

1. Hypotheses 1 and 3 were tested using a pretest-posttest control group design with independent samples for the pretest and posttest.

$$\begin{array}{llll} R & O_1 & X & O_2 \\ R & O_3 & & O_4 \end{array}$$

   The treatment consisted in being enrolled in an ISCS or non-ISCS classroom. One hundred students in each group comprised the sample. Students' perceptions of classroom activities were measured by a 32-item Classroom Activity Checklist (CAC) modeled after a Biology Activities Checklist developed by Kochendorfer (1967). The instrument gives information about (1) the role of teachers in the classroom, (2) student classroom-participation, (3) use of the textbook, (4) design and use of tests, and (5) laboratory activities.

Students' perceptions of the teacher's personality were measured using a modified form of a student inventory (WDM) developed by Reed (1961). It contains 36 items that measure students' perceptions of teachers' warmth, motivation, and demand. Data were analyzed using a multivariate analysis of variance for the five areas of the instrument, and the interaction effect examined.

2. Hypotheses 2 and 4 were tested using 150 ISCS students who were classified as high, average, or low achievers by considering scores on the achievement tests and the number of tests taken. The design was a posttest only design,

$$\begin{array}{lll} R & X & O_1 \\ R & & O_2 \end{array}$$

with the "treatment" equivalent to the student's achievement-progress ranking. Scores from the CAC and the WDM tests were analyzed using analysis of variance for the upper and lower third of the students.

3. Hypothesis 5 was tested with 150 ISCS students using a pretest-posttest design;

$$\begin{array}{llll} R & O_1 & X & O_2 \\ R & O_3 & & O_4 \end{array}$$

ISCS students were classified as for Hypotheses 2 and 4 above. The students were administered in the fall and spring of the school year those parts of the Moore and Sutman (1970) Scientific Attitude Inventory (SAI) that measured attitudes toward science as an approximation of truth and subject to change, science as empirically based, and science as a career. An analysis of covariance with the pretest as the covariate was used to examine the data.

Findings

1. Hypothesis 1 was rejected at the 0.01 level of confidence. Treatment variance was due to the sections of the instrument attributed to the role of the teachers in the classroom and student classroom participation.

2. High achievers perceived student participation, examinations, and laboratory activities in the ISCS program differently than did low achievers.

3. Hypotheses 3 and 4 were not rejected.

4. Attitudes of high ISCS achievers toward science as an approximation of truth and empirically based were higher than were attitudes of low ISCS achievers.

Interpretations

The authors of the research concluded that the ISCS program is consonant with its philosophy in that students enrolled in the program perceived the teacher's role and the classroom activities differently than did non-ISCS students. The high ISCS achievers also perceived the classroom to be more like the "ideal" ISCS classroom than did the low achievers.

The students, however, did not perceive any differences in the ISCS teachers' personality that might be expected from the self-paced, student-centered ISCS course. The cause of this may be due to the use of the student inventory that may be outdated.

The authors also concluded that ISCS high achievers had better attitudes toward two aspects of science than did low ISCS achievers at the end of the course.

This study is best classified as an evaluation study of the ISCS curriculum project. It makes a significant contribution in this area because of the large number of students from whom data were collected and the length of time over which the study extended. Because the authors do not carefully define the differences between the ISCS program and other laboratory programs to which it was compared, generalizations beyond the ISCS program are not appropriate.

The major flaw that is evident in this study arises from the instruments that were used in the study. The four instruments that were used were the Classroom Activity Checklist (CAC), the Student Inventory (WDM), the Scientific Attitude Inventory (SAI), and an achievement test. The first three instruments were modified for the study, the last designed by the authors. Reliability coefficients were not reported for the new or modified instruments. In fact, the only reliability coefficient reported was for the WDM. In addition to this, comparisons were made using subscales of these instruments. Although this may be acceptable for the WDM where subscale reliability coefficients were reported, it is inappropriate for the SAI. The total reliability of this 60-item test using tenth grade students is 0.934 (Moore and Sutman, 1970). The investigators in this study used only half of the test and analyzed scores from subscales of 10 items each. I have found that the reliabilities of the subscales ranged from 0.2 - 0.6 on this instrument using a test-retest procedure on a study conducted at Indiana University.

Another difficulty in the use of the SAI in this study is that it is administered to seventh grade students when it was originally designed for tenth grade students. Although the high ISCS achievers probably would not have difficulty in reading the test items, the low achievers might. This could cause spurious differences between groups in testing Hypothesis 5. This once again points out that although studies may be carefully designed in many respects (as is this one), great care must be taken in the selection and design of the instruments to avoid reaching uninterpretable conclusions.

In general, the reporting of the research in this article is quite clear and understandable. The addition of the sample size and the maximum score possible to the tables would aid the reader in the interpretation of the results.

For example, in Table IX, it would be helpful to know what value of the SAI indicates a positive, negative or neutral attitude.

Another suggestion for improving the study lies in the testing of Hypothesis 5. Instead of determining whether these are differences in attitude toward science between high and low ISCS achievers (which one might expect in any science program), it may be of more value to compare the attitude of ISCS students with students enrolled in other science programs.

In summary, LaShier and Nieft set out to determine the effects of the ISCS program on certain teacher classroom and student variables. They have accomplished this in a limited way because of the instruments used in the study. Care should be taken in interpreting their results because of low instrument reliability.

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INDIVIDUAL STUDIES

Brooks, Marshall and Paul B. Hounshell. "A Study of Locus of Control and Science Achievement." Journal of Research in Science Teaching, 12(2): 175-181, 1975.

Descriptors--*Academic Achievement; *Classroom Environment; Educational Research; Elementary Education; *Elementary School Science; *Elementary Schools; *Locus of Control; Science Education; Vertical Organization

Expanded Abstract and Analysis Prepared Especially for I.S.E. by Donald E. Riechard, Emory University.

Purpose

The purpose was to determine if a student's locus of control was a useful predictor of science achievement in school environments of varying forms of vertical organization. Three specific questions were identified:

1. Do students of the same locus of control achieve the same in science when in schools with different types of vertical organization?

2. Do students with different types of locus of control achieve the same in science when in schools with the same type of vertical organization?

3. Do the student populations of different vertically organized schools have the same distribution of the locus of control construct?

Ten null hypotheses used in examination of the above questions were identified. Each hypothesis, along with a statement on its acceptance or rejection, is given in the Findings section of this abstract.

Rationale

The rationale for this study is grounded in the authors' belief that intelligence tests have not been useful predictors of student success in science. They feel that interaction among variables has been ignored. The relationship of locus of control and its (locus of control) use as a predictor of achievement in some areas other than science is given. Five assumptions relative to the rationale were identified.

This study is referenced to the research of several persons. Among them are Bialer, Butterfield and Weaver, Davis and Phares, Eisenmen and Platt, Lavin, Miller, Rotter, and White and Howard.

Research Design and Procedure

The research design was a static-group comparison which is a pre-experimental design applicable to situations that do not permit manipulation of independent variables. The design is diagrammed by Campbell and Stanley (1963, pp. 182-183) as follows:

$$\begin{array}{cc} X & O_1 \\ \hline & O_2 \end{array}$$

Three pairs of elementary schools were used in the study. One member of each pair was a non-graded school with a policy of continuous progress of learning and multi-age grouping in grades 1-3. The other member of each pair was a graded school. Schools were matched on science curriculum, socioeconomic level, and racial composition.

Testing was done over a two-week period. Students who had entered first grade and were in their third year of attendance were administered the Children's Locus of Control Scale (CLOC) and the Stanford Achievement Test in Science (SATS).

Students were categorized into high, midmost, and low groups based on CLOC scores. Some of the data were presented in tables. Statistical significance was analyzed by the t-test.

Findings

Findings are summarized by the following statements on acceptance or rejection of the null hypotheses defined in the report:

1. There will be no significant difference in science achievement between students scoring high on the CLOC attending non-graded schools and the students scoring high attending graded schools. Accepted.

2. There will be no significant difference in science achievement between students scoring midmost on the CLOC attending non-graded schools and students scoring midmost attending graded schools. Accepted.

3. There will be no significant difference in science achievement between students scoring low on the CLOC attending non-graded schools and students scoring low attending graded schools. Rejected.

4. There will be no significant difference in science achievement between students scoring high on the CLOC attending graded schools and students scoring low attending graded schools. Accepted.

5. There will be no significant difference in science achievement between students scoring high on the CLOC attending graded schools and students scoring midmost attending graded schools. Accepted.

6. There will be no significant difference in science achievement between students scoring midmost on CLOC attending graded schools and students scoring low attending graded schools. Accepted.

7. There will be no significant difference in science achievement between students scoring high on the CLOC attending non-graded schools and students scoring low attending non-graded schools. Rejected.

8. There will be no significant difference in science achievement between students scoring high on the CLOC attending non-graded schools and students scoring midmost attending non-graded schools. Accepted.

9. There will be no significant difference in science achievement between students scoring midmost on the CLOC attending non-graded schools and students scoring low attending non-graded schools. Accepted.

10. There will be no significant difference in locus of control between third year students attending non-graded schools and third year students attending graded schools. Rejected.

Interpretations

The findings suggest that a sustained classroom environment has an influence on the student's locus of control. It also appears that the interactions between a student's locus of control and his classroom environment may affect his science achievement.

ABSTRACTOR'S ANALYSIS

New Conceptual Contributions

The investigation introduces the nature of school organization (graded or non-graded) as a possible factor related to students' locus of control and achievement in science. This seems to be a new thrust in the locus of control research. In fact, this abstractor is not aware of a single study (other than this one) which examines the same relationships. Since the results are not definitive, it is satisfying to note the authors' caution as they state that findings suggest the relationships to be only at "a level of suspicion." The relationships do, however, appear to offer a potentially fruitful direction of study.

Validity of the Study

While questions about the research design and its application (see below) might be raised, there is a good bit of data from which to argue the validity of the instruments used (CLOC and SATS). In drawing inferences from the study, however, it is advisable to question what is actually measured.

Given the authors' interpretations, one might ask, for example, what kind of "science achievement" is actually measured by SATS. It is not the purpose of this review to open debate on the SATS. However, when interpreting results, researchers need to determine if the "science achievement" identified is a measure of factual information, concept development, process or inquiry skills, psychomotor abilities, affect, or other things. It is this abstractor's guess that different loci of control and different types of school environments might have a differential effect on <u>different kinds</u> of "science achievement."

Research Design

The static group comparison used in this study suffers from several weaknesses. A major one identified by Campbell and Stanley (1963, p. 182) is that there are "no formal means for certifying that the groups would have been equivalent had it not been for the X." The matching technique used was an attempt at overcoming that weakness. However, it should be pointed out that many researchers do not hold matching in high esteem as a method of assuring that groups are equivalent. In addition to weaknesses of the design related to equivalency and selection of groups, Campbell and Stanley (1963, p. 178) also point to weaknesses under mortality, interaction of selection and maturation, and interaction of selection and X.

In all fairness to the authors, the difficulty of designing true experimental studies in behavioral research should be recognized. Most educational researchers, including this abstractor, have found problems especially acute when attempting to study someone else's children in someone else's school!

The Written Report

The written report is adequate in conveying what was done. However, from a technical point of view several observations can be made. For example, the alpha level at which a t-value was considered significant was not given. It appears that a value at the 0.01 level caused null hypotheses to be rejected. In some instances, however, it is reported that a given t-value "is not significant at the 0.05 level" and the null hypothesis is "accepted." In other cases, it is simply stated, without identifying a level at all, that a t-value "is not significant."

There also seems to be some inconsistency in the presentation of results. While ten hypotheses were tested, only the data from four of the tests are presented in table form. Three of the tables summarize data on the three rejected hypotheses and one table summarizes data on one of the seven "accepted" hypotheses. The reason for this unique presentation of results is not apparent.

For the reader unfamiliar with the CLOC, it would be helpful had the authors given more information on scores and scoring. How were "high" and "low" scores determined, for example, and how do these scores relate to "internal" or "external" locus of control?

It would be of interest also to know the total number of students from each school. An idea of the total population can be inferred from the tables but a more complete breakdown of the population would have been appropriate under the procedures section.

The discussion on categorizing the CLOC scores into high, low, and midmost was confusing. A primary point of confusion was with the values reported as T-scores. What is reported actually appear to be z-scores. Considering them to be, in fact, z-scores, a conversion table suggests that the "midmost" scores were those which fell between the approximate percentile ranks of 35 and 68 (Clark, et al., 1965, p. 102). The "low" and "high" scores would fall below and above those respective ranks. If this is a correct interpretation, it might have simplified the matter had percentile ranks been stated.

The careful reader will note that one study in the reference list (Crandall, et al.) is not mentioned in the text. Such an omission is not an uncommon occurrence in research reports but should be avoided when possible. The omission of the text reference in this paper does not adversely affect the quality of the report, however.

Suggestions for Future Research

There is a relatively large body of literature on locus of control and this study is referenced to some of the major investigators in the field. Little research exists, however, which deals with locus of control relative to levels of school organization and science achievement. There appears to be a need for further research.

Some suggestions on future research can be made. For example, the research of Miller (referenced in this study) suggests that a subject's sex might have an important bearing on his/her locus of control. Is there an age at which sex or maybe social expectations for a given sex relate to locus of control and science attitudes and achievement? Do boys and girls differ in their abilities to cope with different types of school organization?

The issue on the meaning of "science achievement" was raised above in the discussion on validity. One might explore relationships between locus of control and different measures of science achievement.

The Miller instrument (referenced in this study) can also be used to determine locus of evaluation. How does this measure relate to science achievement or to levels of school organization? Would other instruments for measuring locus of control produce the same results as the instrument used in this study? If one is interested in exploring the last question, he/she might want to examine the locus of control scale developed by Nowicki and Strickland (1973).

As a matter of avoiding some of the seaknesses of design identified above, the researcher is advised to consult Campbell and Stanley (1963). And, of course, the use of some of the covariate analysis programs could simplify the treatment of data involving numerous variables.

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Descriptors--Educational Research; *Evaluation; *Inquiry Training; Science Education; Secondary Education; *Secondary School Science; *Scientific Methodology

Expanded Abstract and Analysis Prepared Especially for I.S.E. by Russell H. Yeany, University of Georgia.

Purpose

The purpose of the study, though not stated in specific terms by the authors, was to assess the "Understanding of the Nature of Scientific Enquiry" (UNSE) skills of Israeli BSCS students through the analysis of the results on a sub-section of the 1971 written Israeli BSCS--Matriculation Examination. This test was constructed to serve the purpose of a national science examination as well as a research instrument.

Rationale

Previous data on Israeli student achievement related to BSCS enrollment were collected with a measure that was judged to have validity problems related to measuring: (1) knowledge of the rules of methodology, and (2) ability to design and experiment. Also, the measure asked the student to design an experiment and followed with questions which were based on the experiment; therefore, the students were responding to dissimilar situations. A third concern with the measure was that the level of task-sophistication varied with the type of experiment designed by the student. There was a diagnosed need to design an instrument that overcame these validity problems when used as a matriculation examination of biology achievement.

Procedure

A measure was developed which consisted of an approximately 325-word passage and a data table on oxygen poisoning in insects. This was followed by eight questions (one had two parts) which measured the subject's ability to interpret the experiment and the table, knowledge of statistics and rules of experimentation, ability to formulate a hypotheses, and ability to design and experiment.

The test was administered to 269 Israeli students who had studied the BSCS Yellow Version in grades nine through eleven as part of the BSCS Second Course in grade twelve. The students were from nine urban secondary schools, five rural schools and an agricultural secondary boarding-school. No pre- or pilot-testing of the test occurred before this study.

All items on the test used an open-response answer format. The answers were read by two markers who had detailed instructions on interpreting students' responses. The mean of the two markers was used as the student's score was 35 points. Inter-marker reliability was r = .74.

Findings

The results were reported item by item as well as by sub-tests which represented levels of cognition (e.g., knowledge, analytical, and constructive mode). Success on the items ranged from a low of 39 percent to a high of 82 percent. The overall mean for the 35-point test was 20.27 points or 58 percent.

The authors analyzed the relationship between sub-test scores and reported significant correlations between knowledge of conventions and constructive mode (r = .18), knowledge of conventions and analytical mode (r = .26) and analytical mode and constructive mode (r = .42).

The open response answers were further analyzed for the blind use of terms (i.e., "magic words") in contradiction to the data given. The misuse of these words (e.g., control, sample, and replication) occurred in 29 percent of the cases.

The results related to the students' ability to formulate hypotheses and design experiments indicated that 64 percent could formulate an accurate and relevant hypotheses; 86 percent designed an experiment relevant to their hypothesis; and, 15 percent designed an adequate experiment.

Interpretations

The authors concluded that the BSCS biology curriculum has not had the desired impact on the student population. A total mean score of less than 70 percent was considered inadequate. The authors pointed out that since the test was given as part of a matriculation examination, the motivation and results were considered as maximal.

Knowledge, it was concluded, was not a sufficient condition for success in demonstrating the understanding of the nature of scientific enquiry (USNE) at the higher levels). Also, there was no clear unidirectional hierarchy involved in UNSE.

Another conclusion was that, for one-third of the population, enquiry concepts remained "a set of magic words" and that the BSCS courses could be improved by adding a series of research papers of increasing difficulty and complexity of design.

ABSTRACTOR'S ANALYSIS

It was difficult to sort out whether the authors were primarily interested in pilot testing a new instrument (or instrument format) or assessing the enquiry skills of the Israeli students. When both are engaged in simultaneously, conclusions about the latter are only valid to the degree that the instrument meets standards which insure its validity and reliability.

In relation to the attempt to develop an instrument which measures the understanding of the nature of scientific enquiry (UNSE), several problems need to be cited.

First, the inter-marker correlation coefficient is reported as if it were the only reliability of interest. It is not. There is still a question of the reliability of the instrument itself. With only eight items on the test, there is a high probability that this value is low. No efforts to assess instrument reliability (i.e., split-half, test-retest, or KR-20) were reported. Because of this, the correlations among the sub-scores must be held as tentative findings. Also, the conclusions about the lack of any hierarchy in UNSE may be questioned until more information is available on the measure's reliability.

Second, the authors are expecting a lot from a single measure consisting of eight items, all of which relate to a single experiment. There is no way to determine if the data can be generalized beyond the single limited context of the Oxygen Poisoning in Insects report. The measure needs to be expanded to include several parallel instances and assess the correlated success of subjects in different experimental contexts in order to determine the validity of using a single context to measure the UNSE skills.

In relation to the attempts to measure the UNSE of the Israeli students, the authors' conclusions must be recognized as being based on very tentative data. Until the measure is further tested for reliability and validity, no hard-fast conclusion can be drawn.

This research report points out a common flaw in educational research that can best be defined by anology--we should not attempt to build the basement and the roof of the house at the same time. The assessment of pupil outcomes must be based upon a sound investment of energies in the development and pilot testing of adequate instrumentation.

It is not impossible to develop and field test an instrument while collecting important information on a criterion variable. But, it should be done with extreme caution; confounded results lead to confounded conclusions.

Swain, J.R.L. "Teacher and Pupil Attitudes to the Nuffield Physical Science Course." School Science Review, 57(199):357-362, 1975.
Descriptors--*Curriculum; *Curriculum Evaluation; *Educational Research; *Physical Sciences; Secondary Education; Secondary School Science; Student Attitudes; Teacher Attitudes

Expanded Abstract and Analysis Prepared Especially for I.S.E. by Richard J. Bady, Mount Senario College.

Purpose and Rationale

The purpose of the study was to survey users of the Nuffield Physical Science course to compile information on teachers' and pupils' perceptions of the course's structure, time allocations, difficulty, and interest. The survey also gathered information on attributes of the schools and teachers who use Nuffield Physical Science, but these data were not discussed in the report.

Research Design and Procedure

Questionnaires were sent to all the schools using the course. The response rate was 92 percent. Data were collected from 178 teachers and 596 pupils.

Findings

Course Structure and Time Allocations

A majority of the teachers (69 percent) said the course needed either minor or no modifications. The remainder said major revisions were needed. Student response was similar. Seventy-one percent of the teachers said that more than the recommended eight periods per week would be required to complete the course. About two-thirds of both the teachers and the pupils said that the course presented a good balance of chemistry and physics (this was a goal of the course's developers).

Course Difficulty and Interest

Both teachers and pupils reported that the difficulty of the course varied greatly from topic to topic. There was fair agreement between teachers and pupils as to which topics were most difficult. The relative interest in each topic by pupils was also given. Further, it was noted that there was little or no relationship between levels of interest and difficulty, and little or no relationship between levels of interest and performance on examinations for the various topics.

Interpretations

The author concluded that since 31 percent of the teachers indicated that the course needed major changes, these results should be noted by the course developers. He further advises that the course should be shortened. While he points out that it is striking that interest level and test performance were not related, he offers no explanation for this finding.

ABSTRACTOR'S ANALYSIS

The study provides information that is of particular importance to course developers. The findings about pupils' perceptions of topic difficulty are also of interest to classroom teachers. However, none of the information is terribly new or surprising.

While the response rate was excellent, the questionnaire itself is described too briefly to draw any further conclusions about the validity of the data.